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STUDIES IN STYLIDIACEAE: NEW TAXA, FIELD
OBSERVATIONS, EVOLUTIONARY TENDENCIESSHERWIN CARLQUIST¹*Claremont Graduate School, Claremont, California 91711*

INTRODUCTION

Stylidiaceae is a distinctively Australian family: 134 of the 137 valid species of *Stylidium* now known occur in Australia, 129 are endemic to Australia. The second largest genus, *Levenhookia* (now 10 species), is endemic to Australia. Of the three smaller genera, *Phyllachne* and *Forstera* are represented by one species each in Tasmania, and only the monotypic *Oreostylidium* is absent from Australia. Species of *Forstera* other than *F. bellidifolia* are endemic to New Zealand, as are *Oreostylidium* and two of the species of *Phyllachne*. One of the New Zealand species of *Phyllachne*, *P. colensoi*, is present in Tasmania; *P. uliginosa* is endemic to Tierra del Fuego. *Stylidium* extends beyond Australia only to the north and west: New Guinea, Indo-Malaysia, southeast Asia.

On the basis of numbers alone, Stylidiaceae obviously has diversified mostly within Australia. The products of this diversification tell us much about the nature of plant evolution in Australia. In addition, there are unique evolutionary phenomena within Stylidiaceae. The area of Australia in which by far the majority of Stylidiaceae occur in southwestern Australia. Perhaps the good dispersibility of their minute seeds has permitted Stylidiaceae to reach southwestern Australia in preference to other families, and perhaps Stylidiaceae were pre-adapted for the soil and climate of southwestern Australia. The new taxa proposed in this paper are all from southwestern Australia, and very likely a few new species still remain to be discovered there.

Taxonomy has been the overriding concern of studies to date. Australian plants are still not well known, so this focus is an understandable one. In fact, my field work in Australia has led me to describe 11 new species and seven new subspecies of Stylidiaceae, as well as to reduce a number of species currently recognized. While this paper deals with taxonomy, I wish to stress the many other facets of Stylidiaceae which have as yet received

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scant attention: anatomy, cytology, pollination biology, and phytochemistry, for example.

ORIGINS; RELATIONSHIPS OF THE GENERA

The question of to which family Styliaceae is most closely related has not been raised very often, perhaps because it is a family with which few botanists are familiar. The alleged relationship of *Donatia* to *Styliaceae*, and of both to *Campanulaceae*, *Asteraceae*, etc., seems to hinge solely on the presence of inulin (Mildbraed, 1908). Otherwise, there is no compelling reason why *Donatia* should be closely allied to *Styliaceae*. Viewed from the standpoint of morphology alone, *Donatia* could just as easily be placed in *Saxifragaceae*—or other families. *Donatia* shows no evidence of the peculiar column which seems to me the most significant single feature in definition of *Styliaceae*. The fact that *Phyllachne* (Fig. 3-4) is a cushion plant resembling *Donatia* in habit might be entirely a parallelism. *Oreostylidium* (Fig. 2) and *Forstera* (Fig. 1) which are not cushion plants, have virtually the same floral morphology as *Phyllachne*. The fact that both *Phyllachne* and *Donatia* occur in Tierra del Fuego, New Zealand, and Tasmania has undoubtedly proved very suggestive. The distribution pattern might suggest either *Campanulaceae* or *Saxifragaceae* as likely relatives of *Styliaceae*, because those families are well represented in far southern regions. The question of relationship of *Styliaceae* needs to be reopened, and the treatment of Thorne (1968) is useful in this respect.

Evolution within *Styliaceae*, regardless of its origins, can be followed because a number of intermediate stages are still extant. That *Phyllachne* and *Oreostylidium* have more numerous primitive characteristics seems certain. These genera have acquired the column which bears both stigma and anthers, and which seems so basic to *Styliaceae*; these genera do not, however, have a sensitive column. As in the other genera, *Phyllachne*, *Oreostylidium*, and *Forstera* have stigma papillae which elongate only after anthers have opened and withered, and thereby have a form of protandry. *Stylidium* has a sensitive column, while *Levenhookia* has a sensitive labellum. All of these devices would seem to aid or insure cross-pollination and may be of value where population size is small, as it probably is in the relatively restricted areas where most species of *Styliaceae* grow natively. A shift from cross- to self-pollination has occurred in a few species of *Stylidium* and *Levenhookia*, as described below.

The nature of the transition from *Forstera*, with actinomorphic flowers and a non-sensitive column, to *Stylidium*, with zygomorphy and a sensitive column, is suggested by *Forstera bellidifolia*. This species has a shorter fifth corolla lobe, corresponding to the labellum of *Stylidium*. Indeed, the similarities in floral structure between *Forstera bellidifolia*, *Stylidium* subgenus *Forsteropsis* (*S. imbricatum* and *S. preissii*), and *Stylidium* subgenus *Centridium* (*S. calcaratum* and *S. perpusillum*) are striking. These groups also agree in the non-septate placenta. *Phyllachne* and *Oreostylidium*, however, have a capsule incompletely septate, a characteristic of most subgenera of *Stylidium*. *Stylidium* subgenus *Nitrangium* section *Rhynchangium* (*S. rhynchocarpum*, for example) have capsules with a septum running the length of the capsule. While one might hypothesize a series in loss of septum,

there is a possibility that there could be secondary increase in septation as well as loss. Presence or absence of septa may be related to particular types of dehiscence and dispersal, and should be studied in that context.

ECOLOGY AND HABIT

One suspects that Stylidiaceae stem from ancestors which prefer acidic or mineral-poor soils. *Phyllachne* and *Forstera* occur in locations rich in Epacridaceae and shrubby conifers. *Oreostylidium* is restricted to the pakihi bogs of New Zealand, bogs in which *Drosera* is a characteristic plant. *Stylidium* in Australia basically seems to favor such localities — but these localities in Australia are only seasonally wet. In Western Australia, the majority of *Stylidium* species occur in sand heaths where *Drosera* and Epacridaceae may be found, sand heaths wet or inundated in winter but quite dry in summer. As compared to *Phyllachne*, *Oreostylidium*, and *Forstera*, *Stylidium* represents adaptations for survival during the dry seasons. *Levenhookia* likewise is adapted to a short growing season by virtue of its ephemeral qualities.

Whatever the ancestors of Stylidiaceae are, they seem to have lost the capability for true secondary growth prior to the origin of this family. *Stylidium laricifolium* has anomalous secondary growth, but only in limited quantity. The peculiar growth forms of Stylidiaceae seem closely related to inability to form woody stems. The prominent tendency in *Stylidium* for new stems to form adventitious roots, and for plants to stand upon these “stilt roots” is illustrative of this. In cushion plants, such as *Phyllachne*, adventitious roots simply grow downward from young stems through older parts of the cushion and eventually reach the soil.

The creeping habit, exemplified by *S. repens*, *S. adpressum*, *S. bulbiferum*, etc., is another expression of growth form related to lack of secondary growth. These species almost invariably form their stems not at the soil surface, but above it, parallelling the surface. During the wet season, aerial roots are sent down to the soil level, and the stolons remain one to several inches above the ground. This habit might represent a means of avoiding excessive heat or cold at the soil surface.

The rosette species of *Stylidium* resemble the habit of *Oreostylidium*, or could even be regarded as a small segment of a cushion plant. Some of the rosette species can form elongate stems under special conditions. These have been named as varieties (*Stylidium amoenum* var. *caulescens*, *Stylidium corymbulosum* var. *proliferum*, *Stylidium fasciculatum* var. *elongatum*, *Stylidium spathulatum* var. *lehmannianum*). Most of these should probably be dropped, for they may be little more than shade forms.

Three groups within *Stylidium* have stems rather evenly covered with leaves: subgenus *Forsteropsis* (*S. imbricatum* and *S. preissii*), subgenus *Stylidium* section *Sparsifoliae* (*S. laricifolium*, *S. glandulosum*), and subgenus *Nitrangium* section *Rhynchangium* (*S. rhynchocarpum*, etc.). These species tend to be small shrubs, limited in size by inability to form woody stems. Aerial roots must continue to form, for older roots can last for only one or two seasons, apparently. If aerial roots form on newer stems, then older stems die, one shrub can form several, and thereby the stature of any given plant tends not to be very great. Adaptation to fire may also

limit the size of a plant. For example, *S. falcatum* forms innovations from a swollen callus-like structure just beneath the soil level. Where I studied this species in the Tutanning Reserve (Carlquist 3956), many plants with old, charred stems but new stems grown from the base could be seen.

Ephemeral annual species of *Stylidium* seem obviously an adaptation to the short wet season in Australia. Their ability to grow in temporarily wet situations has permitted them to enter tropical wet situations. The tropical ephemeral *Stylidium* species have penetrated into southeast Asia, and are among the few Australian groups to have done so.

Perennial species of *Stylidium* which oversummer as bulbs (e.g., *S. petiolare*, etc.: Fig. 19–32) have only a few leaves each spring; these do tend to be succulent, and may prolong the growing and flowering season a little thereby, but they dry soon after the soil does. These bulb-forming species are a remarkable parallel to *Phylloglossum* in its tuber size and tuberous habit. *Phylloglossum* can, in fact, be found growing with the bulb-forming ephemeral *Stylidium* species on moist flats in southwestern Australia.

There is some reason to suppose that Stylidiaceae stem from ancestors with linear leaves. *Phyllachne* (Fig. 4) and *Oreostylidium* (Fig. 2) have such leaves, as do most species of *Stylidium*. However, *Forstera* (Fig. 1) and the species of *Stylidium* with a definite lamina suggest derivation from linear-leaved ancestors. Many of these have laminae with venation describable as “flabellately veined,” “striate,” etc. These patterns are suggestive of expansion of a linear midvein, rather than alteration of a typical reticulate pattern. Moreover, toothed margins or margins otherwise related to vein termini are absent. Only *S. barleei* could be said to represent such a condition at all, and this species is almost certainly primitive in a minimum of characters.

FLORAL BIOLOGY; PROBLEMS OF SPECIATION

Why are there so many species of *Stylidium* — at least in southwestern Australia? Southwestern Australia is relatively flat, and topographic features do not seem sufficiently sharp to account for the more than 100 species of *Stylidium* and *Levenhookia* there. There are gradients in rainfall and temperature, yet these are gradual, of the sort one would expect to be correlated with clinal variations rather than sharply precinctive species.

The most obvious source of discontinuities and diversification in environment would seem to be edaphic. Southwestern Australia is a patchwork of white sand, usually derived from quartzite, and laterite (“ironstone”). These two distinctive soil types may occur as tiny pockets, or as broad expanses many miles long. In some areas, sand heath is the discontinuous phase, in others it is the continuous phase. Most *Stylidium* and *Levenhookia* species of southwestern Australia are sand heath plants, but there are a few notable examples of species with a preference for, or at least a tolerance of, laterite. Among laterite-inhabiting species are the *Stylidium caricifolium* complex

Fig. 1–6.—Fig. 1. *Forstera bidwillii* Hook. f., Carlquist 1235, Arthur's Pass, New Zealand. $\times \frac{1}{2}$.—Fig. 2. *Oreostylidium subulatum* (Hook. f.) Berggren, Carlquist 4138, near Westport, New Zealand; the flowers shown are tetramerous, but pentamerous flowers are more frequent. Capsules at upper right. $\times 1\frac{1}{2}$.—Fig. 3–4. *Phyllachne colensoi* (Hook. f.)

Berggren, *Carlquist 4111*, Arthur's Pass, New Zealand.—Fig. 3. Habit. Cushions attain about 1 meter diameter.—Fig. 4. Portion of cushion showing flowers. $\times 1\frac{1}{2}$.—Fig. 5–6. *Stylidium calcaratum* R. Br., *Carlquist 3572*, S. Perth, W.A.—Fig. 5. Habit. $\times \frac{1}{2}$.—Fig. 6. Flowers. $\times 1\frac{1}{2}$.

(see below), *S. bulbiferum*, and *S. uniflorum*. Some stylidiums occupy laterite-derived soils, but only in very wet places, as on flats near the edge of a stream or rivulet: *S. inundatum*, *S. despectum*, and *S. roseoalatum*, for example (Fig. 9–10, 17–18). With some ephemerals, abundance of water seems more significant than type of soil. Some stylidiums grow in laterite areas, but only where there is an accumulation, even as small pockets, on the surface: *S. imbricatum*, for example.

Many more soil types have influenced *Stylidium* evolution in southwestern Australia. For example, *Stylidium pseudohirsutum* (Fig. 98–100) is endemic to the peculiar white clay-like soils near Needilup, whereas a related species, *S. macranthum*, grows only on coarse white sand.

The ranges of mountains and hills in Western Australia seem important in speciation not so much for their elevation, but from the fact that their rock provides mineral and soil conditions different from that of adjacent lowlands. For example, East Mt. Barren, a dome composed of large blocks of white quartz, hosts two species of *Stylidium* not found elsewhere: *S. albomontis* (Fig. 89–91) and *S. galioides*. On white sand at the base of East Mt. Barren one can find *S. pilosum* (Fig. 92–93) and *S. spinulosum*. Many more examples could be cited; for example, *Stylidium verticillatum* is known only from two peaks of the Stirling Range.

Distinctive flower size, shapes and colors in *Stylidium* and *Levenhookia* coupled with several different pollinating insects and a tendency for flower constancy may result in many other isolating barriers. Several bees (*Exoneura hamulata*, *Parasphcodes hirsiventris*, *Adrenopsis velutina*, *Comptosia cuneata*, *Pthiria albocapitis*, and *Paracolletes albopilosis*) are among the insects recorded as pollinators of *Stylidium* species (Erickson, 1958). There are probably more. When several different species grow together, as frequently they do, flower constancy of pollinating insects has been observed (Erickson, 1958). Different flower size and flowers with distinctive corolla conformations seem to offer isolating mechanisms. A tiny ephemeral with a column 3 mm long seems unlikely to be pollinated by the same insect as a flower with a column 15 mm long, and if it were, the insect would be touched by column and stigma on a different location on its body. An obvious difference, which does not seem to have been appreciated, characterizes the *Stylidium* species in which the column operates from below upward rather than from above downward. In the former case, the insect would be touched on its lower surface. This conformation is the less common one in the genus *Stylidium*. Attention was paid to this feature during my field studies. The species in which this inverted floral orientation was observed include *S. calcaratum* (Fig. 5–7), *S. perpusillum*, *S. choreanthum* (Fig. 35), *S. inversiflorum* (Fig. 54), and *S. spinulosum* (Fig. 65, 66). An insect might pollinate both *S. spinulosum* and *S. scandens*, which grow together, without pollen from one being transferred to the other, owing to position in which pollen and stigmas of each species touch the insect. Species of *Stylidium* in which corolla lobes are elongate laterally (viz. *S. repens*, Fig. 33, 34) may be approached by insects in a different direction with respect to the column and its action. Flowers with laterally extended corolla lobes might place pollen on insects in a part of the body different

from the location in which pollen of species with dorsiventrally extended corolla lobes would be located.

The deep-colored dots or other markings at the bases of corolla lobes are probably guidelines for insect visitors. Likewise, the paired knobs or ridges (e.g., *S. insensitivum*, Fig. 22) and the more common types of throat appendages (e.g., *S. caricifolium*, Fig. 102, 104, 106) probably are related to directing insects toward the throat of the corolla. The labellum in most species of *Stylidium* bears (often over much of its surface) a glossy swelling which seems undoubtedly a nectar ruse. *Stylidium lineatum*, *S. rigidifolium*, and other species have such glistening knobs as throat appendages. These various aspects of pollination biology remain virtually unknown, and have not even received speculative comments.

The presence of a widened column, in which stigma or anthers are held against the surface of the column because the column is geniculate, have received comment from Erickson (1958), who terms this conformation a "locket." Erickson and Willis (1955) named *S. sacculatum* on this basis. I have found this type of column in *S. preissii* (Fig. 8) also. This type of column appears to be nothing more or less than a method of achieving self-pollination. Triggering of the column could result in cross pollination in much the same way as with a *Stylidium* with an ordinary column. However, if the column is not triggered, anthers will shed pollen against the broadened surface of the column, and presumably stigma papillae, when they elongate, will pick up the pollen. Thus, self-pollination will result only if insects do not trigger the column. Thus, a favorable mechanism for retaining outcrossing while maximizing seed set is at least theoretically present. This mechanism is much like that in flowers of Asteraceae, where recurvature of style branches eventually results in contact of stigmatic hairs with pollen collected on the outer surface of the style in a single flower.

The significance of the "locket" column does not appear to be appreciated by Erickson (1958), although she does note another mechanism by which *S. schoenoides* can achieve self-pollination. Erickson (1958) hypothesizes a series from facultative self-pollination in *Levenhookia dubia* to obligate cross pollination in *L. preissii*. This series, as discussed below, should, instead, be read in reverse. *Stylidium* seems basically and predominantly an outcrossing group, and *Levenhookia*, which appears a derivative from *Stylidium*, seems also basically adapted to outcrossing.

The importance of field studies in Stylidiaceae is illustrated by the fact that two species of *Stylidium*, one of them new, have insensitive columns, and have thus adapted to new pollinators and new schemes of pollination. These two species, *S. beaugleholei* (Fig. 11) and *S. insensitivum* (Fig. 19-24) are discussed in detail below. Loss of sensitivity in the column provides yet another isolating mechanism within the genus.

Species of *Stylidium* not closely related can mimic each other, and thus attract the same pollinator. Erickson (1958) has noted this for *S. xanthopis*, a mimic of *Levenhookia leptantha*. Likewise, one might note a similarity between *S. calcaratum* var. *ecorne* (Fig. 7) and *Levenhookia pauciflora*. Several of the small ephemeral annual species of *Stylidium* grow together and are rather similar in appearance. There is a strong mimicry between

S. rhipidium (Fig. 12) and *S. insensitivum* (Fig. 19–24), although these two species are not closely related at all. Such mimicry represents convergent evolution subsequent to formation of barriers between the species which mimic each other. They do not represent an isolating mechanism, for the isolation preceded mimicry, undoubtedly.

Isolating mechanisms can break down where hybrids are possible; although hybridity does not seem yet to have been reported in *Stylidium*, I discovered an obvious hybrid between *S. pulchellum* and *S. petiolare* (Fig. 27–28), and what seems best interpreted as a hybrid in the *S. repens* complex (Fig. 34). The nature of sterility — whether caused by genes, chromosome differences, etc. — remains to be elucidated.

DISPERSAL

Temperate (and to some extent, tropical) Australian groups are mostly those which ancestrally had (1) good dispersal; (2) tolerance of relatively low rainfall; and (3) tolerance of salinity, mineral poverty, and other peculiarities common in Australian soils. Relatively few groups have overcome these hurdles. Western Australia can be considered an “island within an island” in these respects. The plant groups which have managed to establish on Australia, and especially in Western Australia, have speciated to an exceptional extent, a measure of strong floristic disharmony.

Most species of *Stylidium* have very small seeds, and one can hypothesize that small seed size has permitted, in particular, the wide distribution of the ephemeral species. The tropical ephemerals have reached from Australia far into Indo-malaysia and mainland Asia on account of minute seeds. Because they grow in muddy areas, these species might have been distributed by water birds; the seed size, however, is so small that a variety of vectors might be hypothesized. One of the tropical ephemerals (subgenus *Andersonia* of *Stylidium*) has reached southwestern Australia also. *Stylidium exoglossum* has the labellum attached on the outer surface of the throat, as well as other characteristics of subgenus *Andersonia*. This species is native in bogs along the southern coast from East Mt. Barren to Point d'Entrecasteaux. These bogs remain wet at the time when the summer heat has arrived, because they occur in wetter and more southerly locations than bogs farther north in Western Australia. Thus, the locations where *S. exoglossum* grows simulate wet flats in tropical regions during the growing season.

Other ephemeral stylidiiums of southwestern Australia do not belong to subgenus *Andersonia*. Some of these occur also in southeastern Australia (*S. despectum*, *S. inundatum*, *S. beagleholei*). There are no annual ephemeral stylidiiums in southeastern Australia other than those, but there are many ephemerals in southwestern Australia. Evidently, the ephemerals of southwestern Australia have originated in the southwest, but the three species mentioned have reached the southeast by means of long-distance dispersal, a dispersal permitted by very small seed size. The same is true in *Levenhookia*, provided that one regards *L. sonderi* as conspecific with *L. dubia*. Then *L. dubia* and *L. pusilla* are in both western and eastern Australia, but the other *levenhookias* are exclusively western.

None of the perennial species of *Stylidium* occurs both in western and eastern Australia. This may be due to specialized ecological requirements of these species. Seed dispersal has been adequate for occasional interchange between the two regions, but evidently successful establishments from west to east or vice versa have been infrequent, so that the perennial species are endemic to one region or the other.

There are, however, some alterations in seed and fruit morphology in Stylidiaceae which constitute loss of dispersibility. The indehiscent capsule of *Phyllachne* might be an example, and this very likely applies to *Oreostylidium*, where tardy dehiscence occurs. A clear example of loss of dispersibility is demonstrated by *Stylidium galioides*, a species with notably large seeds — probably the largest in the genus. These large seeds seem related to precinctiveness, for much the same reasons suggested for insular plants (Carlquist, 1966, 1967). *Stylidium galioides* is restricted to East Mt. Barren, and this seems to show a relationship between precinctiveness and loss of dispersibility.

SYSTEMATICS; FIELD STUDIES

The new taxa, new combinations, and observations offered in this paper are the result of field work undertaken in Western Australia from September to December, 1967. Stylidiaceae were not the primary goal of this field work, but thanks to Erickson's (1958) lucid and readable book, identification of species was easy, and new taxa were readily recognized. Much information gathered in the field could not have been obtained from herbarium specimens. Because very few photographs of Stylidiaceae have ever been published, publications of photographs of new taxa and, where warranted, certain already known species seemed desirable. As a result of field work, a number of currently recognized species prove to be synonyms or infraspecific taxa, and these changes are offered below.

Taxonomy within the genus *Stylidium* is currently satisfactory to the extent that a number of well-delimited natural groups have been organized by virtue of the work of Mildbraed (1908) and his predecessors. A few groupings are in need of revision; linear capsule shape separates *S. pubigerum* from *S. ciliatum* in Mildbraed's treatment, although these must be related, as Erickson's (1958) arrangement suggests. If Mildbraed's sequence suggests that the annual stylidiids represent (in that habit) a primitive character, that conception needs revision. The question of what features are primitive in *Stylidium*, which specialized, remains to be examined. In lieu of a better system, the arrangement of Mildbraed has been followed below.

Most species of *Stylidium* are clearly differentiated, and present few problems in identification. Where only one or two characters of degree of hairiness, size of leaves, etc., separate two populations, I do not feel that specific status is justified, especially if one population is essentially a geographical extension of the other. For example, *S. elongatum* is only a northern phase of *S. crassifolium* with a hairy inflorescence axis, and is nomenclaturally reduced later in this paper. *Stylidium elongatum* seems an excellent example of a subspecies. This concept is so appropriate here, and elsewhere in

Stylidium, that there is no value in avoiding it. The variety concept is also well illustrated by some situations in *Stylidium*. *Stylidium calcaratum* var. *ecorne* (see below) is such an instance.

STYLIDIUM subgenus CENTRIDIMUM

STYLIDIUM CALCARATUM.—This species is relatively common in southwestern Australia, but *S. calcaratum* var. *ecorne* is relatively infrequent. This variety was published by Erickson and Willis (1956) to recognize the spurless specimens noted in manuscript by Ferdinand von Mueller. Three characters may be found in individuals referable to var. *ecorne*: absence of a spur; upper corolla lobes oblong-acute rather than spatulate—tridentate corolla lobes red violet rather than pale pink (compare Fig. 7 with Fig. 6). However, any one of these features may occur independently on plants which otherwise would be called var. *calcaratum*, a fact noted in part by Erickson (1958). These individuals grow intermixed with var. *calcaratum*. Absence of a spur may be based on a single gene pair, and the other characters found in *S. calcaratum* var. *ecorne* may be linked genetically (to some extent) to the spurless condition.

STYLIDIUM subgenus FORSTEROPSIS

STYLIDIUM IMBRICATUM and **S. PREISSII** (Fig. 8) are the sole members of this subgenus. Field study of *S. preissii* (Carlquist 4013) showed presence of a markedly broadened column. This feature, discussed above, was reported by Erickson (1958) for *S. scandens*, *S. verticillatum*, *S. ericksonae*, *S. pedunculatum*, and a species segregated from *S. repens*, *S. sacculatum*. Mildbraed's (1908) drawing of *S. trichopodium* strongly suggests this type of column in that species also. The broadened geniculate column, as mentioned above, seems clearly an adaptation for self-pollination; its distribution in the genus *Stylidium* suggests it has evolved independently several times, and represents, probably, a small number of genes.

STYLIDIUM subgenus STYLIDIUM

section DESPECTAE

Mildbraed (1908) includes two groups in this section: the annuals, and the bulbous perennials. The annuals are considered first.

STYLIDIUM INUNDATUM.—Willis (1967) is undoubtedly correct in considering *S. inundatum* (Fig. 9) to be synonymous with, and the older name for, *S. brachyphyllum*. *Stylidium despectum* (Fig. 10) is easily distinguished from *S. inundatum*. *Stylidium pygmaeum* R. Br. has not been rediscovered; it would resemble closely depauperate individuals of *S. despectum* in which corolla lobes are elliptical, not spatulate; however, those depauperate in-

Fig. 7–12.—Fig. 7. *Stylidium calcaratum* var. *ecorne* F. Muell. ex Erickson & Willis, Carlquist 3845, Boyanup, W.A.—Fig. 8. *Stylidium preissii* (Sond.) F. Muell., Carlquist 4013, Cape Le Grande, W.A. The markedly broadened column (as well as a rather broad labellum) can be seen on several flowers. Flowers are pale pink in color.—Fig. 9. *Stylidium inundatum* R. Br., Carlquist 3699, near Arthur, W.A. Corollas are pale violet.—Fig. 10. *Stylidium despectum* R. Br., Carlquist 3990, Denmark, W.A. Flowers

are white, broadened tips of corolla lobes pale violet.—Fig. 11. *Stylidium beagleholei* J. H. Willis, *Carlquist* 3994, Torbay, W.A. Flowers are pale pink.—Fig. 12. *Stylidium rhipidium* Erickson & Willis, *Carlquist* 3700, near Arthur, W.A. Flowers are white. All figures, $\times$ ca. $1\frac{1}{2}$.

dividuals have corolla lobes much too small to fit the description of *S. pygmaeum*. This species remains to be discovered again; very few botanists have collected the ephemeral annual stylidium with care, so a rediscovery is very likely.

STYLIDIUM LONGITUBUM.—This species (Fig. 13–14), considered a synonym of *S. utricularioides* by Mildbraed (1908), is definitely a valid and distinct species. Although Erickson (1958) recognized it, her drawings are obviously of *S. utricularioides*, at least with respect to corolla form and coloration. As the photographs herewith show, *S. longitubum* has corolla lobes elongate laterally, not dorsiventrally; the form of lobes in *S. longitubum* is curvate-obovate, not spatulate; the lobes are rose, marked purple about 1/3 of the distance from the throat. Photographic comparisons can be afforded by the illustration of *S. utricularioides* (Fig. 16). *Stylidium longitubum* is apparently endemic only to an area near Perth, and my collection (*Carlquist 4082*) may be the only one made in the twentieth century so far; I found only a single individual.

STYLIDIUM ROSEONANUM.—In 1956, Erickson and Willis named a distinctive annual, *S. roseoalatum*, which I have collected near Wyening (*Carlquist 3603*) and in the Tutanning Reserve (*Carlquist 3953*). In other localities, I found an annual which resembled *S. roseoalatum* in many features, but which is far smaller in every respect. This plant proves to be a new species. In addition to the small size indicated by measurements given below, it has sessile glandular hairs (they tend to be stalked in *S. roseoalatum*), and corolla lobes elliptical (rather than obovate in *S. roseoalatum*), light rose except at the base (also marked purple above white base in *S. roseoalatum*). *Stylidium roseonanum* has a basal rosette of leaves and wiry scape; the wiry scape is unlike that of other annuals, while the basal rosette is found only in *S. inundatum* (Fig. 9), *S. beaugleholei* (Fig. 11), *S. xanthopis*, *S. rhipidium*, and *S. roseoalatum*. Shape of corolla lobes and column easily distinguishes *S. beaugleholei* from *S. roseonanum*. *Stylidium inundatum* has narrower, violet-colored corolla lobes, with long capsules and succulent stems. The very distinctive corolla patterns of *S. xanthopis* and *S. rhipidium* need no further comment. Although superficially like *S. inundatum* in size and perhaps confused with it by collectors, study in the field amply indicates *S. roseonanum* to be a distinct species:

Stylidium roseonanum, sp. nov.

Annua pusilla, parcissime glanduloso-pubescent vel subglabra, folia 3–6, basalia, rosulata, linearia, 1–2 mm longa. Scapus erectus, 1.5–3 plerumque 2 cm altus, pertenuis, nudus vel unibracteatus. Bractea ovata, ca. 1 mm longa. Flores 1–6 plerumque 1 vel 2, subsessiles, parcissime glanduloso-pubescentes. Pedicelli 1 mm longi. Calycis tubus linearis, ca. 4 mm longus, lobi multo breviores, oblanceolato-lineares, obtusi, anteriores 2 paulo majores connati vix 1 mm longi. Corollae lacinae rosaceae, e basi albae, sub-

Fig. 13–18.—Fig. 13–14. *Stylidium longitubum* Benth., *Carlquist 4082*. Cannington, W.A.—Fig. 15. *Stylidium roseonanum* Carlquist, *Carlquist 3742*, Cranbrook, W.A. Flowers are pale rose.—Fig. 16. *Stylidium utricularioides* Benth., *Carlquist 3909*, Bullsbrook,

W.A. Broadened tips of corolla lobes are rose; stems of plants are reddish.—Fig. 17–18. *Stylidium roseoalatum* Erickson & Willis.—Fig. 17. Habit of *Carlquist* 3603, Wyening, W.A.—Fig. 18. Flowers from *Carlquist* 3953, Tutanning Reserve, near Pingelly, W.A.—Fig. 13, $\times 1\frac{1}{2}$; Fig. 14–18, $\times$ ca. $1\frac{1}{2}$.

aequales, oblongae, 2 mm longae vel breviorae. Faucis appendices 2-4, minutes, filiformes. Labellum minutum, exappendiculatum. Columna ca. 1.5 mm longa. Capsula linearis, ca. 5 mm longa. Semina numerosa, perminuta, oblonga.

Diminutive short-lived annual, 1.5-3, mostly 2 cm tall, growing in places wet in winter and spring, scape single from the basal rosette of leaves. Leaves 3-6 in number, 1-2 mm long, linear, obtuse. Scape markedly thin and wiry, with one or no ovate bracts below the lowest flower or flowers; if present, the bract ca. 2 mm long. Flowers solitary or several, each subtended by a minute bract. Pedicels 1 mm long or less. Ovary about 4 mm long, linear. Inflorescence axis and ovary sparingly covered by very short glandular trichomes. Calyx lobes lanceolate, obtuse, typically three separate and two united. Corolla with very short tube, lobes elliptic, 2 mm long or shorter, less than 1 mm wide. Corolla lobes rose, white at base. Throat appendages 2 or 4, filiform, less than 1 mm long. Labellum minute, triangular. Column ca. 1.5 mm long. Capsule linear, about 5 mm long, seeds very small, oblong.

Type: On wet mud, with *S. inundatum*, *S. obtusatum*, *S. rhipidium*, in *Melaleuca-Actinostrobis* swamp, $\frac{1}{4}$ mi. E. of Cranbrook, W.A. October 12, 1967. *Carlquist* 3742 (RSA). *Isotypes:* CANB, K, US.

Other collections: Denmark-Albany road, at turnoff to Torbay. Bare flat with restiad clumps, *S. inundatum*, *S. beaugleholei*, *Utricularia*, *Centrolepis*. November 2, 1967. *Carlquist* 3993 (RSA). On muddy wet soil of sand heath, low scrubby vegetation; with *S. inundatum*, *S. beaugleholei*, *Centrolepis*, *Brizula*, Cape Duke of Orleans Road, W.A. November 7, 1967. *Carlquist* 4021 (RSA).

STYLIDIUM BEAUGLEHOLEI.—This species was described by Willis (1967) from material collected in southeastern Australia. This distinctive ephemeral can now be reported from southwestern Australia as well. It has evidently been overlooked by botanists. I found *S. beaugleholei* at the following localities: Denmark-Albany road, at turnoff to Torbay (November 2, 1967, *Carlquist* 3994, RSA); Cape Duke of Orleans Road (November 7, 1967, *Carlquist* 4020, RSA); paperbark swamp 18 mi. W. of Albany (November 9, 1967, *Carlquist* 4042, RSA).

Because all species of section *Despectae* occur in Western Australia, whereas only a few (*S. inundatum*, *S. despectum*, and *S. beaugleholei*) occur in eastern Australia, discovery of *S. beaugleholei* in Western Australia is important. However, a much more important discovery concerning *S. beaugleholei* came to light during my field studies: the column is insensitive in this species. The flowers of *S. beaugleholei* (Fig. 11) all possess very short columns, none of which show the "hinge" region characteristic of a sensitive column. The column arches over the throat. Pollinators presumably enter the throat of the flower under the column, as they do in *S. insensitivum*. Individuals of *S. beaugleholei* tend to be reddish in color. Corolla lobes are pale pink above, red or marked red on their lower surfaces.

STYLIDIUM RHIPIDIUM.—This distinctive species was discovered by Erickson at the 120 mile peg along the Perth-Albany highway. I have seen it in this locality (*Carlquist* 3700, Fig. 12), and also in a locality farther

south, $\frac{1}{4}$ mile east of Cranbrook (*Carlquist 3743*). It is to be expected at other localities.

The bulb-forming species of section *Despectae* should probably be segregated as a separate section. During my 1967 field work I collected all of these except *S. periscelanthum*, plus a new species described herewith.

STYLIDIUM INSENSITIVUM.—This new species (Fig. 19–24) was seen at Cape Le Grande and at Cranbrook, so that one can suppose it is scattered over a rather wide area, but has not been collected because of the indifference which smaller plants typically receive. In the shape of corolla lobes and their arrangement, *S. insensitivum* mimics *S. rhipidium*, although the two are quite distinct and not closely related. The two do grow together at the Cranbrook locality. If there is mimicry in corolla form between these species, the reason is not evident, for different pollinating insects visit the two species. *Stylidium insensitivum*, like *S. beaugleholei*, has a very short column incapable of sensitive movement. Small beetles, shown in Fig. 23 and 24, were observed on corollas of *S. insensitivum*. They land on the lobes and crawl toward the throat. The throat is faintly spotted and has no appendages but it does have minuted paired callosities which might serve as guidelines for a small insect. The beetles crawl between these under the tip of the column, and undoubtedly brush anthers or stigmas, depending on which is functional at the moment of the visit.

Corresponding to the fact that the column of *S. insensitivum* is immobile, the labellum is erect. This illustrates that recurvature of the labellum in stylidiiums with sensitive columns is an adaptation to accommodate the column in its poised position. The labellum is also erect in *S. beaugleholei*, although so minute as to be inconspicuous.

Stylidium insensitivum has obtuse calyx lobes, and therefore seems related to the *S. obtusatum* complex below. However, the lack of throat appendages, the shapes and sizes of corolla lobes, the insensitive short column and erect labellum make *S. insensitivum* a most distinctive species in the group of bulbous ephemerals.

***Stylidium insensitivum*, sp. nov.**

Perennis pusilla, folia omnia radicalia, petiolata, glabra, petioli basibus dilatatis brunneis subscariosis bulbum parvum efformantes. Laminae orbiculares, crassiusculae, 3–5 mm latae, 3–5 mm longae, petiola linearia, 5–11 mm longa. Scapus 1 (rarius 2), teres, tenellus, glaber, sub corymbosum ebracteatus, cum inflorescentibus 4–7 mm altus. Flores 2–4 plerumque 2–3 in corymbo, pedicellis elongatis, 6–12 mm longis, basibus glandulis. Bracteae ovatae, acutae vel obtusae, 1–2 mm longae. Calycis tubus glaber, clavatus, 3–5 mm longus. Calycis lobi 2 mm longi, lanceolati, obtusi. Corollae tubus 2 mm longus. Corolla alba, corollae laciniae extus roseatae. Corollae laciniae ut in *S. rhipidio* rhipidiformae dispositae, albae, cuneatae, e basi purpureo-maculatae, punctibus callosis minutis 2 per laciniam instructae. Faux nuda. Labellum erectum, lanceolatum vel deltoideum, exappendiculatum. Columna insensitiva, arcuata, 4 mm longa vel brevioris. Capsula clavato-oblonga, ca. 5 mm longa, 2 mm lata, paulo torta, semina numerosa perminuta, oblonga.

Bulb-forming small perennial with basal rosette of leaves. Leaves 3–6, glabrous, lamina orbicular, succulent, 3–5 mm in diameter, in linear petiole 5–11 mm long. Inflorescence 1, rarely 2 per plant, wiry, 4–7 cm tall including flowers. Flowers 1–4, mostly 2–3, borne in a corymb subtended by two or three ovate bracts 1–2 mm long, scape otherwise bare. Pedicels 6–12 mm long, with short glandular trichomes near base. Ovary glabrous, clavate, 3–5 mm long at anthesis. Calyx lobes lanceolate, obtuse, 2 mm long. Corolla tube 2 mm long. Corolla white, tinged rose on reverse of corolla lobes. Corolla forming a fan-like display of corolla lobes as in *S. rhipidium*, lobes cuneate, distal end rounded, obtuse; upper (anterior) pair of lobes ca. 6 mm long, lower pair ca. 8 mm long. Throat appendages absent, but a pair of callosities at the base of each lobe. Labellum deltoid to lanceolate, erect. Column 4 mm long or less, not sensitive, curved over throat, providing a passage for access of small insects to throat. Capsule clavate, about 5 mm long, twisted.

Type: One-half mile east of Mt. Merivale, on Esperance-Cape Le Grande road, W.A. Sept. 21, 1967. *Carlquist* 3439 (RSA). *Isotypes*: CANB, K, PERTH, US.

Other collections: Type locality, plants in fruit. November 7, 1967. *Carlquist* 4022 (RSA). In wet soil of burned paperbark woodland near stream, with *Levenhookia pusilla*, *S. rhipidium*, 1 mi. west of Cranbrook, W.A. October 12, 1967. *Carlquist* 3740 (RSA, US, K).

STYLIDIUM OBTUSATUM.—Sonder's *S. obtusatum* was reduced to a variety of *S. petiolare* by Mildbraed (1908), probably because when dried, the two do not conspicuously reveal distinguishing characteristics. Erickson and Willis (1955) evidently credited this decision without investigating it, for without comment on *S. obtusatum*, they erected three new species which prove to be conspecific with *S. obtusatum*. *Stylidium bolgartense* has the same obovate leaves as typical *S. obtusatum*, as well as the obtuse calyx lobes, and is an exact synonym. *Stylidium rubricalyx* differs in having elliptical leaves and united calyx lobes. Neither of these is a significant character. In fact, plants with elliptical leaves but free calyx lobes can also be found (e.g., *Carlquist* 3543; I did collect typical "*S. rubricalyx*" in the type locality, *Carlquist* 3701). This taxon obviously does not merit specific status, but plants with united calyx lobes may be treated as a variety: *Stylidium obtusatum* Sond. var. *rubricalyx* (Erickson & Willis) S. Carlquist, comb. nov. (*S. rubricalyx* Erickson & Willis, *Muelleria* 1:9, 1955).

With regard to *S. asteroideum* of Erickson and Willis, the situation is not so simple. This species is described as having narrow leaves and pale pink flowers. Two of my collections of *S. obtusatum* have one of these characters without the other. Plants I collected near Wyening (*Carlquist* 3606, Fig. 30) have white flowers but narrow leaves. Plants collected near Cranbrook (*Carlquist* 3741) have pink flowers but orbicular leaves. No doubt *S. obtusatum* is a variable species, each population perhaps slightly

Fig. 19–24. *Stylidium insensitivum* Carlquist.—Fig. 19. Type locality, swamp with dwarfed paperbark trees near Mt. Merivale, W.A.—Fig. 20–22. Views of *S. insensitivum* plants from this locality (*Carlquist* 3439).—Fig. 20. Base of plant, showing 2 leaves,

bulb, roots (right), scape (left).—Fig. 21. Habit of four plants.—Fig. 22. Flowers grouped to show various views.—Fig. 23–24. Views of plants near Cranbrook (*Carlquist* 3740), showing minute beetles in various positions on the corollas. Fig. 23 and 24 are the same plants photographed a minute or two apart. Fig. 20–24, $\times$ ca. $1\frac{1}{2}$.

different. *Stylidium bolgartense* and *S. asteroideum* must be reduced to synonymy with *S. obtusatum*. *Stylidium petiolare* (Fig. 29) grows with *S. obtusatum*, but is always distinct from it. I observed the two species together in the 3701 and 3606 localities.

STYLIDIUM PETIOLARE × *S. PULCHELLUM*.—Between Capel and Boyanup, I discovered a single hybrid individual, *Carlquist* 3847 (Fig. 27–28). Both parental species were abundant and growing intermixed at the same locality (*S. pulchellum*; *Carlquist* 3846: Fig. 25–26). Hybrids have not previously been reported in *Stylidium*. They are probably rare. Another is discussed below in connection with the *S. repens* complex.

STYLIDIUM EMARGINATUM.—This well-marked species is not abundant, and during my field work, I encountered it in its typical form only once (*Carlquist* 3546, 120-mile peg on Perth–Albany highway: Fig. 31). However, I did find a population, referable to *S. emarginatum* but markedly different in corolla shape and throat appendages, along the northern slopes of the Stirling Mts. (Fig. 32). The differences in corolla-lobe shape are obvious; the throat appendages in the Stirling plants are relatively large; in each flower there tend to be four, 2 simple above, 2 bifid below. Throat appendages are usually not reliable by themselves as species characters, although these plants seem quite distinctive. This population does not seem worthy of specific status, but does seem a valid subspecies, so one is proposed here. The name is intended to indicate the similarity—a misleading one—in corolla shape to *S. petiolare*.

Stylidium emarginatum Sond. subsp. *decipiens*, subsp. nov.

Corollae laciniae inaequantes, anteriores angustiores, falciformes; posteriores latiores, spathulatae. Appendices faucis posteriores 2, binatae, vel 4, subulatae; anteriores 2, subulatae.

Corolla lobes markedly unequal: anterior lobes narrower, sickle-shaped; posterior lobes broader, spathulate. Throat appendages subulate, either 6, of which the posterior are paired, or 4, 2 simple above and 2 binate below.

Type: In stony soil of low *Leucopogon*–*Isopogon*–*Eucalyptus* scrub, ca. 4 mi. east of Cranbrook along the northern side of the Stirling Mts. October 12, 1967. *Carlquist* 3750 (RSA). *Isotypes*: US, K.

STYLIDIUM subgenus STYLIDIUM section REPENTES

STYLIDIUM REPENS complex.—*Stylidium sacculatum* was named by Erickson and Willis (1955) on account of the widened column. Erickson (1958) states that *S. sacculatum* grows intermixed with *S. repens*. The widened column undoubtedly represents a self-pollination mechanism, and one which has been evolved several times independently in *Stylidium*, as dis-

Fig. 25–32.—Fig. 25–26. *Stylidium pulchellum* Sond., *Carlquist* 3846, Boyanup, W.A.—Fig. 25. Habit, × ½.—Fig. 26. Inflorescence. × 1.—Fig. 27–28. *Stylidium pulchellum* × *S. petiolare* Sond., *Carlquist* 3847, Boyanup, W.A.—Fig. 27. Habit, × ½.—Fig. 28. Inflorescence. × 1.—Fig. 29. *Stylidium petiolare* Sond., *Carlquist* 3080, Three Springs,

W.A. $\times 1$.—Fig. 30. *Stylidium obtusatum* Sond., Carlquist 3606, Wyening, W.A.—Fig. 31. *Stylidium emarginatum* Sond. subsp. *emarginatum*, Carlquist 3546, near Arthur, W.A. $\times 1$.—Fig. 32. *Stylidium emarginatum* subsp. *decipiens* Carlquist, Carlquist 3750, east of Cranbrook, W.A. $\times 1$.

cussed above under *S. preissii*. The widened column might, if combined with other distinctive characters, indicate specific status. This, however, does not prove to be true. During my field work in Western Australia, I discovered typical "*S. sacculatum*" (Fig. 33), but also a colony of *S. repens* which could be referred to *S. repens* var. *diplectroglossum* Erickson & Willis on account of its labellum morphology, but which also had the widened column of *S. sacculatum*. This colony, *Carlquist* 3694 (Fig. 34), may be considered a hybrid, as indicated in the legend of Fig. 34. Both the widened column and the labellum with filiform appendages are probably characters based on few genes, and these may characterize some populations and not others. The appropriate treatment for "*S. sacculatum*" seems reduction to a variety: *S. repens* R. Br. var. *sacculatum* Erickson & Willis) comb. nov. (*S. sacculatum* Erickson & Willis, *Muelleria* 1:13, 1955).

STYLIDIUM CHOREANTHUM.—This distinctive species, described by Erickson and Willis (1956), occurs in the Southern Cross-Coolgardie region, where I also found it (Fig. 35). However, I discovered that the orientation of the flowers is the reverse of that indicated by the drawings of Erickson (1958). The wider corolla lobes are not below, as hinted by the fanciful species name, but above, and the column operates from below upward, as in *S. spinulosum*, *S. calcaratum*, *S. perpusillum*, and *S. inversiflorum*.

STYLIDIUM subgenus STYLIDIUM

section JUNCEAE

STYLIDIUM JUNCEUM complex.—This group is seemingly in an active state of evolution; certainly it is variable. Some segregates worthy of specific status have been evolved. One of these is *S. laciniatum* C. A. Gardner. This species differs from *S. junceum* in two respects: the incised corolla lobes and the twining habit of the scapes. Otherwise the plant would be considered *S. junceum*. These differences, however, do seem to merit specific status.

Stylidium junceum subsp. *junceum* (Fig. 40) is a relatively tall plant. In contrast, plants near the south coast, in the vicinity of Albany, are markedly diminished in size. Such plants were named *S. junceum* var. *brevius* by E. Pritzel (1904). This name, in an altered form, *S. junceum* var. *brevior*, was used by Mildbraed (1908) and Erickson (1958). There is no justification for changing "*brevius*" to an adjective in another gender, "*brevior*"; Mildbraed evidently intended to change the adjective to neuter gender, but was wrong; the name should be "*brevius*." At any rate, this plant deserves subspecific status on account of the geographical distinctness of the populations referable on grounds of morphology to this concept: *S. junceum* R. Br. subsp. *brevius* (E. Pritzel), comb. nov. (*S. junceum* R. Br. var. *brevius* E. Pritzel, *Englers Bot. Jahrb.* 35:591, 1904).

This plant, like most populations of *S. junceum*, has cream-colored

Fig. 33–38.—Fig. 33 *Stylidium repens* R. Br. var. *sacculatum* (Erickson & Willis) Carlquist, *Carlquist* 3693, Corrigin, W.A. $\times \frac{1}{2}$.—Fig. 34. *Stylidium repens* R. Br. var. *sacculatum* (Erickson & Willis) Carlquist $\times$ *S. repens* var. *diplectroglossum* Erickson & Willis, *Carlquist* 3694, Wandering, W.A. $\times 1$.—Fig. 35. *Stylidium choreanthum* Erick-

son & Willis, *Carlquist 3670*, Ghooli, W.A., showing the correct orientation of flowers. $\times \frac{1}{4}$.—Fig. 36–38. *Stylidium squamellosum* DC., *Carlquist 3998*, near Needilup, W.A.—Fig. 36. Habit. $\times \frac{1}{8}$.—Fig. 37. Base of plant, showing stems raised on aerial roots. $\times 1$.—Fig. 38. Flowers. $\times 1$.

flowers. At one locality where I found it (near Nornalup, *Carlquist 4059*), I found another quite different *Stylidium* of the *junceum* complex. This latter kind of plant was not at all diminished in size, but was as tall or taller than northern *S. junceum*; its flowers were deep red-violet (Fig. 43-45). Further examination showed that these plants had a markedly succulent rhizome (Fig. 44). Although some plants in the *S. junceum* complex are leafless at the time of flowering, withered leaves can be found on the rhizomes. In the new species proposed here, all leaves could be accounted for on adult plants, and these are all scale-like. No member of the *S. junceum* complex has hitherto been found in which the rhizome is markedly succulent; usually it is woody and relatively narrow. Other distinctions of this new species include its very slender, tall scapes and its long-conical capsules. The fact that this new species grows intermixed with *S. junceum* subsp. *brevius*, yet no intermediates occur indicates reproductive isolation of the new species. This species seems just as justified as *S. laciniatum*. If it is not deemed worthy of specific status, then many *Stylidium* species must also fall: *S. carnosum* should be reduced into *S. diversifolium*, or *S. striatum* into *S. brunonianum*. However, the reasons for proposing this species seem entirely adequate:

***Stylidium squamosotuberosum*, sp. nov.**

Perennis rhizomata, ramis crassis, brevibus, ad 5 cm longis, 1-2 cm latis, succulentis, purpureo-brunneis. Planta adulta omnino aphylla, planta juvenalis ignota. Folia omnia squamosa, brunnea, deltoidea, 1-5 mm longa, ca. 1 mm lata. Scapi junciformes, tenelli, 1-5 plerumque 5 per ramo, 50-80 plerumque 65 cm alti, bracteis 6-7 mm longis, anguste linearibus, acutis basi calcaratis et margine scarioso-limbati instructis. Flores subsessiles in racemo breve denso spiciforme; bractee cum margine lato scarioso lanceolatae apicem versus attenuatae, basi ultra interiorem in proceum angustum interdum multo breviorum productae. Pedicelli bracteis subtriplo breviores. Calycis basi bracteolis 2 bracteis similibus sed minoribus angustioribusque praediti. Calycis parce glanduloso-pubescens tubus pedicello subaequilongus oblongo-ovatus, lobi tubo longiores, lanceolati, omnes valde acuti et margine late scarioso-limbati. Corolla rosaceo-purpurea, tubus lobis calycis posterioribus subaequilongus, lacinae extus satis dense nigro-glanduloso-pubescentes, obovatae; appendices faucis membranam humilem obsolete sinuatam pilis glanduliferis magnis nigro-capitatis dense irregulariterque ciliatim efformantes. Labellum e basi late ovata subacuminatum exappendiculatum. Capsula conica, 7 mm longa, 3 mm lata, pedicelli in fructibus 2 mm longi.

Perennial with short creeping rhizomes, rhizome branches to 5 cm long, 1-2 cm thick, succulent, purplish-brown in the living condition. Rhizome bearing scales which are 1-5 mm long, mostly deltoid, with widened bases, brownish. Longest scales adjacent to inflorescence axis. No true leaves on

Fig. 39-45.—Fig. 39-41. *Stylidium junceum* R. Br. subsp. *junceum*, *Carlquist 3874*, Lesmurdie, W.A.—Fig. 39. Habit. $\times 1/20$.—Fig. 40. Basal rosette of leaves. $\times 1$.—Fig. 41. Flowers. $\times 4$.—Fig. 42. *Stylidium junceum* subsp. *brevius* (E. Pritzel) *Carlquist*,

Carlquist 4059, near Nornalup, W.A. Habit, including flowers. $\times \frac{1}{4}$.—Fig. 43–45.
Stylidium squamosotuberosum Carlquist, *Carlquist 4060*, near Nornalup, W.A.—Fig. 43.
 Habit. $\times \frac{1}{20}$.—Fig. 44. Tuberous underground stem. $\times 1$.—Fig. 45. Inflorescence.
 $\times \frac{1}{4}$.

adult plants, juvenile plants not seen. Scape 2-5 per branch of rhizome, almost never solitary. Inflorescence axes 50-80, mostly 65 cm tall, notably slender, with scattered linear spurred scarious-margined bracts 6-7 mm long, upwardly appressed to the scape. Bracteoles about 6 mm long or less. Pedicels 1-2 mm long. Ovary at anthesis 2-3 mm long, clavate, densely glandular-hairy. Calyx lobes longer than the tube, scarious-margined, the anterior ones $1\frac{1}{2}$ -2 times longer than the posterior ones, lanceolate, acuminate. Corolla densely glandular on the outer surface; deep red-purple outside, bright red-purple within. Corolla lobes oblong, upper pair overlapping lower pair, clearly at a slightly higher level when viewed laterally. Corolla lobes about 5-6 mm long, 4 mm wide. Throat appendages minute, covered by glandular hairs. Labellum narrow triangular, glandular, without appendages. Column about 5 mm long, purple. Capsule oblong-conic, about 7 mm long, 3 mm wide, excluding calyx lobes. Pedicel in fruit 2 mm long.

Type: In coarse stony soil along margins of highway, in scrubby vegetation with restiads, *Tetradthea*, *Boronia*, etc. 5 mi. west of Nornalup on road to Manjimup, W.A. November 10, 1967. *Carlquist* 4060 (RSA). *Isotypes*: K, CANB, US.

STYLIDIUM subgenus STYLIDIUM

section SAXIFRAGOIDEAE

STYLIDIUM LUTEUM.—This species has been collected only in the immediate vicinity of Albany, at least as far as this species is currently interpreted. Plants exceptional for the species in their flat, glaucous leaves and prominently ridged glaucous ovaries were found near Manjimup (*Carlquist* 4061, Fig. 58-59), and also on the Denbarker road (*Carlquist* 3983). These plants are otherwise referable to typical *S. luteum*. Because they represent a geographical extension of the species, as well as distinctive morphological features, status as a subspecies seems warranted:

STYLIDIUM LUTEUM R. Br. subsp. *glaucifolium*, subsp. nov.

Planta omnino glauca. Calycis tubus manifeste nervosus.

Plant glaucous throughout. Ovary markedly ridged.

Type: In wet sand with *Hibbertia stellaris*, *Hypocalymna*, *Melaleuca*, 1 mile north of Manjimup, W.A. November 10, 1967. *Carlquist* 4061 (RSA). *Isotype*: K.

Other collection: In white sand with *Scaevola*, *Kennedya*, 8 mi. north of Denmark on Denbarker road, W.A. November 2, 1967. *Carlquist* 3983 (RSA).

Another *S. luteum* variant has come to light on the Mt. Barren range. This plant has glaucous leaves like the above, but clavate, rather than sphaeroidal ovaries which are, unlike those of typical *S. luteum*, devoid of glandular trichomes. As with the subspecies above, this represents a geographical extension for the species and subspecific status likewise seems advisable:

STYLIDIUM LUTEUM R. Br. subsp. *clavatum*, subsp. nov.

Planta omnino glauca. Calycis tubus eglandulosus, clavatus.

Plant glaucous throughout. Glandular hairs absent on ovary; ovary clavate.

Type: In wet sandy places, with restiad clumps, East Mt. Barren. November 4, 1967. *Carlquist 4007a* (RSA).

STYLIDIUM SQUAMELLOSUM DC.—Although Erickson (1958) cites this species, she evidently has seen no plants she identified as this, for the only collection mentioned is one cited by Mildbraed (1908). However, a species proposed by Erickson and Willis (1955), *S. zeicolor*, agrees with the description of *S. squamellosum* perfectly in all respects other than flower color: yellow in *S. zeicolor*, while *S. squamellosum* is supposedly purplish. Flower color on dried specimens is notoriously unreliable, so de Candolle's designation of flower color need not be accepted at face value. In fact, one population of *S. squamellosum* I discovered (*Carlquist 3910*, 37-mile peg, northern highway) had yellow flowers marked purplish on the reverse of corolla lobes, but agreed in all respects with *S. squamellosum*, or *S. zeicolor*. Type material of *S. zeicolor* agrees perfectly with materials cited by Mildbraed, for *S. squamellosum*, and thus *S. zeicolor* must be regarded as a synonym. Other collections of *S. squamellosum* I made include *Carlquist 3998* (4 miles west of Needilup: Fig. 36–38) and *Carlquist 3606* (3 miles north of Bolgart).

STYLIDIUM LONGIBRACTEATUM.—This new species (Fig. 77–80) shows resemblances to *S. pseudocaespitosum* and to *S. squamellosum* on account of the presence of scale-leaves. From *S. pseudocaespitosum* it differs by having markedly swollen stem bases (Fig. 77), glabrous pungent leaves, hairy stems, inflorescence with non-glandular hairs or glabrescent, long bracts, flowers without throat appendages, calyx lobes which are acute, and a paniculate inflorescence rather than a simple raceme. The new species differs from *S. squamellosum* in having markedly swollen stem bases, long glabrous pungent leaves, hairy stems, non-glandular hairs on inflorescence or inflorescence glabrescent, inflorescence paniculate with long bracts, flowers without throat appendages. Species other than *S. pseudocaespitosum* and *S. squamellosum* are apparently more distantly related and do not need to be discussed.

Stylidium longibracteatum, sp. nov.

Perennis caespitosa, caudex polycephalus, lanatus, infra folia squamis brevibus linearibus subacutis instructus. Folia basalia suberecta anguste linearia, mucranato-acuta, pungentia, glabra, 3–6 cm longa. Scapi cum floribus usque 12–17 cm alti, piloso-pubescentes, bracteae conspicuae, linearia, mucronatae, ca. 1–1.5 cm longae, patentes. Pedicelli bracteola ca. 4 mm longa. Calycis tubus 2–3 mm longus, obovato-clavatus, glabrus. Calycis lobi e basi lato lineari-lanceolato, obtusi, 2 mm longi. Corollae rosaceo-albidae, tubus lobis calycinis subaequilongus, 2–3 mm longus. Corollae lacinae ca. 2 mm longae, obovato-oblongae, glabrae. Faux nuda. Labellum ovatum, obtusum, basi appendiculis 2 subulato-filiformis instructum. Capsula ignota.

Caespitose perennial, inflorescence terminating each of the turbinate branches of the caudex. Stem short-woolly, each year's growth covered with

scale-leaves below, foliage leaves above. Leaves upright, linear, terete, mucronate, glabrous, 3–6 cm long. Inflorescence 12–17 cm tall, lightly pilose-pubescent or glabrescent, all hairs non-glandular. Inflorescence an elongate panicle, the lowest branches bearing 2–3 flowers, upper branches one-flowered. Bracts of the inflorescence scattered along the scape and also subtending each inflorescence branch, conspicuous, 1–1.5 cm long, developing well before branches of the inflorescence elongate, linear, pungent. Bracteoles similar, about 4 mm long. Ovary glabrous, obovate, 2–3 mm long. Calyx lobes glabrous, about 2–3 mm long. Corolla lobes obovate-oblong, ca. 2 mm long. Throat bare. Labellum ovate, obtuse, with two filiform appendages at the base. Capsule not known.

Type: On rocky outcrop, about 5 mi. N. of Yalgoo, W.A. September 6, 1967. *Carlquist 3006* (RSA).

STYLIDIUM SPATHULATUM complex.—Erickson and Willis (1956) correctly transferred *S. luteum* var. *glandulosum* Mildbraed to *S. spathulatum*. However, these plants are distinguished not only by their dense covering of glandular hairs and their very narrow leaves, but by their habitat as well—open sand instead of moist, shady localities. Therefore this taxon seems worthy of subspecific status: *S. spathulatum* R. Br. subsp. *glandulosum* (Mildbraed) comb. nov. (*S. luteum* R. Br. var. *glandulosum* Mildbraed, *Pflanzenreich* 4:278, p. 57, 1908).

STYLIDIUM SPATHULATUM subsp. *SPATHULATUM* (Fig. 46–47) is slightly variable in leaf shape and size of plant. It is doubtful if plants with elongate stems (a condition occasional in most of the rosette-forming species of *Stylidium*), named *S. spathulatum* var. *lehmannianum* (Sond.) Mildbraed deserve any taxonomic recognition, unless as a forma.

Plants of *S. spathulatum* from near Collie have distinctive leaves and calyx lobes (Fig. 48, 49), and seem worthy of recognition as a new subspecies:

STYLIDIUM SPATHULATUM R. Br. subsp. *acuminatum*, subsp. nov.

Folia acuminata, conspicue flabellato-venosa. Inflorescentia dense glandulosa. Calycis lobi acuti.

Leaves acuminate, markedly flabellately veined. Inflorescence densely glandular-pubescent. Calyx lobes acute.

Type: On floor of eucalypt forest, with *Hakea* and *Xanthorrhoea*, between Collie and Harvey, W.A. October 18, 1967. *Carlquist 3849* (RSA).

STYLIDIUM GLAUCUM.—This species is easily recognized by such features as its small lilac-colored flowers and its oblanceolate leaves, glaucous below. A plant with distinctively narrow leaves (Fig. 50, 51) seems worthy of segregation as a subspecies:

Fig. 46–52.—Fig. 46–47. *Stylidium spathulatum* R. Br. subsp. *spathulatum*, *Carlquist 3730*, Mt. Adelaide, W.A.—Fig. 46. Habit. $\times 1/8$.—Fig. 47. Flowers. $\times 1$.—Fig. 48–49. *Stylidium spathulatum* subsp. *acuminatum* *Carlquist, Carlquist 3849* (photograph from dried specimen), Collie, W.A.—Fig. 48. Basal leaf rosette. $\times \frac{1}{2}$.—Fig. 49. Inflorescence with young fruits, showing acute calyx lobes. $\times 1$.—Fig. 50–51. *Stylidium glaucum* R.

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Br. subsp. *angustifolium* Carlquist, *Carlquist 3799*, Northcliffe (photographs from dried specimen).—Fig. 50. Habit. $\times \frac{1}{2}$.—Fig. 51. Basal rosette of leaves. $\times 1$.—Fig. 52. *Stylidium diuroides* Lindl. subsp. *nanum* Carlquist, *Carlquist 3961*, east of Cranbrook, W.A. Habit. $\times \frac{1}{4}$.

STYLIDIUM GLAUCUM Labill. subsp. *angustifolium*, subsp. nov.

Folia omnino glauca, linearia vel oblanceolato-linearia, 10–25 mm longa, ad 2 mm lata. Racemus simplex, pauciflorus. Calycis tubus sessilo-glandulosus.

Leaves glaucous above and below, linear to oblanceolate-linear, 10–25 mm long, to 2 mm wide. Inflorescence a simple raceme, relatively few-flowered. Ovary with sessile glandular trichomes.

Type: With *Beaufortia*, *Xyris*, restiads in paperbark swamp 6 mi. south of Northcliffe, W.A. October 16, 1967. *Carlquist* 3799 (RSA).

STYLIDIUM BRUNONIANUM.—As in *S. junceum*, there are populations of *S. brunonianum* in the Albany–Stirlings region which are markedly diminished in size of vegetative features and scape length, although flowers are not much smaller than those of subsp. *brunonianum*. These populations of dwarf plants were called *S. tenue* by Sonder, and *S. brunonianum* var. *minor* by Benth. These deserve subspecific status: *S. brunonianum* Benth. subsp. *minor* (Benth.) comb. nov. (*Stylidium brunonianum* Benth. var. *minor* Benth. Fl. Austr. IV:19, 1869).

STYLIDIUM DIUROIDES.—Corresponding with plants of diminished stature in *S. brunonianum* and *S. junceum*, the southern coastal sand heaths bear individuals of *S. diuroides* markedly diminished in size. These represent also a range extension for the species, which is typically a Darling Range plant (Fig. 55, 56). Plants from Mt. Leseur are a new species (*S. inversiflorum*). The dwarf *S. diuroides* may be called:

STYLIDIUM DIUROIDES Lindl. subsp. *nanum*, subsp. nov.

Planta tenella, 6–14 plerumque 11 cm alta. Inflorescentia pauciflora. Folia minuta, 2–6 plerumque 4 mm longa.

Plant diminutive, 6–14, usually 11 cm tall including inflorescence. Inflorescence with relatively few flowers. Leaves small, 2–6 mm (mostly ca. 4 mm) long.

Type: In wet sand heath with *Conostylis*, *Centrolepis*, ca. 4 mi. east of Cranbrook, along northern side of Stirling Mts., W.A. October 12, 1967. *Carlquist* 3749 (RSA). *Isotypes:* K, CANB, US.

STYLIDIUM PILIFERUM.—In line with the above, a dwarf race of this species deserves transfer to subspecific status: *S. piliferum* R. Br. subsp. *minor* (Mildbraed) comb. nov. (*S. piliferum* R. Br. var. *minor* Mildbraed, Pflanzenreich IV: 278, p. 71, 1908).

STYLIDIUM INVERSIFLORUM.—Erickson (1958) says, concerning *S. diuroides*, that “material from Mt. Leseur is sparsely leaved, 2-whorled, and with calyx lobes twice as long as the tube, very glandular hairy.” This description applies to what proves to be a new species from sand heaths in the vicinity

Fig. 53–59.—Fig. 53–54. *Stylidium inversiflorum* Carlquist, *Carlquist* 3642, Jurien Bay, W.A.—Fig. 53. Habit. $\times \frac{1}{4}$.—Fig. 54. Inflorescence. $\times 1\frac{1}{2}$.—Fig. 55–56. *Stylidium diuroides* Lindl. subsp. *diuroides*, *Carlquist* 3124, Bullsbrook, W.A.—Fig. 55. Habit. $\times$

1/5.—Fig. 56. Inflorescence. $\times \frac{1}{4}$.—Fig. 57. *Stylidium lepidum* F. Muell., Carlquist 3544, near Arthur, W.A. Habit, with inflorescences. $\times \frac{1}{4}$.—Fig. 58–59. *Stylidium luteum* R. Br. subsp. *glaucofolium* Carlquist, Carlquist 4061, Manjimup, W.A.—Fig. 58. Leaf rosettes. $\times 1$.—Fig. 59. Inflorescence. $\times 1\frac{1}{2}$.

of Jurien Bay (a region which includes Mt. Leseur), and this new species (Fig. 53-54) proves quite different from *S. diuroides*. In addition to the elongate stems, borne high on prop roots and bearing whorls of terete leaves, this plant is distinguished by many floral details, especially the inverted orientation of the flowers. The lack of throat appendages is notable. The membranous fold in the throat of the corolla is a feature which otherwise is found only in *S. lepidum* (Fig. 57) and *S. corymbulosum*. The shape of the corolla lobes is distinctive, and mimics corolla-lobe shape of other species with inverted floral orientation, *S. calcaratum* (Fig. 5, 6), and *S. spinulosum* (Fig. 65), although not *S. choreanthum* (Fig. 35). Because *S. inversiflorum* is a distinctive species, I cannot select any other species as clearly its closest relative, and placement in sect. Saxifragoideae can be considered only tentative.

Stylidium inversiflorum, sp. nov.

Perennis adscendens, aulis simplicis; innovationes glabrae, 2-5 cm longae, pseudoverticillatae, primo anno saepe rubrescentes, apice folia majora dense rosulata gerentes, demum efoliatae, cortice griseo-nigrescente obtecte et e nodis inferioribus radicanter efformantes. Folia anguste linearia, teretis, recta, plerumque erecto-patentia, glabra, acuta nonnullis mucronata, 5-40 plerumque 20 mm longa. Racemus simplex. Inflorescentia cum floribus 5-17 cm longa, glabra in parte inferiora. Bractae lineares, 5 mm longae vel breviorae. Pedicelli tenelli, glanduloso-pubescentes, 5 mm longi vel breviori. Calycis tubus glabrus vel glandulosus, clavatus, 2-3 mm longus. Calycis lobi lanceolati, obtusi, 2 mm longi. Corollae tubus 2 mm longus. Corolla flavida, ut in *S. spinuloso*, *S. calcarato*, *S. perpusillo* et *S. choreantho* lata. Corollae laciniae plerumque valde inaequales, posteriores 2 late lineari-cuneatae vel spathulatae, apice latiores, subtruncatae manifeste multidentatae; anteriores 2 longiores irregulariter spathulato-oblongo-lineares medio circa angulate prorsum curvatae, subserratae. Corollae laciniae e basi 1-2 callosis instructae, e basi purpureo-brunneo-maculatae. Corolla faux exappendiculata, sed membrana faucis instructa. Labellum lanceolatum, saepe curvatum. Columna 4 mm longa vel breviora. Capsula clavata, 3 mm longa.

Perennial, usually unbranched, the stem usually supported by aerial roots. Stem terete, wiry, glabrous, pale or reddish, turning gray when old. Leaves in false verticils, 1 or 2 of which are formed each year, separated by lengths of stem which are bare or provided with a few short leaves. Leaves acicular, slender, straight, 5-40 (mostly 20) mm long, glabrous, green, acute but not mucronate. Scape terminal, glabrous, ebracteate below portion which bears flowers. Entire inflorescence 5-17 cm long, always a simple raceme. Upper portions of inflorescence and pedicels sparsely glandular-pubescent. Bracts of the inflorescence linear, 5 mm long or shorter (rarely a few vegetative leaves present at the level of the lowermost flowers). Pedicels 5 mm long or shorter, wiry. Ovary clavate, glabrous or with a few glandular hairs, 2-3 mm long at anthesis, calyx lobes lanceolate, obtuse, 2 mm long. Corolla tube short. Flowers yellow with orientation inverted compared with that of most *Stylidium* species, but like that of *S. spinulosum*, *S. calcaratum*, *S. perpusillum*, and *S. choreanthum*, the column operating from below upward

in the space between the 2 lower (morphologically posterior) curving corolla lobes. Upper corolla lobes truncate, spathulate, with toothed distal ends. Lower (morphologically anterior) corolla lobes irregularly spathulate-oblong, curved. All corolla lobes provided with a small purple mark near base (appearing brown on the yellow background). One or two minute callus-like or gibbus-like protuberances at the base of each corolla lobe and a membranous wing inserted on the upper side of the throat; no true throat appendages present. Labellum lanceolate, often curved, with no appendages. Column 4 mm long or less. Capsule clavate, about 3 mm long.

Type: In sand heath with *Hakea*, *Melaleuca*, *Leucopogon*, *Leschenaultia* along Cadda Road, north of Badgingarra, W.A. October 28, 1967. *Carlquist* 3925 (RSA). *Isotype*: K.

Other collection: In sand, with *Macropidia fuliginosa*, *Daviesia epiphylla*, Cockleshell Gully, W.A. October 4, 1967 (RSA).

STYLIDIUM AEONIOIDES.—In the same general area where *S. inversiflorum* grows, another new species can be found (Fig. 60–62). The presence of scale leaves in this new species suggests possible affinity with *S. squamellosum*, but the leaves are entirely different, the plant glabrous, and the flowers unlike in size and details. *Stylidium diuroides* is also quite different, as is *S. inversiflorum*. The hyaline-margined leaves find a parallel only in *S. maitlandianum* (Fig. 63), a species which is close to *S. diversiflorum* and, to a lesser extent, *S. carnosum*, *S. brunonianum*, *S. striatum*, and *S. glaucum*, none of which suggest close affinity to *S. aeonioides*. Leaves of *S. maitlandianum* are succulent, whereas those of *S. aeonioides* are fibrous and flabellately veined. *Stylidium aeonioides* is apparently a plant of ironstone slopes, but seems to favor sandy pockets on those slopes. The proposed specific name is intended to suggest a resemblance in aspect (but not in size) to any of several species of *Aeonium* (Crassulaceae).

Stylidium aeonioides, sp. nov.

Perennis caudice simplice, caespitosa, infra folia squamis brevibus lineari-bus subacutis instructus. Folia basalia rosulata, patentia, elliptica, glabra, manifeste flabellatim venosa et striata, ut petioli margine albo-hyalino fimbriato limbato. Lamina 5–15 plerumque 20 mm longa, 3–6 plerumque 4 mm lata. Petiola linearia, albida, ca. 5 mm longa. Scapi 1–4, laterales. Scapus glabrus e basi rubrescens. Inflorescentia panicula corymbiformis vel elongata, ramosi dichasiformes. Scapi bracteae numerosa, ellipticae, ca. 4 mm longae, 1 mm latae, margine albido-hyalina, limbata. Pedicelli glandulosi ad apicem, bibracteolati. Calycis tubus turbinatus, 1 mm longus. Calycis lobi deltoidei obtusi, 2 mm longi. Flores flavides. Corollae tubus brevis. Corollae laciniae inaequales, 2 majores ca. 3 mm longi, 2 mm lati; 2 minores 2.5 mm longi, 2 mm lati, ovato-ellipticae, obtusae. Labellum deltoideum, minutum, acutum, exappendiculatum. Appendices faucis minutes, 6 vel 8, filiformes. Columna ca. 3 mm longa. Capsula turbinata, 2 mm longa.

Caespitose perennial, rooting along the short, erect, usually unbranched stem, the rosette of spreading leaves tending to be appressed to soil. Leaves elliptic-spathulate, fibrous-coriaceous, narrowing into a linear petiole. Lami-

na 5–15, mostly about 10 mm long, 3–6 (mostly about 4) mm wide, petiole about 5 mm long. Leaves glabrous, but with margins transparent-fringed. Vegetative leaves alternating annually with zones of minute scale leaves which are green at first but turn brown and cover older portions of the stem. Scapes one to several per rosette, lateral, 6–18 cm tall. Inflorescence axis wiry, slender, reddish below, green above, glabrous; portion below lowest flower bearing numerous scattered elliptical transparent-fringed bracts about 4 mm long, 1.5 mm wide. Inflorescence a panicle, corymbiform at first, elongate later, branches composed of symmetrical simple or compound dichasia. Pedicels each bearing 2 bracteoles, glandular at base of ovary. Ovary turbinate, ca. 1 mm long, calyx lobes ca. 2 mm long, deltoid, obtuse. Flowers yellow. Corolla tube short. Corolla lobes ovate-elliptic, obtuse, rounded, slightly unequal, the smaller about 2.5 mm long, the larger about 3 mm long, all about 2 mm wide. Labellum deltoid, acute, minute. Throat typically with six minute tooth-shaped appendages, two of which may be bifid, probably representing fused pairs, so that a total of 8 throat appendages might be recognized. Column about 3 mm long. Capsule about 2 mm long, turbinate.

Type: In scrubby vegetation (*Comesperma*, *Hakea*, *Dryandra*, *Stirlingia*) on hillside on Cadda Road (to Frenchman's Bay), 1 mile from Eneabba-Ba'gingarra Highway, W.A. October 28, 1967. *Carlquist* 3926 (RSA). *Isotypes:* K, US, CANB, PERTH, E, CHR.

STYLIDIUM subgenus STYLIDIUM section STYLIDIUM

STYLIDIUM SPINULOSUM complex.—*Stylidium spinulosum* is a distinctive species of the southern coastal area of Western Australia, often encountered around Mt. Barker (Fig. 64, 65). A population of *S. spinulosum* on East Mt. Barren (*Carlquist* 4008) has smaller stature, shorter leaves, fewer flowers than the typical *S. spinulosum*, but does not seem to deserve taxonomic recognition. There is, however, a population on Mt. Toolbrunup, Stirling Range, which does merit subspecific status (Fig. 66, 67). Its rosettes have notably short leaves (Fig. 67), and elongate stems are rare. The flowers are few per scape, the corolla salmon-pink within. These features, taken together with the preference for stony rubble and the montane locality rather than lowland sand, might suggest specific status. However, the Toolbrunup plants share with typical *S. spinulosum* the same peculiar floral morphology, and subspecific status seems the most appropriate.

STYLIDIUM SPINULOSUM R. Br. subsp. *montanum*, subsp. nov.

Perennis caespitosus, innovationes breves. Folia 5–18 mm longa, margine cum denticulis antrorsis, patentis, vel retrorsis. Corollae laciniae aurantiacolorosae, extus albae rubro-striatae. Corollae laciniae posteriores patentis.

Type: In crevices of rocky rubble, beneath shrubbery in somewhat ex-

Fig. 60–65.—Fig. 60–62. *Stylidium aconioides* Carlquist, *Carlquist* 3926, Badgingarra, W.A.—Fig. 60. Habit. $\times \frac{1}{4}$.—Fig. 61. Group of flowers. $\times 1\frac{1}{2}$.—Fig. 62. Stem, showing scales (left); basal rosette of leaves (right). $\times 1$.—Fig. 63. *Stylidium maitlandianum*

E. Pritzel, *Carlquist* 3635, Cockleshell Gully, W.A. Basal rosette of leaves, showing hyaline margins like those of *S. aconioides*. $\times \frac{1}{4}$.—Fig. 64–65. *Stylidium spinulosum* R. Br. subsp. *spinulosum*, *Carlquist* 3722, Mt. Barker, W.A.—Fig. 64. Habit. $\times \frac{1}{5}$.—Fig. 65. Inflorescence. $\times 1\frac{1}{2}$.

posed places along lower part of trail, Mt. Toolbrunup, W.A. November 8, 1967. *Carlquist 4038* (RSA).

STYLIDIUM ARENICOLA.—In yellow sandplain in the interior of southwestern Australia I encountered an undescribed *Stylidium* (Fig. 74–76). This plant has evidently been overlooked; vegetatively, it bears a superficial resemblance to *S. piliferum*. Very likely it is the plant to which Erickson (1958) refers under *S. dispersum*: “a small form of this plant possibly occurs in yellow sandplain east of Southern Cross.” The new species is probably not closely related to *S. dispersum*. It has a bilabiate calyx, a rather large spherical capsule, incompletely septate, and numerous seeds at the base; there are prominent throat appendages on the corolla throat. In *S. dispersum* throat appendages are absent, and the capsule is very small, flattened, and bears one or two seeds pendant from the apex; the capsule is septate. *Stylidium piliferum* (Fig. 72, 73), together with allied species such as *S. hispidum* and *S. miniatum*, has vertically elongate rather than rounded inflorescences, large flowers without throat appendages, small non-inflated capsules, ovoid in shape, and thus the new species is clearly separable from that group.

Stylidium arenicola, sp. nov.

Perennis caudice dense caespitosa, caudex glabrus. Folia omnia radicalia densissime rosulata pulvinos hemisphaericos efformantia. Folia argentoviridia, glabra, linearia, 1–3 plerumque 1.2–1.5 cm longa, 1 mm lata, in sicco valde bicarinata, margine hyalino, apice mucronata. Inflorescentia paniculata, rotundata, 3–10 plerumque 5 cm alta, dichasiforme ramosa, dense glanduloso-pubescent, viridis. Bractee et bracteolae lineares, 4 mm longae vel breviores. Pedicelli 5 mm longi vel breviores, tenelli. Calycis tubus ad anthesim sphaericus, 1 mm longus; calycis lobi 1 mm longi, connati in labia 2. Corollae tubus brevis; corolla alba, corollae lacinae extus rubro-striatae, obovatae, 2 mm longae vel breviores. Appendices faucis valde conspicuae, 4, 2 posteriores eodem bidentatae, apice rubro-maculatae. Labellum minutum, ovatum, acuminatum, exappendiculatum. Columna ca. 3 mm longa, rubra. Capsula sphaerica, 4 mm in diametro, rubrescens. Capsulae septa incompleta; semina numerosa, oblonga, minuta.

Caespitose perennial forming clumps, glabrous, leaf rosettes dense, hemispherical. Leaves silvery-green, linear, 1–3 (mostly 1.2–1.5) cm long, somewhat flattened, bicarinate above and below when dry, margins inconspicuously cartilaginous and minutely roughened, apex mucronate. Inflorescence paniculate, rounded, all branches dichasially branched, inflorescence 3–10 (mostly 5) cm tall, 1–4 inflorescences per rosette. Inflorescence axis and its branches densely glandular-pubescent, green. Each branch of the inflorescence subtended by a bract or bracteole, these linear, mucronate, 3 mm long or less, no bracts on the scape below the lowest branch. Pedicels 5 mm long or shorter. Ovary at anthesis 1 mm long, sphaeroidal,

Fig. 66–71.—Fig. 66–67. *Stylidium spinulosum* R. Br. subsp. *montanum* Carlquist, *Carlquist 4038*, Mt. Toolbrunup, W.A.—Fig. 66. Habit, showing inflorescences. $\times \frac{1}{4}$.—Fig. 67. Leaf rosettes and, extreme right, fruit. $\times 1\frac{1}{2}$.—Fig. 68–71. *Stylidium yilgarnense*

E. Pritzel.—Fig. 68–69. Plants from the type locality, Ghooli, W.A., *Carlquist 3677*.—Fig. 68. Habit. $\times 1/5$.—Fig. 69. Flowers. $\times \frac{1}{4}$.—Fig. 70–71. Plants from the type locality of "*S. glanduliferum* S. Moore," *Carlquist 3657*, near Kununoppin, W.A.—Fig. 70. Habit. $\times 1/6$.—Fig. 71. Flowers. $\times \frac{1}{2}$.

calyx lobes 1 mm long, obtuse, mostly united into two lips. Corolla tube short, corolla white, marked red in a fan-like spot on the reverse of each corolla lobe. Corolla lobes obovate, subequal, 2 mm long or less in length. Labellum deltoid, minute, without appendages. Throat provided with conspicuous linear or triangular white appendages, often 4, of which the posterior pair may be bidentate. Appendages often red-tipped. Capsule sphaerical, about 4 mm in diameter, reddish, incompletely septate within, seeds numerous, near base of placenta, minute, oblong.

Type: With *S. limbatum*, *Cyanostegia*, *Velleia*, *Dampiera luteiflora* in yellow sandplain 5 mi. N. of Merredin on road to Nungarin, W.A. October 6, 1967. *Carlquist* 3663 (RSA). *Isotypes:* US, CANB, E, CHR.

Other collections: In yellow sand with *Stackhousia*, *Hibbertia*, *Stylidium limbatum* in burned-over area in which *Gyrostemon* is now replacing *Isopogon-Casuarina*. $\frac{1}{4}$ mile north of Spargoville, on Norseman-Coolgardie road, W.A. September 18, 1967. *Carlquist* 3370 (RSA). In yellow sand, with *Grevillea*, *Callitris*, *Verticordia*, $\frac{1}{4}$ mile east of Ghooli (approx. 8 mi. E. of Southern Cross), W.A. October 7, 1967. *Carlquist* 3667 (RSA).

STYLIDIUM HUMPHREYSII.—*Stylidium arenicola* has a counterpart in the red sand regions farther inland in Western Australia. This species (Fig. 81–87) can easily be recognized by the accumulation of wool on stems, an accumulation which becomes evident as leaves fall. The leaves are much larger than those of *S. arenicola*, the flowers and flower-parts much larger, and the throat appendages different. I take pleasure in naming this species for the late Mr. Fred W. Humphreys, amateur botanist and until his death Director of Social Services for Western Australia. He and his wife Evelyn aided my field work in Western Australia, as they have aided others. The specimen which becomes the type of *S. humphreysii* was given me for identification by Mr. Humphreys shortly before his death.

Stylidium humphreysii, sp. nov.

Perennis caudice dense caespitosa, caudice dense lanata, pilis lanatis in parte inferiore conspicuae. Folia omnia radicalia, glabra, densissime rosulata pulvinos hemisphaericos efformantis. Folia argenteo-viridia, linearia, 2–4 plerumque 3 cm longa, mucronata, margine hyalino. Inflorescentia paniculata, rotundata, 7–12 cm alta, ramosis dichasiformes, dense glanduloso-pubescent, omnino rubra. Bractee et bracteolae 6 mm longae vel breviores, lineares. Pedicelli 7 mm longi vel breviores. Calycis tubus ad anthesim sphaericus, 2 mm longus; calycis lobi 2–3 mm longi, connati in labia 2. Corolla probabilititer rosea; corollae tubus 2–3 mm longus. Corollae laciniae obovatae, ca. 4 mm longae. Appendices faucis conspicuae, 4, anteriores 2 lineares, 2 mm longae, posteriores 2 rotundatae, ca. 1 mm longae. Labellum ovato-lanceolatum, acuminatum, exappendiculatum. Columna ca. 8 mm longa, rubra, capsula sphaerica, ca. 7 mm longa, rubra. Capsulae septa incompleta, semina numerosa, oblonga.

Fig. 72–77.—Fig. 72–73. *Stylidium piliferum* R. Br., *Carlquist* 3697, Wandering, W.A.—Fig. 72. Basal leaf rosette. $\times 1$.—Fig. 73. Flowers. $\times 1\frac{1}{2}$.—Fig. 74–76. *Stylidium arenicola* Carlquist, *Carlquist* 3663, near Merredin, W.A.—Fig. 74. Habit. $\times \frac{1}{2}$.—Fig. 75.

Leaf rosette and portion of inflorescence, showing two fruits. $\times 1$.—Fig. 76. Flowers. $\times 2$.—Fig. 77. *Stylidium longibracteatum* Carlquist, Carlquist 3006, north of Yalgoo, W.A. Bases of two plants (photograph from dried specimen), showing turbate form of stems, presence of scale-leaves, woolliness of stem (left). $\times 1\frac{1}{2}$.

Caespitose perennial, forming clumps or stems solitary, stems densely covered with pale straw-colored woolly non-glandular hairs, this particularly evident on older portions of the stem where leaves have been shed. Leaves silvery-green, linear, flat but not bicarinate when dry, 2-4 (mostly 3) cm long, mucronate, with very narrow hyaline margins. Inflorescence paniculate, rounded, the branches regularly or irregularly dichasially branched, 7-12 cm tall, densely glandular-pubescent, reddish. Each branch of the inflorescence subtended by a linear mucronate bract or bracteole, 6 mm long or less, no bracts elsewhere. Pedicels at anthesis 4-7 mm long. Ovary at anthesis sphaerical, 2 mm long. Calyx lobes united variously into two lips, 2-3 mm long. Ovary and calyx lobes reddish. Corolla tube 2-3 mm long. Corolla probably rose-colored. Corolla lobes oblong, about 4 mm long, subequal, narrowed toward bases. Throat appendages rather conspicuous, 4, the anterior 2 linear, about 2 mm long, the posterior 2 rounded, shorter. Column about 8 mm long. Capsule about 7 mm in diameter, red, incompletely septate within, seeds numerous near base of placenta, minute, oblong.

Type: On red sand in the vicinity of Laverton, W.A. No date available. Collected by Fred W. Humphreys (RSA).

STYLIDIUM subgenus STYLIDIUM
section SQUAMOSAE

STYLIDIUM PSEUDOHIRSUTUM.—This species (Fig. 98-100) was named by Mildbraed (1908) on the basis of a single Drummond collection from an unknown locality. A locality can now be cited, because plants perfectly matching the detailed description of *S. pseudohirsutum* are now at hand (Carlquist 3997 and 4033, about 2 miles west of Needilup on Jerramungup-Ongerup road). The color of flowers was not specified by Mildbraed. Flowers are white within (Fig. 99), and the lower surfaces of corolla lobes are yellow, spotted light brown. The shape of corolla lobes in Mildbraed's drawing is not accurate, probably because shape of corolla lobes is very difficult to determine from dried specimens.

STYLIDIUM MACRANTHUM.—A specimen of a smooth-leaved plant superficially resembling *S. pseudohirsutum* was named *S. pseudohirsutum* f. *laevifolium* by Mildbraed (1908). This treatment was followed by Erickson (1958), who inadvertently called it "var. *laevifolium*" without indicating a change in status or specifying the basonym. Evidently she did not see this plant in the field. In any case, study of these plants in the field (Fig. 94-97) indicates that they are quite different from *S. pseudohirsutum* and merit recognition as a new species. *Stylidium macranthum* differs by having plants slightly smaller; inflorescence more densely hairy; leaves smooth; flowers long-pedicillate; calyx lobes linear, long; corolla rose-purple,

Fig. 78-87.—Fig. 78-80. *Stylidium longibracteatum* Carlquist.—Fig. 78. Habit. $\times \frac{1}{2}$.—Fig. 79-80. Lateral and dorsiventral views of flowers. $\times 3$.—Fig. 81-84. *Stylidium humphreysii* Carlquist, drawings from type specimen.—Fig. 81. Habit. $\times \frac{1}{2}$.—Fig. 82.

Lateral view of flower. $\times 3$.—Fig. 83–84. Views of corolla, showing labellum and throat appendages. $\times 3$.—Fig. 85. View of throat of corolla. $\times 6$.—Fig. 86. Tip of column, showing anthers. $\times 6$.—Fig. 87. Lateral and top views of calyx, showing various degree of union of calyx lobes. $\times 3$. Drawings by Mrs. Jeanne R. Janish.

outside surfaces yellow spotted purplish; corolla lobes shaped somewhat differently from those of *S. pseudohirsutum*; labellum with two subulate appendages rather than fringed; ovary with short glandular hairs, rather than mixed non-glandular and glandular hairs; habitat in white sand rather than powdery white clay-like soil. *Stylidium macranthum* is named for its striking rose-violet flowers, probably the largest in the genus *Stylidium*. One might think that such a conspicuous plant would have attracted notice earlier. It is, however, native only in the vicinity of Esperance and may have been missed by collectors because it is rather local in distribution. However, specimens of this plant have perhaps been confused with *S. reduplicatum* R. Br. Two botanists, Willis (1956) and Erickson (1958) have found that *S. reduplicatum* is a synonym of *S. pilosum* (Fig. 92, 93), an earlier name of Labillardière. Mildbraed's study of Robert Brown's type of *S. reduplicatum* from Lucky Bay yielded a description which perfectly matches plants of *S. pilosum*; Mildbraed did not see material of *S. pilosum*, so he used the name *S. reduplicatum*. Willis (1956) had material of this description compared with the type of *S. pilosum*. Because it is identical, *S. reduplicatum* must be dropped, as Willis directs. Thus there is no name applicable to the plants named here as *S. macranthum*, other than Mildbraed's forma of *S. pseudohirsutum*.

Stylidium macranthum, sp. nov.

Perennis mediocris caudice caespitoso. Folia basalia linearia, acutopungentia, marginibus revolutis, glabra, 5–25 plerumque 15 mm longa. Squamae interstinctae paucae, foliorum ca. $\frac{1}{4}$ longitud. aequantes, plerumque 2–6 cm longae, scariosae pallide roseo-brunneae. Scapi erecti, pilis longis patentibus albido-sericeis eglandulosis infra, glanduloso-pubescent eglandulosisque supra. Pedicelli calycesque glandulosi. Racemus simplex (ramosus rari), laxis, 6–38 plerumque 20–25 cm altus. Bracteae lineares, 10 mm longae vel breviores, bracteolae 2 per pedicellum, ca. 3 mm longae. Pedicelli 3–40 plerumque 15–20 mm longi. Calycis tubus oblongus, 3–3.5 mm longus ad anthesim, dense glandulosus. Calycis lobi lineares, obtusi, ca. 4 mm longi. Corolla tubus 5–7 mm longus. Corolla roseo-purpurea, exteriore flavida, purpureo-maculata. Corollae laciniae 10–13 mm longae, anteriores deltoideo-acuminatae, falciformi-curvatae, posteriores obliquiter oblongo-curvatae, margine leviter crenulato. Appendices faucis anteriores 2 e basi latae, deltoideae, paulo oblique, ca. 2 mm longae; posteriores 4, minores, filiformes, papillosae, ad apicem purpureo-maculatae. Labellum lanceolatum, basi appendiculis lanceolatis, labellum proprium aequantes. Columna 12 mm longa, antherae conspicuae, stigma magna. Capsula ovato-sphaerica, 8 mm longa, lobi 5 mm longi, nonseptata, semina basalia.

Short-stemmed perennial, the leaves all basal and various in number. Leaves erect, somewhat arcuate, linear, very narrow, 1–2 mm wide, margins revolute. Leaves 5–25, mostly ca. 15 cm long, pungent. Scale leaves mostly

Fig. 88–93.—Fig. 88. *Stylidium leptocalyx* Sond., Carlquist 3190, Regan's Ford, W.A. Flowers, showing form of corolla. $\times 1\frac{1}{2}$.—Fig. 89–91. *Stylidium albomontis* Carlquist, Carlquist 4011, East Mt. Barren, W.A.—Fig. 89. Habit, showing plant growing in crevice

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of quartz; plant has fallen over, scape has turned upward. $\times 1/10$.—Fig. 90. Base of plant. Scale-leaves show clearly. $\times 1$.—Fig. 91. Inflorescence. $\times 1$.—Fig. 92–93. *Stylidium pilosum* Labill., Carlquist 4006, Hopetoun, W.A.—Fig. 92. Habit. $\times 1/12$.—Fig. 93. Flowers. $\times 1$.

2–6 cm long, rose-brown. Inflorescence a basi-petal raceme (very rarely paniculate by virtue of a single two-flowered branch), 6–39, mostly 20–25 cm tall. Inflorescence pilose with nonglandular hairs below, mixed with glandular hairs above, and on pedicels and ovaries only glandular hairs present. Inflorescence bracts linear, 10 mm long or shorter, bracteoles usually 2 per pedicel, about 3 mm long. Pedicels mostly long, 3–40, mostly 15–20 mm long. Ovaries oblong, 3–3.5 mm long at anthesis, densely glandular. Calyx lobes linear, obtuse, about 4 mm long. Corolla tube 5–7 mm long. Corolla rose violet within, spotted purple on a yellowish background on reverse of corolla lobes. Corolla lobes about 10–12 mm long. Anterior (upper) pair of corolla lobes curved deltoid-acuminate, the base broad. Posterior (lower) pair of corolla lobes curved oblong-oblique. Labellum lanceolate, not fringed, with two long filiform appendages. Anterior throat appendages about 2 mm long, irregularly obliquely deltoid or wing-like in shape. Posterior throat appendages digitate, purple-tipped, papillose. Column about 12 mm long, anthers and stigmas rather large. Capsule ovate to sphaeroidal, about 8 mm long, tipped by the 5-mm-long calyx lobes, non-septate, seeds all basal.

Type: In white sand hills adjacent to paperbark swamps, with *Stylidium preissii* and *S. corymbulosum*, *Anarthria*, Cape Le Grande, W.A. November 5, 1967. *Carlquist* 4012 (RSA). *Isotypes*: K, US, CANB, PERTH, E, CHR.

Other collections: In loam of sand heath, with *Isopogon*, *Lambertia*, various Myrtaceae, 10 miles west of Esperance on road to Ravensthorpe, W.A. September 23, 1967. *Carlquist* 3464 (RSA, US). With *Stylidium corymbulosum*, *Comesperma volubile*, *Hakea*, *Isopogon*, *Lambertia* in wet sand, Cape Duke of Orleans road just south of east-west road from Esperance. November 7, 1967. *Carlquist* 4017 (RSA, US, CANB, PERTH, K).

STYLIDIUM LEPTOCALYX.—Because Mildbraed's drawings of corollas in this species are misleading (probably because they are derived from dried materials), I am illustrating this species (Fig. 88).

STYLIDIUM CARICIFOLIUM complex.—Typical plants of *S. caricifolium* Lindl. have leaves which are minutely roughened and white flowers, as seen in Fig. 101–102. Some populations of *S. caricifolium*, such as that in the Tutanning Reserve (*Carlquist* 3955) have densely puberulent leaves. Plants with glabrous leaves, which tend to occur in the eastern part of southwestern Australia (Fig. 103, 104), were named *S. nungarinense* by S. Moore (1920). Study of plants from the type locality shows that they agree with *S. caricifolium* in all respects other than hairiness of leaves. Moore's claim that flowers are smaller and differently shaped cannot be credited; he was probably dealing with depauperate individuals, but plants in wet places have flowers as large, even perhaps larger than those of *S. caricifolium*. These plants should be regarded as an inland subspecies, differing in no important respect from *S. caricifolium*: *Stylidium caricifolium* Lindl. subsp. *nungarinense* (S. Moore) comb. nov. (*S. nungarinense* S. Moore, Jour. Linnaean Soc. 45:183, 1920).

Fig. 94–100.—Fig. 94–97. *Stylidium macranthum* Carlquist, *Carlquist* 3464, west of Esperance, W.A.—Fig. 94. Flowers, showing reverse of corolla lobes for some flowers. × ½.—Fig. 95. Flowers, showing characteristic form. × ¾.—Fig. 96. Habit. × 1/8.—Fig. 97.

Base of plant. $\times \frac{1}{2}$.—Fig. 98–100. *Stylidium pseudohirsutum* Mildbraed, Carlquist 3997, Needilup, W.A.—Fig. 98. Habit. $\times \frac{1}{12}$.—Fig. 99. Flowers, showing characteristic form of corolla lobes, upper surface of corollas. $\times \frac{1}{4}$.—Fig. 100. Flowers, showing lower surface of corolla, broad, short calyx lobes, lack of pedicels, etc. $\times \frac{1}{4}$.

Just as *S. nungarinense* cannot be maintained as a species, neither can *S. affine* Sond. It differs from *S. nungarinense* only in flower color and geographical distribution. *Stylidium affine* has pale pink flowers, and occurs on the Darling Range. I have also found it on white sand near the coast at Lancelin (Carlquist 3861). The *S. caricifolium* complex is, with that single exception, a laterite-inhabiting species. *Stylidium affine* (Fig. 105, 106) differs in no detail of floral morphology from other members of the *S. caricifolium* complex. If *S. affine* were a good species, one would certainly expect some small detail to distinguish it: flowers of all other species of the section Squamosae can be identified by details of corolla-lobe shape, corolla-lobe size, throat appendages, labellum morphology, or calyx lobes. Clearly *S. affine* cannot be maintained: *Stylidium caricifolium* Lindl. subsp. *affine* (Sond.) comb. nov. (*S. affine* Sond. in Lehm. Pl. Preiss. I:371, 1844-1845).

STYLIDIUM PILOSUM.—The identity of this species (Fig. 92, 93) has been clarified, as discussed above under *S. macranthum*. I have collected this species near Hopetoun, where it occurs on white sand of a coastal sand heath. This species is of interest because it is the closest relative of the new species below.

STYLIDIUM ALBOMONTIS.—Among the white quartz boulders of East Mt. Barren one can find a *Stylidium* which does not agree, even subspecifically, with any named species. It appears similar to that figured as *Candollea reduplicata* by Ferdinand von Mueller (1892), but that drawing, although well done, does not figure critical characters, and might represent another species, such as *S. leptocalyx*: the drawing was probably prepared without consultation of the type of *Stylidium reduplicatum*. In any case, the plants on East Mt. Barren differ from *S. pilosum* by having much smaller stature; later flowering time (by about a month); a simple raceme with fewer flowers, rather than a branched panicle; shorter pedicels; much smaller flowers, with distinctive shape of corolla lobes; much smaller capsules. These plants (Fig. 89-91) deserve specific status.

Stylidium albomontis, sp. nov.

Perennis caudice caespitoso. Folia basalia, erecta sed saepe arcuata, linearia, mucronata, marginibus distincte revolutis, scabrida, 9-30 plerumque 20 cm longa, ad 4 mm lata, rigida. Squamae interstinctae paucae, 1-11 cm longae, ca. 1 cm lata, roseatae. Scapi erecti, pilis longis patentibus, in parte inferiore glandulosis eglandulosisque mixtis, in parte superiora glanduloso-pubescentes. Scapus aphyllus, racemus simplex. Pedicelli ad anthesim ca. 2 mm longi, paulo crassi. Calycis tubus dense glanduloso-pubescent, ca. 5 mm longus, oblongus. Calycis lobi ca. 2 mm longi ad anthesim, liberi, corollae tubus ca. 4 mm longus. Corollae laciniae subaequales, 6-8 mm longae, cuneatae, truncatae, manifeste serrulato-crenolatae, extus glandu-

Fig. 101-106.—Fig. 101-102. *Stylidium caricifolium* Lindl. subsp. *caricifolium*, Carlquist 3594, Bolgart.—Fig. 101. Habit, fruits at upper right.—Fig. 102. Flowers (one flower inverted at lower right).—Fig. 103-104. *Stylidium caricifolium* Lindl. subsp. *nungarinense* (S. Moore) Carlquist, Carlquist 3686, Narembreen, W.A.—Fig. 103. Habit,

two plants shown.—Fig. 104. Flowers and young fruits.—Fig. 105–106. *Stylidium caricifolium* Lindl. subsp. *affine* (Sond.) Carlquist, *Carlquist* 3580, Lesmurdie Falls, W.A.—Fig. 105. Habit.—Fig. 106. Flowers.—Fig. 101, 103, 105, $\times 1/8$; Fig. 102, 104, 106, $\times 1$.

losae, rosaceo-violaceae. Labellum ovato-lanceolatum, appendices subulatae. Appendices faucines pallidae, conspicuae, anteriores 2 obliquiter lanceolatae, posteriores 2 binatae, papillosae, ad apicem purpureo-maculatae. Columna ca. 8 mm longa. Capsula 6–10 mm longa, ovoidea, pedicelli in fructibus 2–5 mm longi. Semina ignota.

Short-stemmed perennial, occasionally with short offsets, the leaves all basal and various in number. Leaves erect, often arcuate, 9–30, mostly about 20 cm long, ensiform-linear, 4 mm wide or less, margins markedly revolute. Leaf surfaces scabrid, leaf texture rigid, leaf tip mucronate. Scale leaves 1–11 cm long, 1 cm wide, pale rose. Scapes 20–60, mostly 30 cm tall, portion bearing flowers 8–10 cm long. Axis of inflorescence with glandular and non-glandular hairs mixed, non-glandular much less frequent in upper parts of inflorescence, which bear a dense covering of glandular hairs. Inflorescence a simple, unbranched raceme. Bracts and bracteoles linear, 6 mm long or shorter. Pedicels about 2 mm long at anthesis, relatively thick. Ovary 5 mm long at anthesis, oblong, densely glandular. Calyx lobes about 2 mm long, free. Corolla tube 4 mm long. Lobes equal, 6–8 mm long, cuneate, truncate, glandular pubescent on outer surface, pale red-violet, distinctly crenulate or serrulate around most of margin. Labellum ovate-lanceolate, with short subulate appendages. Throat appendages conspicuous, anterior pair obliquely lanceolate, posterior pair binate, papillose, purple-tipped. Column about 8 mm long. Capsules 6–10 mm long, on pedicels 2–5 mm long.

Type: Among quartz blocks, with *Stylidium galioides*, *Regelia*, *Leucopogon*, *Pimelea*, East Mt. Barren. November 4, 1967. *Carlquist 4011* (RSA). *Isotypes:* US, K.

STYLIDIUM subgenus NITRANGIUM section SONDERELLA

STYLIDIUM TENUICARPUM.—In the Tutanning Reserve east of Pingelly, W.A., I found plants which at first recalled *S. macrocarpum* (*S. streptocarpum* of several authors) in their curving buds and elongate capsules. However, the Tutanning population (Fig. 107–109) differs from *S. macrocarpum* (Fig. 110) by having the following features: flat, hyaline-margined leaves; scale leaves at the beginning (or end) of each year's growth, like those of *S. squamellosum* or *S. aeonioides*; inflorescence a simple raceme, never branched; inflorescence and ovaries densely pubescent with non-glandular hairs; corollas yellow, with an orange spot at the base of each corolla lobe; long, narrow capsules, very little wider at the base than distally. Species other than *S. macrocarpum* seem more remotely related, although *S. pubigerum* is somewhat reminiscent, but differs in many features. At any rate, the Tutanning plants deserve specific status:

Stylidium tenuicarpum, sp. nov.

Perennis caespitosa robusta, caudice crasso caepe polycephalo. Folia omnia basalia dense conferta, erecto-patentia, lineari-oblancoolata, 2–6 plerumque 4 cm longa, ad 2 mm lata, longimucronata, glabra, margine

hyalino. Supra et infra folia caulis squamis vel squamoso-foliis brevibus instructa. Racemus simplex, 4–35 plerumque ca. 15 cm altus, pilosus, eglandulosus, scapus ebracteatus. Bractae lineares, 1 cm longae vel breviores, bracteolae minute, 2 per pedicellum. Pedicelli 1–10, plerumque 3–4 mm longi. Calycis tubus ad anthesim 2–3 cm longus, eglanduloso-pubescent, nutans vel arcuatus, rarius rectus, teretus, linearis, 1–2 mm latus. Calycis lobi 2–3 mm longi, acuti. Corolla flavida, corollae laciniae 4–6 mm longae, 2 mm latae, oblongae, extus eglanduloso-pubescentes. Labellum conspicuum, deltoideum, appendiculis 2 minutis instructum. Columna ca. 7 mm longa. Capsula arcuata vel recta, teres, linearis, 2.5–3.5 cm longa, 1–2 mm lata.

Caespitose perennial, rosettes single or several from a thick, short stem, often many-headed. Leaves erect-spreading, oblanceolate, acuminate, pale green, glabrous, flat, with narrow transparent margins, mucronate or ciliate at the tip, 2–6 (mostly 4) cm long, 2 mm wide or narrower. Shorter leaves, the shortest of which are deltoid and scale-like, formed in various numbers at the end of each year's growth, surrounding the base of the scape; scale leaves also on elongate stems where present. Inflorescence a simple raceme, 4–35 (mostly about 15) cm tall, pilose with non-glandular hairs, no bracts below the lowest flowers but one bract subtending each pedicel. Bracts lanceolate, 1 cm long (lower bracts) to 2 mm (upper bracts), acute, transparent-margined; bracteoles usually two per pedicel, 1–2 mm long. Pedicels 1–10 mm long. Ovary linear, curved, 2–3 cm long at anthesis, pubescent with non-glandular hairs; ovaries curved in bud, nutant. Calyx lobes 2–3 mm long, acute. Corolla yellow, tube 2 mm long, lobes oblong, 4–6 mm long, 3 mm wide, each with an orange spot at the base, lightly pubescent with non-glandular hairs outside. Throat bare. Labellum conspicuous, 1.5 mm long, deltoid, with small acute lateral membranous appendages. Column about 7 mm long. Capsule 2.5–3.5 cm long, mostly 1 mm wide, curved, linear.

Type: In lateritic soil on floor of *Eucalyptus*–*Casuarina* woodland, Tutanning Reserve east of Pingelly, W.A. October 30, 1967. *Carlquist* 3952 (RSA). *Isotypes*: K, US, PERTH, CANB, E, BSB, CHR, UC.

STYLIDIUM subgenus NITRANGIUM

section THYRSIFORMES

STYLIDIUM YILGARNENSE.—This species was described by Pritzel (1904) from material collected at Ghooli, near Southern Cross. I have collected material in flower (Fig. 68, 69) from this locality. The flowers are somewhat larger than those of plants collected at the type locality (or nearby) of S. Moore's "*S. glanduliferum*" (Fig. 70, 71). Moore's (1920) supposition that "*S. glanduliferum*" has throat appendages different from those in *S. yilgarnense* is merely based on the incompleteness of Pritzel's description. This is not surprising in view of the difficulty of obtaining details from dried flowers of *Stylidium*. However, there seems no reason to perpetuate this faulty understanding, and *S. glanduliferum* S. Moore must be considered a synonym under *S. yilgarnense* Pritzel.

STYLIDIUM CRASSIFOLIUM and *S. ELONGATUM*.—*Stylidium crassifolium* (Fig. 111, 112) is widely distributed in Western Australia. *Stylidium elongatum* differs very little from it: essentially only in having a pilose scape. Because trichomes are usually present on primordia of both glabrous and hairy plants, but vanish early on the glabrous ones, differences of vestiture are often fairly minor. They clearly are in this instance, for *S. elongatum* represents such small difference from *S. crassifolium* that the concept of species in *Stylidium* would be quite distorted if both were maintained. *Stylidium crassifolium* is replaced by *S. elongatum* imperceptibly toward the north (Geraldton, Northampton), and therefore *S. elongatum* is merely a northerly subspecies of *S. crassifolium*: *S. crassifolium* R. Br. subsp. *elongatum* (Benth.) comb. nov. (*S. elongatum* Benth., Fl. Austr. IV:11, 1869).

LEVENHOOKIA

The genus *Levenhookia* is restricted to Western Australia except for *L. pusilla* (W.A., S.A.), *L. dubia* (W.A., S.A., Vic., N.S.W.) and *L. sonderi* (Vic.). *Levenhookia sonderi* is considered to be a variety of *L. dubia* by Mildbraed (1908). It is certainly close to *L. dubia*, just as *L. octomaculata* (Fig. 114) is to *L. stipitata* (Fig. 113). With the recent addition of *L. chippendalei*, a species of the interior of Western Australia, nine species have been described. These species form an interesting series, as described by Erickson (1958). However, the evolutionary sequence is probably the reverse of that proposed by Erickson, and should be read from cross-pollination, as in *L. preissii*, to self-pollination, as in *L. dubia*. This series is more logical, for *L. preissii* and particularly *L. pauciflora* (Fig. 117) are the most similar to *Stylidium* subg. *Centridium*, the group within *Stylidium* that most suggests ancestors of *Levenhookia*. During my field work in Western Australia in 1967, I encountered a large population of a new species of *Levenhookia*, which is perhaps related to *L. pauciflora* and *L. preissii* most closely, but is quiet distinct from them. It is certainly not closely related to *L. leptantha* (Fig. 116) or *L. pusilla* (Fig. 115). *Levenhookia pulcherrima*, proposed below, agrees with *L. preissii* and *L. pauciflora* in having upper corolla lobes different from lower ones. However, it is unique in the emarginate or notched nature of corolla lobes and in their large size. *Levenhookia pulcherrima* has distinctive red markings (Fig. 118, 119) on upper corolla lobes. While *L. preissii* and *L. pauciflora* have callosities in the throat, well figured by Erickson (1958), *L. pulcherrima* has a triangular appendage between the bases of the two upper corolla lobes, and a pair of lateral callosities. *Levenhookia pulcherrima* has a labellum which is not clawed, as in *L. preissii* and *L. pauciflora*; its labellum also lacks the terminal brush seen on the labellum of *S. pauciflora*, or the odd knob-like terminal appendage seen on the labellum of *S. preissii*. *Levenhookia pulcherrima* has a unique arrangement of stigmas. The lower is straight, the upper recurved (Fig. 119, lower left). In *L. preissii*, both are curved, but the tips approach each other. In *L. pauciflora*, the two stigmas are short, erect, but

$\times \frac{1}{4}$.—Fig. 109. Grouping of flowers. $\times \frac{1}{4}$.—Fig. 110. *Stylidium macrocarpum* (Benth.) Erickson & Willis, *Carlquist* 3637, Cockleshell Gully, W.A. Portion of inflorescence.—Fig. 111–112. *Stylidium crassifolium* R. Br., *Carlquist* 2918, Perenjori, W.A.—Fig. 111. Habit. $\times \frac{1}{12}$.—Fig. 112. Portion of inflorescence. $\times \frac{1}{4}$.

divergent. The shape of corolla lobes in *L. pulcherrima* is unique; calyx lobes are notably long; the plants are relatively large (Fig. 118), exceeded in size only by those of *S. preissii* and *S. chippendalei*; leaves and stems of *L. pulcherrima* are more heavily glandular than in other species. Other less important features distinguishing *L. pulcherrima* could be cited. In addition, the locality in which this species was found, remote from areas occupied by *S. preissii* and *S. pauciflora*, is noteworthy.

Levenhookia pulcherrima, sp. nov.

Annua omnino glanduloso-pubescent, ad 12, plerumque 7–8 cm alta. Caulis ruber, simplex vel saepius subcorymboso-ramosus, ramis patentibus. Folia caulina inferiora spatulata, petiolata. Folia superiora oblanceolata, 1.8 cm longae vel breviora. Bractae foliosae, 15 mm longae vel breviores. Flores ad anthesim subsessiles, calycis tubus sphaericus, 1 mm longus, calycis lobi 2 mm longi, lanceolati. Corollae tubus 4–5 mm longus, pallidus. Corollae laciniae rosaceae vel albido-rosaceae, inaequales. Corollae laciniae anteriores minores, ca. 3 mm longae, obovatae, conspicue emarginatae e subbasi roseo-maculatae in formibus W, e basi leuco-flavidae. Laciniae posteriores majores, rosaceae sed immaculatae, emarginatae, curvato-spatulatae, ca. 4 mm longae. Labellum sessile ovoideum, album, ad apicem griseo-purpureo-maculatum, appendiculatum. Faux callis lateralibus 2 et dentibus deltoideis instructus. Stigmata filiformes, stigma anteriora recurvata, stigma posteriora recta. Capsula nonseptata, sphaerica, ca. 3 mm longa, ad apicem calycis lobi 4 mm longi. Pedicelli in fructibus 2 mm longi. Semina basalia, minuta, papillosa.

Annual, with glandular trichomes throughout, branched or smaller plants unbranched. Depauperate plants 1-flowered, about 2.5 cm tall, tallest plants 12 cm tall, average plants about 7–8 cm. Stems red, leaves green, older leaves turning red. Lower leaves broadly spatulate and clearly petiolate. Upper leaves oblanceolate, to 1.8 cm long, tapering imperceptibly into petioles. Bract-leaves oblanceolate-linear, to 1.5 cm. Flowers at anthesis subsessile, ovary sphaerical, ca. 1 mm in diameter, calyx lobes ca. 2 mm long, lanceolate. Corolla tube 4–5 mm long, pale. Corolla lobes pink to rose, unequal, the anterior ones shorter, about 3 mm long, obovate, conspicuously emarginate, each bearing at the base a W-form or inverted V-form red marking; the base of the lobes between this marking and the throat yellowish or white. Posterior corolla lobes about 4 mm long, variously curved-spatulate, usually emarginate, the space between the claws of these two lobes accommodating the labellum and its enclosed (prior to sensitive motion) column, bases of posterior lobes fading abruptly into the throat, not spotted or marked. Labellum obovate in outline, not clawed, white, the terminal portion bearing on either side a circular gray-purple mark; acute short appendages present near the base of the labellum. Stigma lobes

Fig. 113–119. Species of *Levenhookia*.—Fig. 113. *Levenhookia stipitata* (Benth.) F. Muell., *Carlquist* 3599, Bolgart, W.A. $\times$ 1.—Fig. 114. *Levenhookia octomaculata* Erickson & Willis, *Carlquist* 3924, Badgingarra, W.A. $\times$ 1.—Fig. 115. *Levenhookia pusilla* R. Br., *Carlquist* 3739, Cranbrook, W.A. $\times$ 1.—Fig. 116. *Levenhookia leptantha* Benth.,

Carlquist 3018, north of Northampton, W.A. $\times 1$.—Fig. 117. *Levenhookia pauciflora* Benth., *Carlquist 3705*, Porongorups, W.A. $\times 1$.—Fig. 118–119. *Levenhookia pulcherrima* Carlquist, *Carlquist 3999*, Phillips River west of Ravensthorpe, W.A.—Fig. 118. Habit. $\times \frac{1}{2}$.—Fig. 119. Group of flowers. $\times 1$.

unlike, the posterior straight, the anterior recurved, its tip pointing toward the throat. Throat with two minute callous lumps, one on each side of the throat; a minute triangular throat appendage located between the bases of the anterior lobes. Capsules spherical, 3 mm in diameter, topped by the calyx lobes which elongate to 4 mm in fruit. Capsule non-septate, seeds basal, spherical, minute, roughened. Pedicels in fruit 2 mm long.

Type: In flats of hardpacked sand of *Casuarina* woodland, above Phillips River just east of the bridge on Ongerup-Ravensthorpe Highway, W.A. November 8, 1967. *Carlquist* 4027 (RSA). *Isotypes:* US, K, CANB, PERTH, E, CHR, BSB, UC, and others.

Other collections: same locality, November 3, 1967. *Carlquist* 3999 (RSA, K, US, CANB, PERTH, E, BSB, CHR, UC).

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