Some Observations on the genus Arhtrocnemum

H. Tölken

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Introduction

Only in 1954 the notes of late Prof. Moss on the genera *Arthrocnemum* and *Salicornia* were published, and although this was a big step forward in the classification of these genera, it proved to be unsatisfactory in many cases. This, however, should not throw the work on that subject done by him into shade, as shows his ealier works (Moss, 1910, 1912, 1914),and only his notes published by Prof. Adamson in 1954 were unfortunately fragmentary. The revision of the genus *Arthrocnemum* is taken up again, as so many salt marches on the Cape Flats are drained and the rivers chanalized, sothat the number of localities are increasing rapidly, and fresh material is essential for this work.

The aim of this work is to cover a as large field as possible, but always with the eye on some further evidence for the taxonomy of the species. Unfortunately only a few species which are growing on the Cape Penninsula and some fresh marterial of *A. affine* from Swakopmund was available for this study. This gives perhaps a bit onesided view, but indications of similar problems in other species or of difficulties with explaining phenomena has been given for later research.

Investigations were mainly done on fresh material, and dried herbarium specimen were usually only consulted for confirming certain characters found in fresh. To aid this it was made use of photos where ever possible, but it was found sometimes almost impossible to get clear pictures, as the flowers are minute and inconspicuous.

For conveniance the whole treatise has been divided into three main parts:

(1) The ecological part (autecology) in which the zonation phenomenon at Milnerton has been emphasized, but at hte same time it gives an account of the particular habitat each species requires.

(2) A brief account of the anatomy especially the abnormal secondary growth in the stem and root has been given, and a discussion of the origin of the fleshy segmented branches follows.

(3) Lastly the history and the distribution of the whole genus *Arthrocnemum*, and a treatise of the classification and its difficulties of the species of the Cape Peninsula is produced.

This work is purely preliminary, and it is tried to get access not only to the problematic taxonomy , but to an understanding of these plants as such. The author is well aware of some generalisatios or speculative assumptions, but the main point of this treatise is to get a new approach to that difficult group of plants, of which each detail seems to be worth to be recorded for later evaluation.

ECOLOGY

When inspecting the species of Arthrocnemum and Salicornia at Rugby (Milnerton) and also further on to Paarden Eiland, a clear zonation of the different species can be observed at various places. An unusual aggregation of five species of Arthrocnemum and Salicornia Meyeriana makes the phenomenon more obvious.

As the zones of the different species are parallel with the water's edge all along the banks of the river, the availability of water - being considered as the most important working factor - is studied in some more detail in the following experiment. Not only the distance away from the standing water, but also the salinety of the soil determines the availability of the water or the latter might even be toxic to certain species. Thus it is expressed in terms of osmotic pressure (atmospheres) which is determined by freezing point method. Lateron some additional factors, of which only observations have been made, will be discussed to give a whole picture of the ecology and as far as possible an explanation for the zonation phenomenon.

Method.

This experiment is done just after some smaller rains at the end of May.

First two line transects far apart were run, to give a diagramatic picture of the zonation of the occuring species and their abundance. Transect A (fig 1) was taken on the right (coming from Cape Town) of Marine Drive.near Paarden Eiland. Transect B (fig 2) was taken at Rugby on the left side of the road.

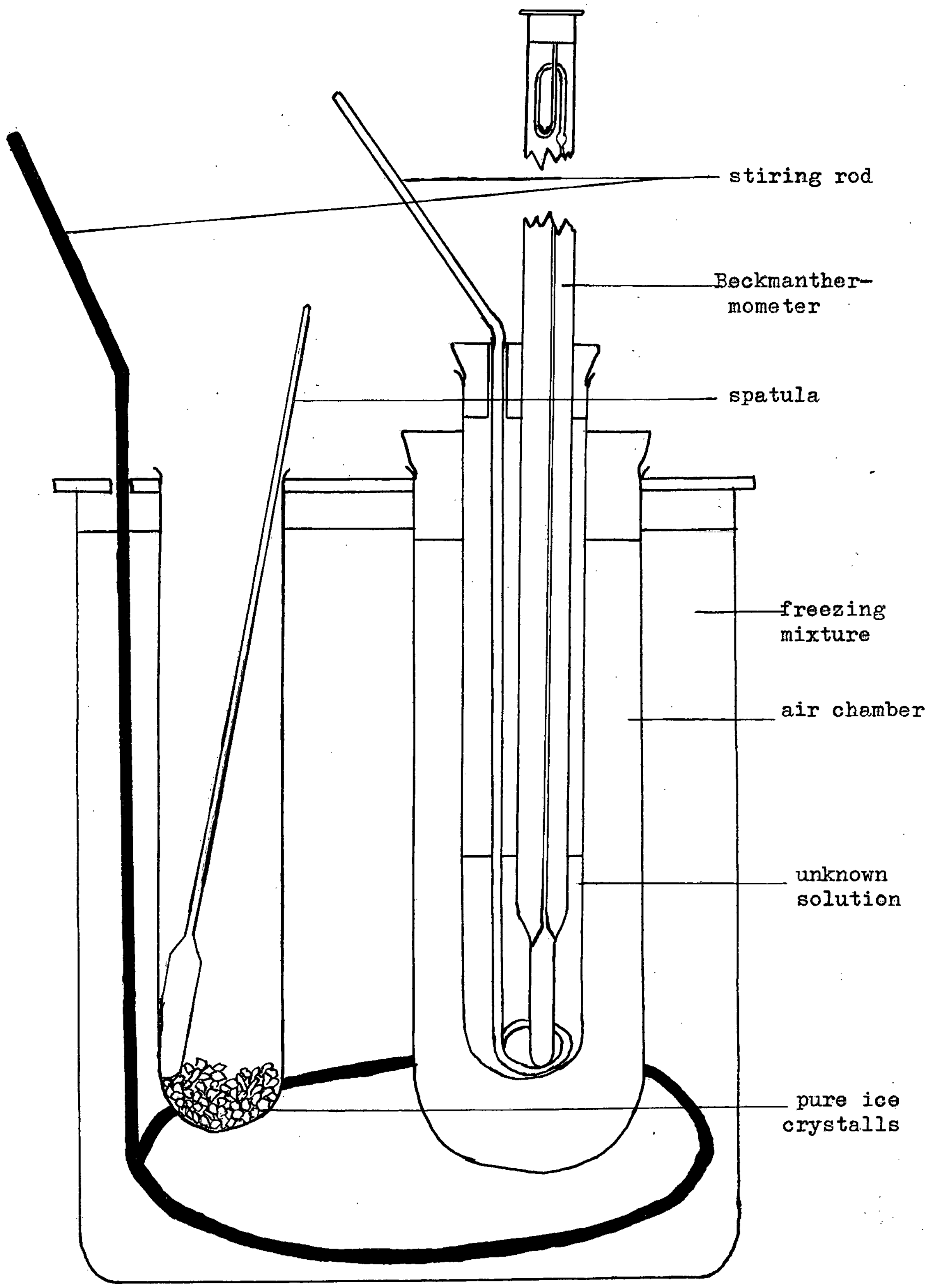
Along these transects soil samples were collected just below the surface and put into polythene bags to avoid contamination or drying out. Sample No8 was taken about fifty yards away from transect A. Intensive sampling was done along transect A; that means on places where the certain specie is flourishing and on transitional zones between the species. Along transect B only checkpoints were taken.

This moist unsieveted soil is weight in petridishes and then dried in an oven at a temperature of 98° - lo4° C. After a day and a half they were let cool down in a desicator and again weight. Now the soil samples were put back into the oven for three hours, and then weighing after cooling down, gave the same weights, and thus assure complete dryness of the samples.

From these soils loogm where weighted out into small erlenmeyer flasks, and onto that looml of boiled deionized water was poured with a 5oml pipet. The flasks were closed with corks and then thoroughly shaken. Unfortunately they stood like that for four days , due to a lack of time to complete. Priliminary attempts to determine the osmotic pressure, as described later, of other soil samples showed, that those of the clayish samples are somewhat high and thus a day before the final determination some more boiled deionized water is poured into some of the samples, as can be seen in table 1.

The solutions were filtered of the soil with normal filter paper to assure that all colloids are present, because the osmotic pressure of the total soil solution is to be determined. The freezing points of these filtrates and of

Fig 3 Apparatus.



the boiled deionized water were determind with the apparatus as described by Crockfort & Nevill(1956) and a diagram is shown in fig 3 . After a first rough determination the solution is warmed up again until all ice crystals disappear. Then it is cooled down just below its roughly predetermined freezing point and a small piece of ice of pure water is added to improve crystallization and prevent undercooling. When warming up again, caution is taken that this ice will not melt - as being pure ice it will melt at a higher temperature - and thus do not dilute the sample solution. Furthermore if it would melt, it is too little to affect the results. Both stirring rods must be moved continuously. The highest temperature read on the Beckmanthermometer after crystalization is the freezing point. Three readings of each solution were taken (see table 2).

From this the osmotic pressure is worked out with the following formule: (Harris 1914)

$$\pi = 12.o6\Delta - o.o21\Delta^2$$

(where π stands for the osmotic pressure, and Δ for the freezing point depression.)
Harris (1914) states that it will give an accuracy, "which depends only upon the precision of the freezing point determinations..." . As the Beckmanthermometer gives an accuracy of two decimals and an estimated third one, the results should be very accurate.

For comparing the results the osmotic pressure (π_1) is worked out per loogm of soil and looml water. However, with different soil types the water contents varies considerably, and thus the 'theoretical' osmotic pressure (π_2) is worked out, assuming that the moist soil is deprived of water only during drying , and that lgm water = 1 ml water. The word 'theoretical' is not used, because of these assumptions, which result only minor errors, but it is unknown what salts or compounds are found in the solutions and what are their solubilities. That means it is most probable that in the higher osmotic pressures the value is too high, as there can certainly disolve more salt in loo ml of water than in the actual soil solution. In summer often a crust of salts can be seen in some areas. The error on the other samples should be very small, even though the first weights are only accurate within o.5gm. The effect of rotting during the four days of standing can not be estimated, but could certainly have been much, as inorganic salts, which give the greatest osmotic pressures, are only formed slowly by the decay of organic matter. To estimate an error, it does not seem likely to have exeded 3%.

Results.

To give an indication of the sort of soil dealt with in the different samples, a short discription of the different layers is given. Absolute measurements of the sedimentation layers of the different samples could not be taken as not uniform erlenmeyer flasks were used, and it would not have ment much more for this purpose.

Sedimntation layers:
Sample 1: Coarse sand with little clay and organic matter.
" 2: " " " " " " " "
" 3: Coarse sand and clay in ratio 3:1 , little organic matter.
" 4: Finer sand and clay in ratio 3:2, " " "
" 5: Fine sand with little clay, but much organic matter.
" 6: Coarser sand and little clay, little organic matter.
" 7: Little sand and clay, almost entirely organic matter.
" 8: More sand and clay, with much organic matter.
" 9: Coarse sand and little clay, with much organic matter.
" lo: " " " " " and little " "

Table I

sample No	empty dish (gm)	dish + wet sand (gm)	dish+ dry sand (gm)	water (gm)	dry sand (gm)	for determination	
						dry sand (gm)	water (ml)
1	35.0	213.0	203.0	10.0	168.0	99.140	100
2	29.2	212.0	189.6	22.4	160.4	99.795	150
3	41.3	229.0	201.8	27.2	160.5	100.750	150
4	31.5	234.0	208.6	25.4	177.1	99.510	175
5	38.0	198.5	186.5	12.0	148.5	100.290	125
6	34.0	196.5	186.3	10.2	152.3	99.590	100
7	19.8	153.0	96.6	56.2	76.8	70.250	125
8	26.5	224.0	199.5	24.5	173.0	100.070	100
9	36.0	219.5	178.0	41.5	142.0	99.630	100
10	36.7	225.8	175.0	50.8	138.3	99.395	125

Table II

sample No	freezing point (°B)	mean (°B)	Δ (°B)	π (atm)	π_1 (atm)	π_2 (atm)
pure water	2.520 2.520 2.515	2.518	–	–	–	–
1	2.322 2.317 2.318	2.319	0.199	2.399	2.41	40.49
2	2.045 2.042 2.045	2.044	0.474	5.671	8.62	61.73
3	1.942 1.947 1.945	1.945	0.573	6.84	10.14	59.69
4	0.950 0.950 0.960	0.957	1.561	20.09	35.42	246.90
5	2.102 2.095 2.101	2.099	0.419	5.05	6.09	75.37
6	2.282 2.287 2.288	2.286	0.232	2.78	2.86	43.55
7	0.810 0.810 0.812	0.811	1.707	20.51	45.97	62.84
8	2.028 2.025 2.028	2.027	0.491	5.92	5.93	41.79
9	1.170 1.172 1.175	1.172	1.346	16.32	16.32	55.08
10	1.077 1.072 1.078	1.076	1.442	17.36	21.83	59.44

(°B stands for degrees on the Beckmanthermometer)

From these results it can clearly be seen, that *Arthrocnemum capense* grows best in soils with a very low osmotic pressure (samples 1,6). It also preferes a very coarse sand, and that indicates, that it can not be very saline, as its water contents is very low.(see π_1). This preference is clearcut even from the so near related *A.perenne*, which forms usually a transitional zone between the former and *A.africanum*. Its transitional position is shown in sample 9, whereas in sample 2 it shows already the value of A. africanum, which seem to flourish at about 6o atmospheres (samples 3,1o), but can tolerate 75atm. osmotic pressure of the soil (sample5). For both A. africanum and A.Pilansii the osmotic pressures may vary considerably, and it seems that the availability of water can not fully account for their separation, although the latter has a lower range (sample 7,8) than the former, and they are overlapping in the middle. Also the type of soil does not say much, exept there is much more organic matter found around A.Pillansii.

Clearly Salicornia Meyeriana preferes very saline soils , as it is always found as the last zone around open patches in the vegetation, for which sample 4 gives evidence to be too salty, that plants can grow on it. In summer these patches are usually covered with a white crust of salt. Being a shrubby annual plant it certainly could compete with prostrate species, if it had a preference to less saline soils.

The water availability alone does not explain the phenomenon of zonation, even if a greater variety of samples are taken, but it might give the tolerance ranges of the different species, and these obviously overlap.

Discussion.

Inspecting the plants in their habitat the information got from the experiment is valid. A. capense is mainly found on coarse sand of the higher banks of the rivers or salt pans. The soil also seems not to be very saline,as the plant is usually growing together with grasses and herbs e.g. Oxalis spp. It is found in greater abundance near Paarden Eiland, where the mentioned conditions are prevailing, whereas further to Rietvlei the soil is clayish and it is scarcely or not atall growing there.

With the exeptional great rains this year, huge areas were swamped, and gave another reason for the zonation in some species, for which the evaluation of the experimental results could not give a satisfactory explanation. It is namely found that A. africanum is capable of surviving complete submerging (compare highwater levels on transects A,B). After six weeks an investigation showed, that the fleshy parts of the stems were decaying, but in the axils small absolutely fresh latent sprouts assured the vitality of the plants (Tölken No 163). Other plants of which the upper part of the stem is still above the water, grew rapidly, but on the submerged parts the leaves also rot. In A. africanum there is a tendency to dry up in the winter, even if they are not floaded, and in the spring they sprout again out of dormant 'buds'.

On the other hand bushes of A. Pillansii are always found on small elevations or higher up on the banks of the rivers. As they are hard and dense shrubs, the question arises, wether the soil elevations are only deposited silt and organic matter from the river ? Investigations have shown that the plant can form adventitious roots, if the stems are covered with sand. In fact the specie becomes dominant towards Rietvlei, and there it is usually prostrate to half-erect. Digging up a plant, it was found that the stems might be covered with silt and organic matter, and the plant only produce adventitious roots and is growing on vigorously. On the other hand with the extraordinary rains this year some of the bushes being partly submerged died. Thus it does not want to be covered by water for a long time.

Also at Velddrift it grew abundant in the mouth of the

Geat Berg River, and it can be observed there , that it grows as a bush away from the water, but seems to become suberect to prostrate at the water's edge. Sometimes both growthforms occur next to one another without being possible to explain it by the above mentioned findings.

In the case of A. perenne it is not quite clear, but it seems more likely, that it does obey to an osmotic pressure tolerance rather than to the hight of the water level, as it is usually found next to the water's edge, but might as well be submerged without any harm. A. variiflorum, which usually does occur in patches among A. africanum seems to be capable to endure the submerging. Salicornia Meyeriana - being an annual - is not atall affected, as it dies down before the areas are swamped.

The question might be asked, whether this 'treatment' affects the later growth of the plants? Some plants which have been too long under water died, but the greater majority grew luxuriantly as soon as they emerged from the water. (Tölken No 164) All places known to the author on the Cape Peninsula and vicinity where A. africanum grows are temporally floaded. In South West Africa A. affine is found, which seems to be very near related to the former species. In fact no real difference exept the more vigorous appearance could be found between the two species. The seedcharacter seem to intergrade. Moss (1954) suspects that this difference is due to a hotter climate, but a remarkable herbarium specimen with the following remark of the finder (Merxmüller & Giess No 174o) gives another indication: ' Pflanzen auf dem Trockenem rot und robust, am Rand des Salztümpels grün und zarter'. The piece of the smaller plant must, without knowing its origin, be identified as A. africanum, as seeds are not available from it. In those areas where it grows, the rainfall can be ignored, and they are also not temporally floaded, and they grow around lagoons or places where water seeps through from the sea or rivers.(see photo fig 4). Furthermore the plants do not dry down and become dormant during the winter, and only become retarded, but still are very fleshy.

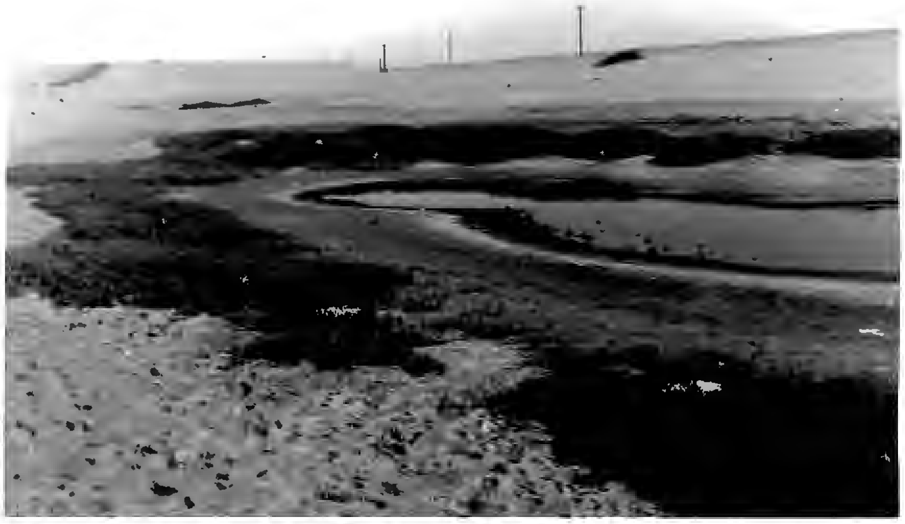


Fig 4 Typical habitat A.affine (some 3om across the railway-line is the sea, on the right.)

Another phenomenon, which seems to be closely related to more vigorous growth is the number of flowers per cymule. Fresh material of A. affine from Swakopmund showed, that in three spikes out of five at east one cyme had more than three flowers. These spikes were usually older ones, which indicates, that these lateral flowers are growing much later. Here it must be refered to A. heptiflorum (Bolus No 18806) - a specie not dealt with in this treatise - which clearly shows, that there are only three flowers per cyme to begin with, and the others become visible later. On the other hand in A. africanum only one spike with four flowers per cyme was found on a plant growing luxuriantly at Wilde Vogel Vlei.

Especially in A. africanum one can frequently observe, that the terminal spike suddently grows vegetatively for some segments, followed by another spike, and even may repeat this (see photo fig 5). What the causing factor for this phenomenon is unknown to the author, as it was only found in the prostrate species but not in the suberect A. Pilansii.

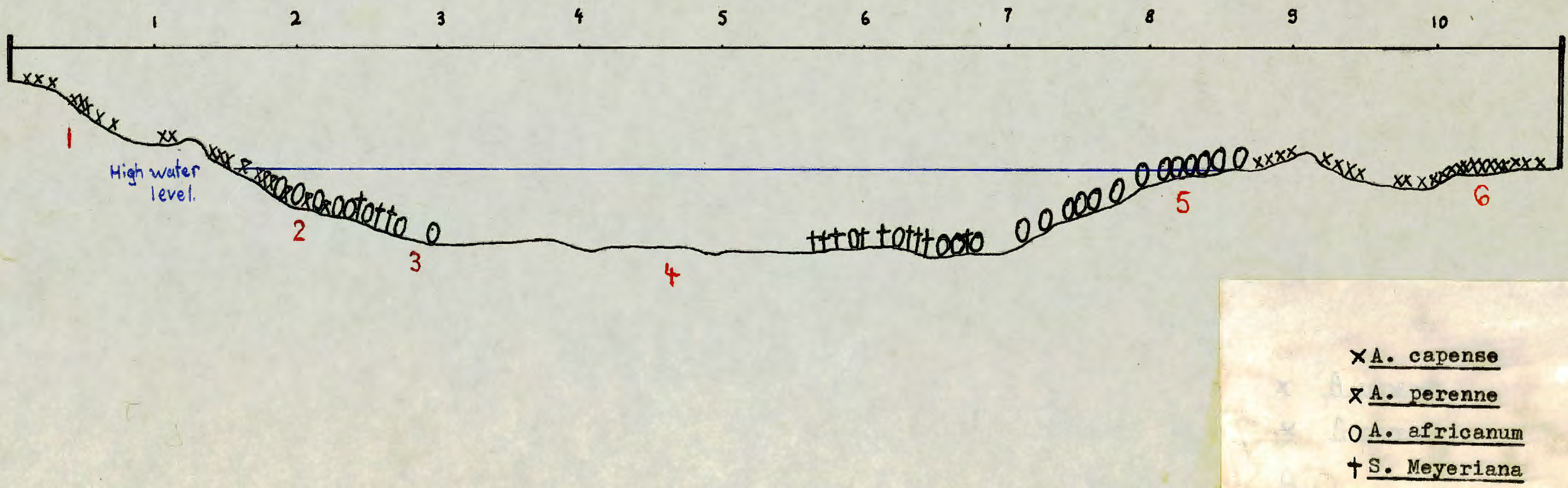
A. africanum was found rooting at the nodes at Paarden Eiland, but not at Milnerton. In the case of the former coarse sand is blown onto the plants, whereas it grows in mud without sand around in the latter locality. Branches put into the water did not root within six weeks, after which it had to be removed being attacked by fungi. At Lamberts Bay and Velddrift it was also growing in mud and clay similar to Milnerton, but still it was rooting at the nodes. This seems to be induced by covering the stems with sand or mud. In some species as A. capense adventitious roots are formed spontaneous, but it must not be stressed in classification as it might occure, in fact does occure very often in other species even in the bushy forms.

Also colour is variable according to conditions, and only certain shadings of red are specific in some cases (mentioned later). The colour seems to vary to the availability of water in summer. In winter however, all plants turn to their special shading of red or red-brown, exept A. littoreum, which becomes dull yellow. Only occationally some segments of dying branches might turn red. This might be due to their habitat remaining constant, being next to the tidal zone among rocks. The red is caused by anthocyanins in the waterstorage layer, and the amount of chlorophyll in the palisade cells around it result the special shadings up to an extend.

Fig 5 A. africanum whith three spikes in succession.

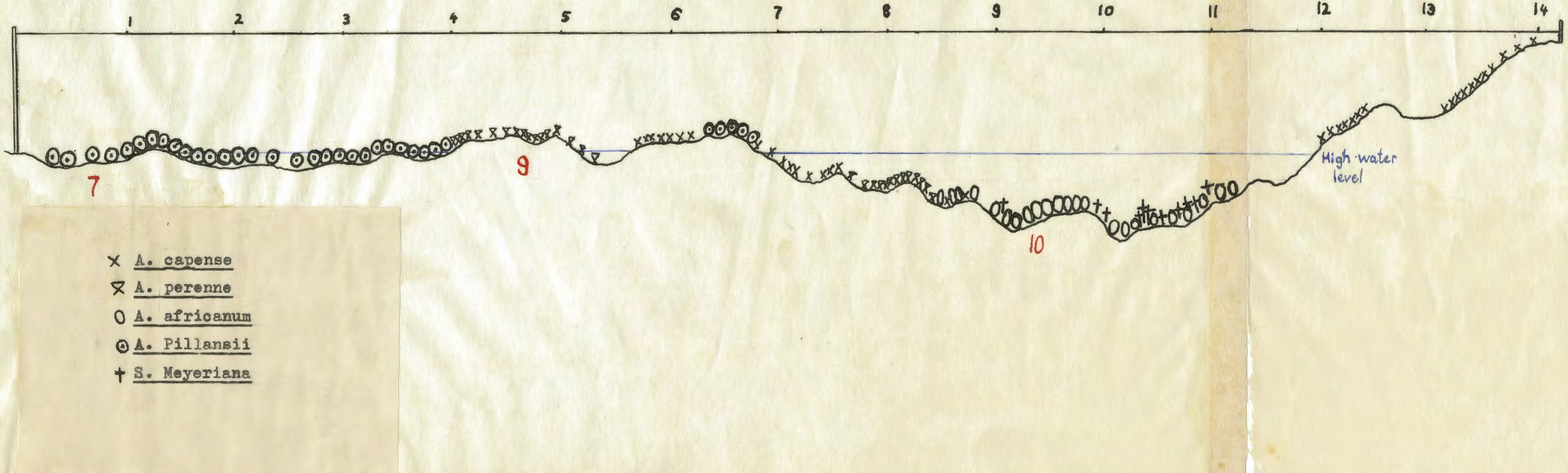
Transect A

Fig. 1



Transect B

Fig 2



A N A T O M Y

The anatomy especially that of the stem has been studied extensively, but it is also not of much use in the taxonomy of the species. It has a very interesting abnormal secodary thickening. Only a brief account will be given , and for the details it can be refered to the work of de Fraine (1912) on some *Salicornia* species, which do not differ greatly from the regional *Arthrocnemum* species.

For transverse sections the stem of *A. affine* was used, because of its convenient size, but sections of all the other species were also investigated.

From the outside (compare diagram fig 6) first a normal epidermis with a sometimes remarkable thick cuticle is found, and underneath it is usually only one layer of palisades, seldom fragments of a second one, which is not a complete one.all around. This is followed up by big parenchymatous cells of a waterstorage tissue, with small scattered vascular traces in it. Among the palisades cells long dead cells with spiral cellulose thickening continueing into the parenchyma, occure in the subgenus Gymnanthemum. The stele consists of a endodermis with some sclerids, and consists of rather unusual angular cells, which later become hardly distinguishable from the outer secondary cortex. The pericycle is usually 3 - 4 cells thick parencymatious, and gives rise to a polygenous cambium.

To the outside the cambium gives rise to a secondary cortex of which the cells of the outer layers enlarges , and are characterised by their angular form and slightly lignified walls. No intercellular spaces can be seen. The cells of the inner layers are small, half or only quarter the size of outer ones, and are loosely pact. In longitudinal section (LS) it can be seen, that they do not differentiate, and are hardly distinguishable from the cambial region exept that the cells are slightly more collenchymatious. They are certainly not that irregular, as de Fraine (1912) describes from *Salicornia spp.*, and the term aerenchyma seems not well placed in this case, although intercellular spaces are present. In *A. africanum* the cells are pact with starch graines, but in other species it is little or nothing.

The outer layer is actually the beginning of the cork, although not yet suberinized, and a 'cork cambium' is formed to the inside. When this 'cork cambium' arises is not quite clear, as it is not very active in the beginning, and there are not rows of undifferentiated cells, and furthermore it sometimes contains starch. On the other hand in radial LS these cells appear much narrower than the adjacent secondary cortex cells, but division sideways takes place more often than periclinal division. Thus it looks more like ordinary cell division rather than cambial activety. As soon as the leaves are worn off, it becomes an active cork cambium, and the cells are suberinized soon. The fleshy leafy part falls off just above or leaving fragments of the endodermis. Meanwhile stonecells - dumb-bell shaped in LS - develope amid the inner secondary cortex in *A. africanum* only. Now chlorophyll is formed and the sec. cortex serves as photosynthetic tissue.

To the inside the cambium gives rise to storied secondary tissue with scattered vascular bundles. In the shrubby species like *A.Pillansii* the ground tissue is very much lignified with almost no lumen left in the cells, but in the prostrate species it looks like slightly lignified parenchyma with only sclerid caps to the outside of the vascular bundles. No secondary medullary rays can be distinguished.

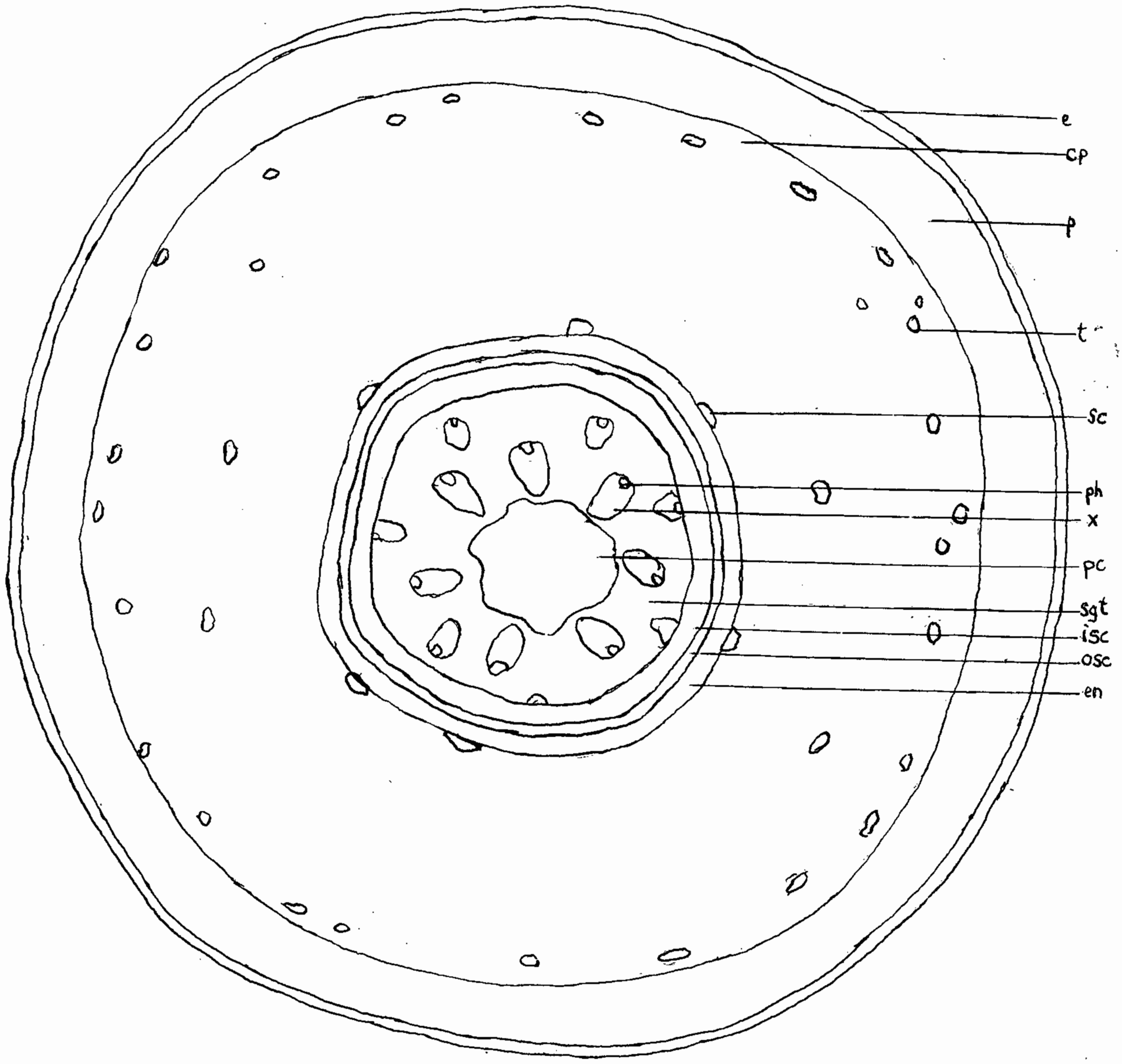


Fig 6:1 TS of stem, cp waterstorage tissue, e epidermis, en endodermis, isc inner sec. cortex, osc outer sec. cortex, p palisades, pc pith canal, ph phloem, sc sclerieds, sgt sec. ground tissue, t traces, x xylem.

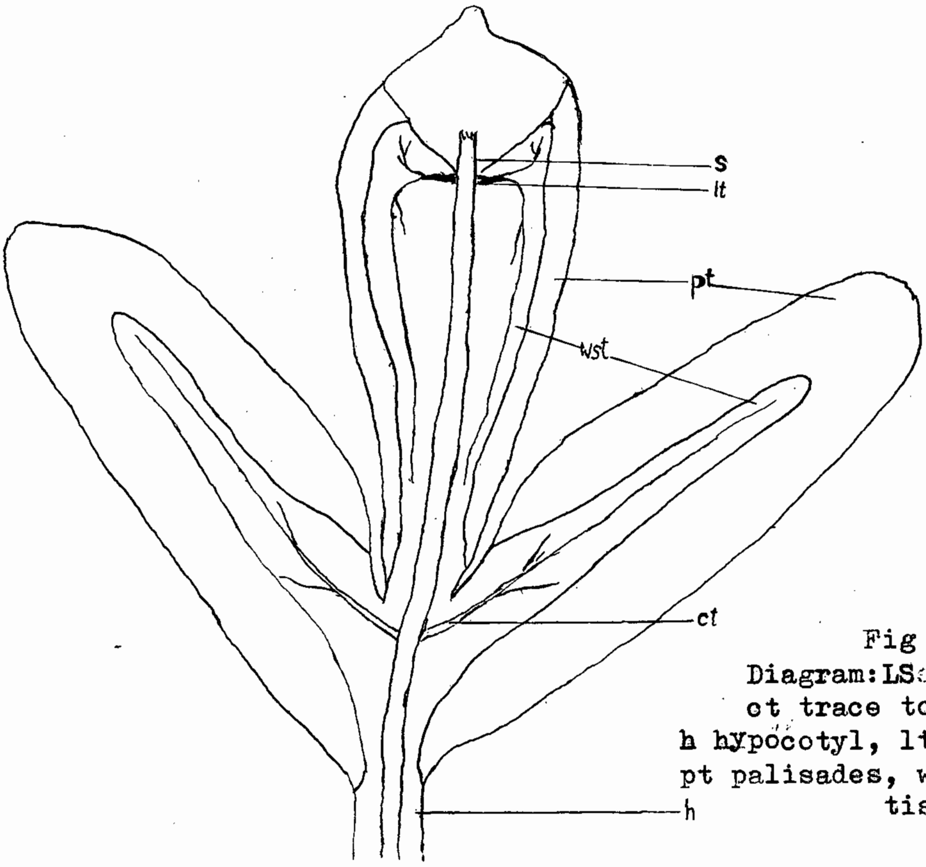


Fig 6:2
Diagram: LS seedling.
ct trace to cotyledon,
h hypocotyl, lt leaf trace,
pt palisades, wst waterstorage tissue.

The vascular bundles consist of a small phloem to the outside, which contains a few narrow cells with horisontal transverse walls, probably not sieve tubes - mucilage cells (de Fraine, 1912) - as sieve plates could not be distinguished clearly. The xylem to the inside consists of 2 - 3 vessels and some trachieds around them.

Originally six primary vascular bundles are found, but then increases with the formation of traces to lateral branches and by cambium activety. The xylem is endarch and slightly not fully amphivasal. Only few vesels mainly trachieds are present.

In old stems a 'year ring ' effect is shown by the number of vascular bundles produced at times.

The pith consists of parenchyma, but is partly broken down to give rise to a schizogenous pith canal. The rest of it and the parenchyma of the primary medullary rays become later lignified, and often starch and othėr granules are found in here.

The pallisades, the waterstorage tissue and its traces indicates a fusion of the leaf to the stem. Furthermore the external appearance of the two opposite decussate leaves suggests that the fleshy leaf envelope is fused to the stem. This is strengthened by the leaf-like cotyledons, which are fused below to form a sheath around the growing point, and on the inside of it there is no chlorenchyma layer (see fig 6:2). However, the first segment shows the leaves already completely united to the axis, which is fleshy to the cotyledons below.

The traces to the lateral branches and the leaftips arises at the nodes at the end of each segment. The leaf traces branches soon and four bundles run down the segment, and form ultimately a reticulum (see fig 7). Thus the fleshy part of the stem is in actual fact an enlargement of the abaxial surface of the leaf, and the so called 'leaf tip' is a degenerated fleshy leaf. The cotyledons show already to an extend what is going to happen, only that the two lateral branchtraces of the lower leaf are still smaller than the midvein.

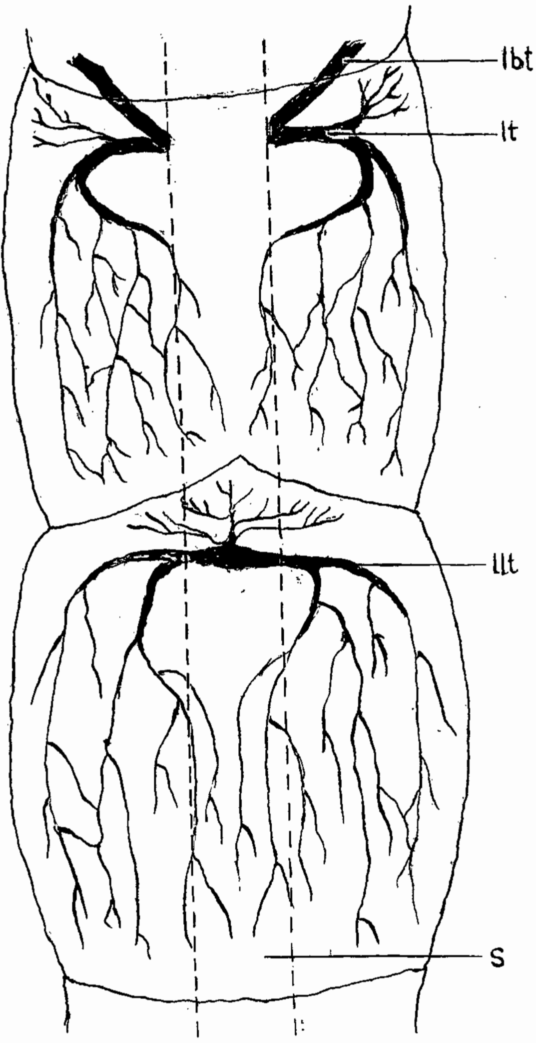


Fig 7 Diagram of the traces. lbt trace of lateral branch; llt lateral leaf trace; lt leaf trace; s stele.(de Fraine, alt.)

The primary root is typical triarch dicotyledonous, and secondary thickening is similar to that of the stem. The vacular bundles seem to be more abundant and bigger than in the stem. In <u>A. africanum</u> and also sometimes in <u>A. affine</u> the phloem tend to disappear schizogeneously.

TAXONOMY AND DISTRIBUTION

The History of the Genus Arthrocnemum.

Since Moquin-Tandon separated the genus Arthrocnemum from Salicornia in 1840, these genera produced much trouble in classification, and were redefined several times. Unfortunately the original description was not available, but from criticisms it seemed to be a bit vague about floral differences, and thus the separation of the perennial Arthrocnemums from the annual Salicornias might give objections. Moss (1914) remarks, 'this is curious for the latter species (S. perennis included in Arthrocnemum) possesses none of the characters of Moquins genus Arthrocnemum' .

De Candolle (1849) separated the two genera on the endosperm, which is scanty if present and situated in the centre with the embryo curved around it in Salicornia. In Arthrocnemum it is found centrally and laterally of the embryo and is abundant.

Bentham and Hooker (1860) simplified this formulation by sorting those with endosperm under the genus Arthrocnemum, and without into the genus Salicornia. This idea was adopted by other botanists like Engler & Plantle (1892) , Paulsen (1918) and Chevalier (1922). This character, however, is very often impracticable and makes identification without seeds impossible.

In the meanwhile Moss (1910) sinks the genus Arthrocnemum to subgenus level with Salicornia glauca as only species. In 1914 Moss remarks he can not see, why annuals and perennials can be separated into different genera without floral dissimilarities.

The main difficulty with these plants was, that dried material was of very little use, and do not show the typical structures, as the stigma for example. Soon it was also found, that the character of the presence of endosperm might be variable and not of generic significance (Paulsen, 1918). Furthermore it does not include the original species contained in Moquin's genus.

Thus Moss (1954) redefined the genera, and put the genus Arthrocnemum on a sound foundation.

Distribution of the genus Arthrocnemum.

As the species of the two genera were transfered from one to another, and the genus Arthrocnemum is redefined only recently and since then no work on it has been produced, many of the species are of doubtful position. However, the species described by Moss (1954) have usually a wide distribution range and cover the whole area from which species of Arthrocnemum have been described before. Thus the emphasise must be put on the distribution area of the whole genus and not on that of the species.

Many of the species occure along the South African coast, but this might be due to the work of Moss in this country, but there is little doubt, whether other species described for Australia are also valid species. The following species give the distribution of the genus as such, and the distribution of the species occuring on or near the Cape Peninsula will be delt with later.

A. indicum is recorded from: Senegal, Angola , Natal, Lourenco Marques, Zanzibar, Egypt, Madagascar, India and Ceylon, East Indies and Australia.

A. africanum is found along both but mainly the eastern coast of South Africa.

A. perenne var. lignosa grows in Southern Britain, western Europe and north-western Africa, whereas *A.perenne var. radicans* occures along the east coast of South Africa up to East Africa.

A. heptiflorum occurs along the eastern coast of South Africa up to Lourenco Marques, and again in Australia and New Zealand. The same pattern is shown by *A. australasicum* exept that it is also recorded from the East Indies and New Caledonia.

In short it can be said that the genus *Arthrocnemum* occurs in western Europe, more or less around the whole African continent, south-eastern Asia, East Indies, Australia and New Zealand.

Dispersal Mechanism.

The seeds of these plants do not show any special facility to dispersal. The hairs on the seed membrane are also of not much help, as they are usually minute, and furthermore the fleshy perianth remains wrapped around the seed with only the point with micropyle outside. In strong wind or rain the whole unit gets loose, and drops down without being dispersed. If it is wet enough the seeds germinate within a week.

In floaded saltpans or in rivers the fruit were found drifting with the aid of the large water repelling perianth, and thus might be taken away by stream or - as it was found - they are blown to the banks of the saltpans. These seeds germinate soon, but the seeds do not need so much water for germination, and do well with wet soil only. Soon thousands of seedlings float on the water, but they do not grow in that stage, exept that the cotyledons enlarge and some rootlets develope. The growth of the first segment is very much retarded, in fact not a single one with it was found drifting.

The possibility that they are dispersed in this condition is great, as after two month still some floating ones were found. They looked too miserable to assume that they germinated recently, and floating seeds with retarded germination were not found. Usually the seedlings get entangled in the algae near the banks, and as soon as the waterlevel sinks, they can establish on the devastated banks or among still dornant fellow plants (see fig 8)

Fig 8
x Colony of seedlings; arrow points to a still loose root.

This type of dispersal seems quite convincing, but it does not give an explanation to the zonation nor to how *A. africanum* or even *Salicornia Meyeriana* - having to establish every year - could be found mainly in the floaded areas and not so much on the margins of it. This must be further investigated as the water dries up, but unfortunately this takes still some time until it will occur.

Some Difficulties in Classification.

As said before these plants always gave some difficulties for classification, not only because they are so variable, but also the general terms used in the keys have to be applied with some reservations, or certain characters of appearance are not realy describable. Furthermore characters given here are mainly for fresh material as herbarium material is insufficient, because 'not only do these plants dry badly, but they are frequently gathered before they are in flower. In fact it is suprising what a large number of botanists there are, who have never observed the flowers of *Salicornias*' (Moss, 1914). The flowering times are between February - May, but scattered solitary spikes are found even in September on plants not affected by submerging. Identification of barren material is highly speculative.

From the floral diagram (see fig 9) it can be seen, that there are three fused perianth leaves. This might be unusual in the family Chenopodiaceae, but it seems to be a reduction, as in *A. africanum* frequently a fourth smaller one is found anteriorly. It is only partly fused at the base. This supression of the anterior floral parts is also reflected in the later maturety of the anterior stamen, or might sometimes even be absent in *A.Pillansii*. This does not explain the reduction of the lateral stamens of the normal flower of the family.

In the key the protogynous genus *Arthrocnemum* is separated from the protandrous genus *Salicornia*. As the stamens appear in succession, and the stigma is usually fresh for a long time, it may overlap lower down in the spike. Then look for the youngest flowers higher up the spike, and the sought condition will be seen. What is ment by stigma tufted or bifid fimbriate is shown in fig 9a,b.

It must be mentioned that in the subgenus *Ægianthemum* the perianth tube might look in dried material as not opening to the apex. Investigations showed that it is mainly due to a longer posterior perianth lobe, which is free, but might cover the opening. This can be seen if an anther protrudes. Furtermore the flowers are usually quite hidden by the 'segment' (leaf tip), but on the other hand it might be exposed even half as long as the segment, but still its other characters can be seen. (*Levyns* No 10710) Thus a certain plant need not to have each character, and still will show positive.

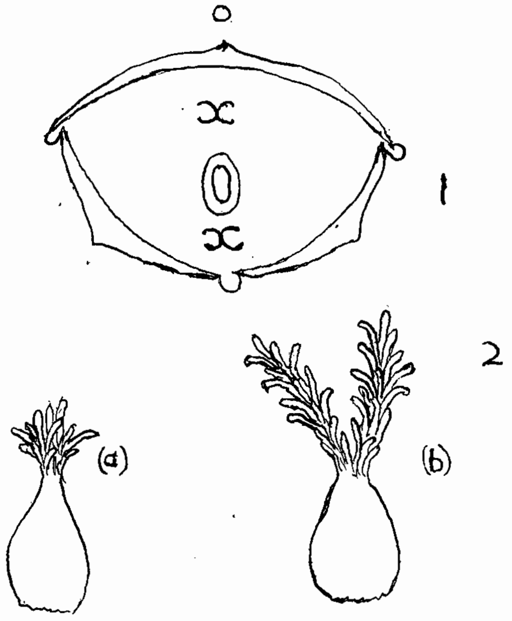


Fig 9:1 Floral diagram; 2 ovary with (a) tufted (b) bifid fimbriate stigma.

As the classification of these plants is mainly based on more than one character it is also difficult to arrange these in the order of their importance in the key.

These are all straight forward characters, but as soon as measurements are taken in consideration it does not work satisfactory, and certainly not only one measurement should be taken, but always a number of them. Also the relation:

$$\frac{\text{length of the segment}}{\text{length of corresponding central flower}}$$

as it is used for keying out the species of the subgenus Gymnanthemum is not very satisfacctory. Histograms of one spike A.Pillansii and A. dunense, which show in both cases the variability of this relation along the spike. For the latter it should be 2 or more, but for this young spike it is not true, and this is done on the Co-type (see fig lo) The scattered appearance can also be seen in the other histograms produced for A. Pillansii later. The difficulty arises here of which fertile segment should the measurements be taken, as the relation is very high in the beginning and later tend to go lower and lower. The stigma protrude by growing, and goes on to do so, so that the measurement of it does not say much. Even the length and the width of the seeds depend to whether they are from the central or the lateral flowers. (see mounted seeds of A. africanum figll)

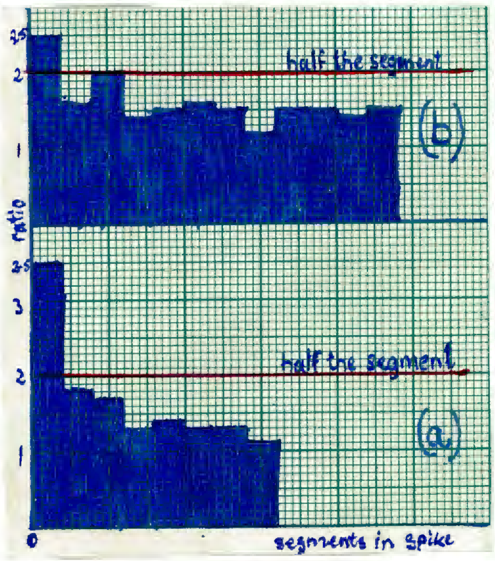


Fig lo (a) A. Pillansii
(b) A. dunense

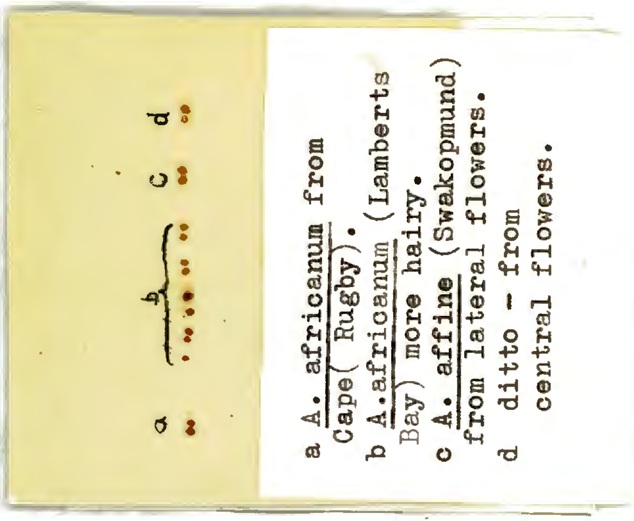


Fig 11 Seeds of A. africanum and A. affine.

Also it is not clear, why A. capense is keyed partly by short spikes, and the in the description they are said to reach a length of 7cm , which is a remarkable size only found in A. variiflorum. For them, however, the length of 3-3.5cm is given due to the unfortunate choise of a not yet flowering type specimen. The sizes the other way around seems to be more appropiate, although longer ones for the former one and shorter ones of the latter might very well occur. Sizes given in the description are always for mature spikes.

Furthermore the character of rooting at the nodes is often too much stressed, especially not rooting in the shrubby, where usually only the top branches are collected for herbarium material, and the rooting of the lower branches is not observed. It also depends on the environment, as already pointed out in the ecological part. All species have the ability to form adventitious roots, even in A. littoreum, which only does not get the chance, as it is growing erect it is found (Tölken No 165).

Observations on A.Pillansii and A. hottentotticum.

According to the description these two species should differ in the following respects:

	A. hottentotticum	A. Pillansii
(a)	Shrubby up to 70cm high	Decubent up to 15cm high.
(b)	Spikes up to 2cm long	Spikes 4-6cm long.
(c)	Pollen spherical, punctuate	Pollen oval, slightly rough.
(d)	Seeds covered with short curved hairs	Seeds glabrous when young; when mature with stout conical hairs, spreading not coiled at tip.

For field investigations the first character, was considered as being the most conveniant, and it was found to work very well. The length of the spikes did not completely fit the descriptions, as many of the bushy plants were longer than 2cm, and with especially vigorous growth on dumped not saline soil at Rugby spikes of 4cm and more were found (see Tölken No 148)

Furthermore in all pollen analysis no oval ones were found unless they were not mature yet, and then the typical punctuate structure of the exine is not clearly exhibited. That means they usually appear slightly rough.

As seeds were not availuable at that stage, it was tried to key them out by the key of Moss(1954) with the result that most of the plants turned out to be A. Pillansii, whether they were from shrubby or decubent plants. Even more in some spikes it was slightly more than half and in others it was less, making them different species. The same effort was applied to dried specimens cited by Moss (1954) resulting the two histograms (fig 12). They clearly show, that it is impossible to separate the two species in that way, as they overlap, and only the summit of A. Pillansii is before the 2 (thus the relation is less half) and for A. hottentotticum more than 2.

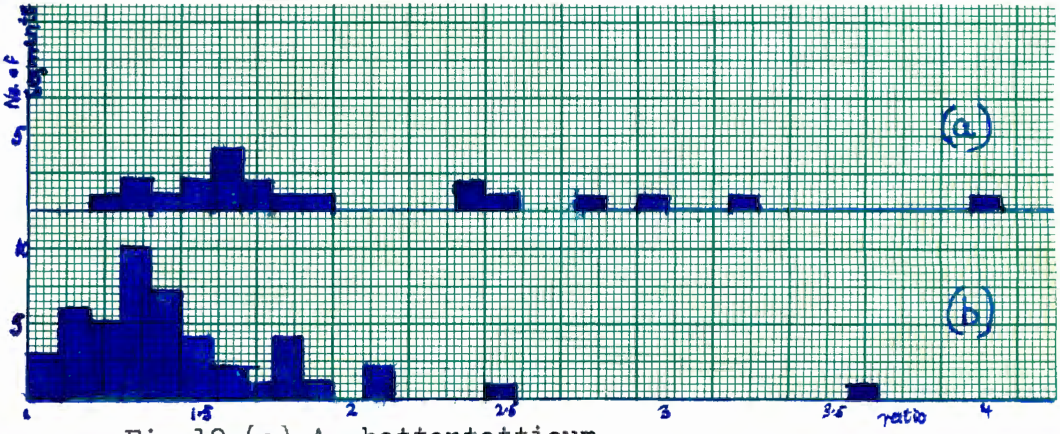


Fig 12 (a) A. hottentotticum
(b) A. Pillansii.

The only difference this herbarium material showed was, that A. hottentotticum is much more branched than A.Pillansii. Both showed also according to description an flattened main branch, and the central flower being longer than the lateral ones, and the two interlocked fimbriate stigmas in fresh.

Considering the seed characters it is rather odd, that the seeds in young stages should be glabrous in A. Pillansii, where in other species the hair developement begins early. What are the characters of young seeds of A.hottentotticum? Among dry seeds collected there were all forms from glabrous to hairy ones found. This is a very large range, and some species of Salicornia have been separated on this character (Clapham et al.1952) At present no correspondence is seen with either the one or the other to a shrubby or decubent grows. Furthermore it seems to have a whole range of intermediates, and the hairs seem even to vary in having curved or straight hairs.

As already pointed out in the ecological part, these plants do not like to be even partly submerged, and with the extraordinary high water levels in the salt pans this year, many plants died. Among these were shrubby ones, but mainly suberect ones. The higher number of the latter is,however, greatly due to the distribution of the decubent ones nearer to the waters edge, and the bushy ones still further away.

All this makes the idea of an identical specie with two growthforms more believable, but sometimes both forms without any intermediates are found next to another. It is impossible to explain that on the vicinity to water and further investigations and observations are needed. As long as it can not be distinguished exept vegetatively, both are kept as A. Pillansii - being the older name - for further discussions.

Sometimes dried material of young plants of the decubent ones might be hard to distinguish from A. perenne , or even in fresh difficulties might arise. For the latter case there can be distinguished between the colours, because A. perenne and A.capense and A. variiflorum show a brownish-red shading (ca bloodred No 82o, p166 - cardinal red No 822, p 168 in the Horticultural Colour Charts) apart from appearance, whereas A. Pillansii always has a purplish red (ca Pansy violet No o33, p 116 - lilac purple No o31, p115). If it does not show the typical flowers of A.perenne reaching half - two-thirds of the segment, then the flowers are still too young and indistinguishable. Such doubtful cases are usually sorted under the name of A. perenne e. g . Rodin No 1212; Flanagan No 1119 ; Schönland No 5128 (looks like scraps of A.littoreum, but barren).

Being sometimes shrubby how is it distinguishable from A. littoreum?The latter species shows a fastigiate growth, and fading usually to yellow (ca empire yellow No 6o3/1, p 66) very seldom red (ca chinese coral No 614, p72 in the Horticultural Colour Charts) . In A. Pillansii the lateral branches are spreading, and they are much branched and the spikes are shorter; and they are growing never together with the former among rocks, and the latter on sandy soils along rivers.

Hybrids

'The species of Salicornia are windpollinated; and hybrids are often abundant when allied species grow together' (Moss, 1912). In other words the accumulation and zonation of species of Arthrocnemum at Milnerton form an ideal condition for hybridization. Obvious hybrids in external character are not all that frequent, and only two plants from there are known to the author.

The one a A. variiflorum X A. Pillansii hybrid (Tölken No 147) has been investigated in some more detail. At first sight it looks very similar to a decubent A. Pillansii, but it has too long spikes, but they are arranged in that way. The long spikes and the colour is that of A.variiflorum, but again it is dull and the segments are not fleshy as in A.Pillansii, however, not brittle as usually in the latter. This is typical, that the hybrid nature is shown in its fresh characters, and in dried material it is hardly observable. Although the range of variation is usually not that large, and can be excluded, and thus should prove the hybrid, it is not all that easy in young plants.

Furthermore there are two mranges in size of pollen grains found, but both are fully developed: spherical and punctuate. One being the normal range found in all species namely o.253 - o.377 mm and the other one o. o84 - o.127 mm and there are no intermediate sizes of pollen grains found. The pollen was always taken from fresh material, and mounted in diluted glycerine and then immediately measured in order to avoid any swelling or shrinkage.

Likewise another mature anther was mounted, and with the aid of a moving stage for the microscope, along ten rows the number of big and small pollen grains were counted. The results are given in the tabel below.

Row No	1	2	3	4	5	6	7	8	9	lo	total	ratio
small ones	33	45	31	36	63	15	16	6	29	37	318	1
larger "	121	214	134	243	337	1o8	134	46	141	127	16o5	5.~~05~~

A similar finding is recorded from a Nicotiana glauca X N. plumbaginifolia hybrid (Goodspeed 1954), and it was due to meiotic irregularities; that means some chromosomes did not reach the poles by the end of the second meiotic division, resulting larger and smaller nuclei as each group of chromosomes is surrounded by a membrane. This might explain the phenomenon got, but the very clear ratio 1:5 is rather startling, and further investigations of the meiotic process itself is necessary.

The plant seems to be not completely sterile, as seed developement takes place. At least the seedmembrane developes, but not always the embryo; in fact only one seed with a fully developed embryo is found, and this was certainly not due to any contamination of the seeds with other ones.

The other plant found - a A. Pilansii X A.africanum hybrid - shows similar ranges in size of the pollen grains, and no fully developed seed was found. All this proves that they are realy hybrids, and it is not mere variation; that means an abnormal character, which does not fit the key for that certain one, but the species can be identified by taking the other characters into consideration. Variation can be found anywhere, and if looked for even between zones of 'putative parents'. The author is convinced, that hybridization is not all that common as Moss states for the species of Salicornias.

Keys and Descriptions

As mainly species occuring on or in the near vicinity of the Cape Peninsula were investigated, examples of herbarium material and the distribution of them in this area, will be given only.

Key to Genera.

Annuals; branches all terminating in spikes; flowers protandrous; stigmas tufted; central flower superimposed to two laterals*
.. .. Salicornia

Perennials; branches not all terminating in spikes; flowers protogynous; stigmas bifid rarely trifid; central flower separating the laterals .. .. Arthrocnemum

ARTHROCNEMUM.

(The name from the Greek arthron, a joint, and kneme, a limb.) Moq. Chen. Mon. Enum. III. 184o; D.C. Prodr. 13.2. 114. 1849; Ung.-Sternb. Vers. Syst. Salic. 36. 1866; Atti Congr. Bot. Firen. 1874. 268 1876; Benth. & Hook. Gen. Pl. 3.1. 65. 186o; Baker & Clarke Fl. Trop. Afr. 6.1. 85. 19o9; Moss Journ. S. Afr. Bot. 2o. 4. 1954.

Perennial shrubs or undershrubs. Shoots erect, decubent or prostrate, usually much branched, often rooting at the nodes. Some branches barren, others terminating in spikes. Leaves fleshy. Spikes cylindrical or tapering. Cymules 3-9 flowered. Bractioles wanting. Flowers protogynous, usually bisexual rarely female only. Perianth persistent: 3 rarely 4 , fused to form a tube. Stamens 2 appearing in succession. Stigmas 2 rarely 3, ovary unilocular with 1 basal ovule. Seeds vertical, elliptical to subspherical, leathery testa smooth, punctuate or hairy. Cotyledons green, succulent, conduplicate. Endosperm starchy, usually wanting.

The type species is A. fruticosus (L) Moq.
These plants are found on saline localities in tropical and warm temperate zones.

The subgenera are kept, because they seem to be a natural division, but the sections are artificial with the transitional A. variiflorum.

Key to the Subgenera .

Perianth tube open at the apex; flowers almost or quite hidden by the edge of the segment; upper part of flower not embeded in segment .. .. Angianthemum

Perianth tube opening laterally; Flowers exposed above edge of the segment, and fully embeded in segment
.. .. Gymnanthemum

ANGIANTHEMUM Moss Journ. S. Afr. Bot. 2o. 5. 1954.
Decubent or prostrate undershrubs. Cymules usually 3-flowered rarely 4-, 5-. The flowers are hidden or almost hidden by the subtending segment. Upper part of flower not embeded in segment, perianth tube open at the apex. Seeds smooth or denticulate, not hairy. Little endosperm, starchy.
Spirally thickened cells are absent from both barren and fertile segments.

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* Exept S. dolichochya (Moss, 1912)

Key to Species.

Slender: segments not longer than 2 cm; seeds twice as long as broad, denticulate, where the teeth are rounded off
.. .. africanum

Stout: segments longer than 2 cm; seeds almost spherical, denticulate, where teeth are sharply pointed
.. .. affine

A. africanum Moss Journ. S. Afr. Bot. 14. 37. 1948. S. herbacea auct. (e.g. Harvey Gen. S. Afr. Pl. 285. 1838 (nomen) non L. S. natalensis auct. (e. g. Wright Fl. Cap. 5.1. 45o. 1911) non Bunge. S. fruticosa var. capensis Ung.-Sternb. Vers. Syst. Salic. 59. 1866.

A very common prostrate perennial, scarcely woody. Shoots shinning, glaucous, usually gray-green or yellowish when young, fading to brownish-yellow or redish-brown. Often rooting at nodes. Barren segment up to 2cm long and o.5 cm wide, fleshy, the older cylindrical, the younger obconical, with pale or purple rim at the top. Free leaf tips appressed when fresh, spreading when dry. Spikes tapering rarely cylindrical, up to 6 cm long with about 3o segments. Lateral spikes shorter, usually flowers more exposed. Cymules 3-flowered, flowers usually quite hidden, completely separated from another. Upper part of flower not embedded in segment, perianth tube open at the apex. Stamens 2, spherical punctuate pollen. Bifid stigmas threadlike not fimbriate. Seeds twice as long as broad with denticulate testa, where the teeth are roundish. Little usually no endosperm in mature seeds. No spirally thickenėd cells occur in the chlorenchyma.

Flowering period March-April; seeds ripe May - June.

Type specimen Moss 14243.

UItvlugt Moss2691; Rugby Moss; Levyns; Tölken 163, 164; Camps Bay Burchell 844; Raapenberg Guthrie 1313; Marloth 8145; W. Dod 2398; Black River Bolus; Diep River Pillans 323o; Ronde Vlei Compton 15699 ; Sand Vlei Moss3143; Page; Muizenberg Moss 359o; W.Dod 976; Michell; Fishhoek Moss 3145, 14243 (type); Kommetjie Moss 359o ; W. Dod 976; Barnard 44148; Adamson.

A. affine Moss Journ. S. Afr. Bot. 2o. 8. 1954.

A prostrate perennial, gets woody with age. Shoots glaucous, usually gray-green, fading to brownish or dark red. Barren segments longer than 2 cm usually 3 - 5 cm long and o.8 cm wide. Segments obconical, fleshy with a pale rim at the top. Free leaf tip appressed when fresh, spreading when dry. Spikes even tapering when mature up to 6- 7 cm long. Lateral spikes shorter. Cymules 3-flowered, frequently 4 or 5. Flowers quite hidden, completely separating from another. Upper part of the flower is not embeded in segment, perianth tube open at the apex. Stamens 2, pollen spherical punctuate. Bifid stigmas threadlike not fimbriate. Seeds broadly oval or spherical and denticulate, where the teeth are pointed. No endosperm in mature seeds. No spirally thickened cells occur in chlorenchyma.

Flowering period March - May.

Type specimen Moss 18122 Swakopmund, SWA.

As already mentioned in the ecological part a small specimen collected by Merxmüller & Giess (No 174o) is very similar to A.africanum. Unfortunately it consists of young spikes and the seed character could not be investigated. They differ in size of the segments and the seed characters. Seeds collected from Lamberts Bay show already signs of intergradation (fig 11).

Fig 13 A.africanum . Note flowers in lateral spike more exposed. (1division =1cm)

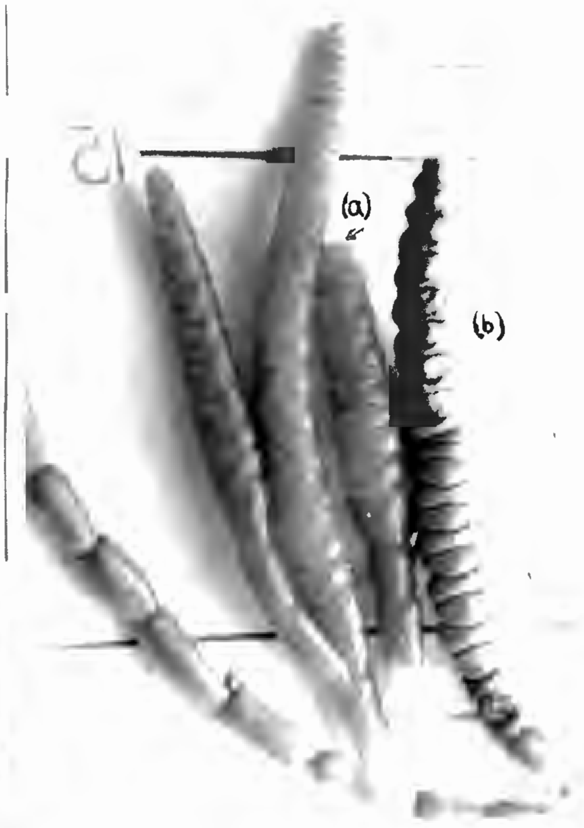


Fig 14 (a) A. affine (pickled)
(b) A. africanum
(1 division = 1 cm)

Fig 15 A. affine. Note longer terminal spikes and the typical growth.

2 GYMNANTHEMUM Moss Journ. S. Afr. Bot. 2o. 8. 1954.

Shrubs or undershrubs with cymules 3 - 9 flowered. The flowers are exposed and well embeded in the segment. The perianth tube opens laterally. Seeds usually covered with conical hairs, rarly smooth. No endosperm. Spirally thickened cells are present in the chlorenchyma of the stems.

Key to Species.

(1) Woody shrubs; losing leaves on main branches; stigmas usually interlocked 2

Scarcely woody prostrate undershrubs; do not lose leaves on older branches; bifid or trifid stigmas spreading 3

(2) Fastigiate branch arrangement; flowers almost as long as segment; Cymules laterally almost or contiguous (up to 2mm apart) .. .. littoreum

Side branches spreading; flowers ca half as long as segment; Cymules laterally separated (2 - 4 mm apart) .. .. Pillansii

(3) Decubent dull green with purple-red spots; segments not fleshy, drying out soon behind apex; Flowers ca half as long as segment .. .. Pillansii

Prostrate shining, glaucous less often dull green, fading to red-brown; segments fleshy; fresh for a long while; flowers two-thirds of segment or more 4

(4) Flowers not angular, not with a dent inwards near the opening; flowers not clearly separating .. .. perenne

Flowers angular, dented inwards near opening of flower; flowers completely separating 5

(5) Old barren segments 1.5 - 2 cm long, o.4 - o.7 cm wide; shiny green glaucous , fading to brown to brownish-red; normally not rooting at nodes; usually more than 3 flowers per cymule .. .. variiflorum

Old barren segments up to 1.5cm long, o.2 - o.3 cm wide; dull green fading to brownish red; spontaneous rooting at nodes; always 3 flowers per cyme . .. . capense

A. littoreum Moss Journ. S. Afr. Bot. 14. 38. 1948.
S. fruticosa auct. (Harv. Gen. S. Af. Pl. 285. 1838 (nomen); Bolus & W. Dod Trans. S. Af. Phil. Soc. 14. 3ii. 19o3 (nomen); Wright Fl. Cap. 5.1. 449. 1911 (p. max. pte.)) non L. nec aliorum.

An erect fastigiate woody shrub up to 1m high with many stems up to 8cm thick at the base. Barren segments subglaucous (dull) fading to dull yellow rarely redish-brown, cylindrical 1 -2 cm long, up to o.4 cm wide. Not rooting at nodes. Leaf tips appressed when fresh, spreading when dry. Spikes tapering when young, cylindrical when mature, up to 1o cm long, o.5 - o.8 cm wide. Spikes are born terminal on the main branches or short subapical branches. Cymules 3 flowered rarely 4,5 and being almost or contiguous around the segment. Central flower only slightly bigger than the lateral ones. Stamens 2, pollen sperical and punctuate. Bifid stigmas fimbriate, interlocking, chlorophyll in ovary wall. Seeds hairy, coiled at tip. Numerous spirally thickened cells in chlorenchyma.

Flowering period February - April; seeds ripe May - June. Always found next to or in the intertidal zone along rocky coasts.

Type specimen Moss 8775.

Robben Island Marloth; Walgate 489; Camps Bay W. Dod 3o56; Marloth 8917; Moss 3132, 8765, 8775 (type); Prior; Page; Bakoven Bay Tölken ; Hout Bay Harvey 194; Olifantsbosch Tölken 165; Pilgrims Tölken 162; Buffels Bay Tölken 159; Boordjiesdrif Tölken 16o; below Paulsberg W. Dod 3o12; Millers Pt. Tölken 161; Kalk Bay Pillans3242; Guthrie 1395 ; Kommetjie Simons 88; Tölken 158.

Fig 16 A. littoreum
Long but not fleshy spike.
(1 division = 1 cm)

Fig 17 A. littoreum. Fleshy spike with conspicuous flowers.
(1 division = 1 cm)

Fig 19
A.littoreum
Plant in habitat.

A. Pillansii Moss Journ. S. Afr. Bot. 14. 38. 1948.

Woody perennial shrubby or decubent with laterally flattened stems up to 3 - 4 cm wide. Shoots glaucous, usually dull green with purplish-red spots on the older segments, fading to purplish-red. If decubent usually rooting at the nodes. Barren segments up to 1 cm long, usually o.5 - o.6 cm, o.2 - o.4 cm wide; not fleshy usually appressed at the base. Sterile segments dry out soon after the apex and falls off. Spikes tapering when young, cylindrical when mature, up to 5 cm long, usually 2 -3 cm with 15- 2o segments. Spikes always in clusters, one terminal and several lateral ones. Cymules 3flowered. Flowers exposed to half the segment, with the central one slightly bigger than the laterals. Perianth tube opens laterally, flowers embeded in segment. Stamens 2 often 1 or o, pollen spherical punctuate. Bifid fimbriate stigmas interlocking. Seeds ovate, glabrous or covered with spreading or curved short hairs. No endosperm. Spirally thickened cells occur in chlorenchyma.

Flowering February - March; seeds ripe May - June.

Type specimen Moss 8764.

Ascot Levyns 16968; Milnerton Moss 3141, 8874, 8764 (type) 979o; Pillans 3223, 3224; Mund & Maire 2o; Adamson 917, 2852; Salt River Moss 3141 ; Lakeside Moss 18367;

Fig 19 A. Pillansii
(1 division = 1 cm)

Fig 2o A.Pillansii
Only islands of the plant left, after saltpan is floaded.

A. perenne (Mill.) Moss Journ. S. Afr. Bot. 14. 4o. 1948
S. perennis Mill. Gard. Dict. ed. 8. 1768.
Var. radicans Moss l.c.

S. fruticosa auct. (e.g. L. Fl. Ang. 1754; With. Bot. Arr. ed. 2. 3. 1787; Smith Fl. Brit. 3. 18oo) non L. Sp. Pl. ed. 2.5. 1762; S. radicans Sm. Eng. Bot. t.1691. 18o7; A. fruticosum var. radicans Moq. Chen, Enum. 112. 184o; D.C. Prodr. 13.1. 151. 1849; S. fruticosa var. radicans Gr. & Godr. Fl. Fr. 3. 28. 1855; S. fruticosa var. paardeneilandica Ung.-Sternb. Vers. Syst. Salic. 59. 1866. (cf. incl. var. densiflora Ung.-Sternb. Atti Cong. Bot. Fir. 3ol. 1876. and var densiflora viridis Ung.-Sternb. l.c. 278. f.2o.) S. sarmentosa Duval- Jouve Bull. Bot. Soc. Fr. 15. 174. 1868; S. perennis var radicans Moss & Salisbury Camb. Brit. Fl. 2. 188. t.195. 1914; S. arabica var. paardeneilandica Chev. Rev. Bot. App. 2. 33. 58. 1922.

A prostrate scarcely woody perennial. Shoots shining, glaucous or yellowish, fading to brown, brownish-red. Occational rooting at nodes. Barren segments obconical 1 - 1.5 cm long, up to o.4 cm wide with pale or brown rim at top. Free leaf tips appressed when fresh, slightly spreading when dry. Spikes, measuring 2 -4 cm long, o.4 cm wide, are born on the main branches or occationally on shorter subapical branches. Spikes are tapering and have a knobby appearance. Cymules 3 flowered, flowers well embeded: not conspicuous, or angular. Flowers almost contiguous around the segment. Flowers reaching a third in the lowest and three-quaters in the upper segment. Perianth tube opens laterally. Stamens 2, pollen spherical punctuate. Stigmas bi-rarely trifid and fimbriate, spreading. Seeds ovate, covered with long spreading hairs curved at the tips. No endosperm. Spirally thickened cells occur in chlorenchyma.

Flowering period February - March; seeds ripe May.

Type specimen Drege 221 .

Paarden Eiland Drege 221; Salt River Moss 313o, 8757; Levyns; Pillans 3227; Woodstock Moss 8756; Noordhoek Pillans 3144;

This species is very similar to A. variiflorum, in fact the author is not able to separate dried material in young stage from another. However, the appearance of the flowers and the conspicuous rim at the free end of the leaves in A. perenne var. radicans separates the two. It is common at Rugby, and forms a zone sometimes mixed with A. variiflorum next to A. capense. As these three are so similar, and the measurements of the discussed specie~~s~~ is somewhat intermediate,it is tempting to ignore the still so small characters separating them. Unfortunately it was flowering only very little this year. It is often confused with the young prostrate A. Pillansii, as already discussed before.

A. variiflorum Moss Journ. S. Afr. Bot. 14. 39. 1948.

A scarcely woody but tough prostrate perennial. Shoots shining green, glaucous or yellowish, fading to brownish-red. Normally not rooting at nodes. Barren segments 1.5 -2 cm long and o.4-o.7cm wide, slightly obconical when young, cylindrical when older, with usually no rim at the end. Spikes 3 - 6cm long o.4 - o.7cm wide, tapering when young, cylindrical later. Fertile segments very swollen giving a knobby appearance. Conspicuous cymules 3- 5 flowered, 5 flowered at the base, 3 flowered at the top. Spikes with 3 flowered cymules may be found occasionally. Central flower extending at least two-thirds up the segment, only half way in the lowest one; slightly longer than and completely separating from the lateral flowers. Flowers are embeded in segment, opening laterally. Stamens 2, pollen spherical punctuate. Stigmas 2 rarely 3, fimbriate and spreading. Seeds oblong-ovate with long hairs speading, coiled at the tips. No endosperm.

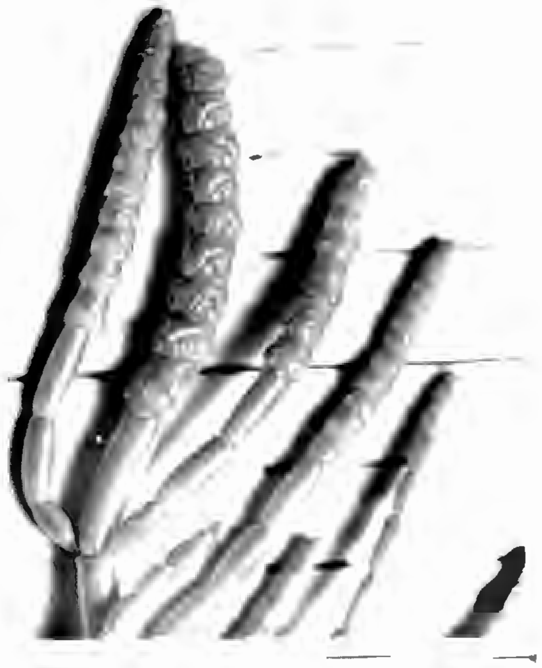


Fig 21 A. variiflorum
Same growth as in A.affine
(fig 15) (1 division = 1cm)

Fig 22. A. variiflorum
(1 division = 1cm)

Fig 23 A. perenne
(1 division = 1cm)

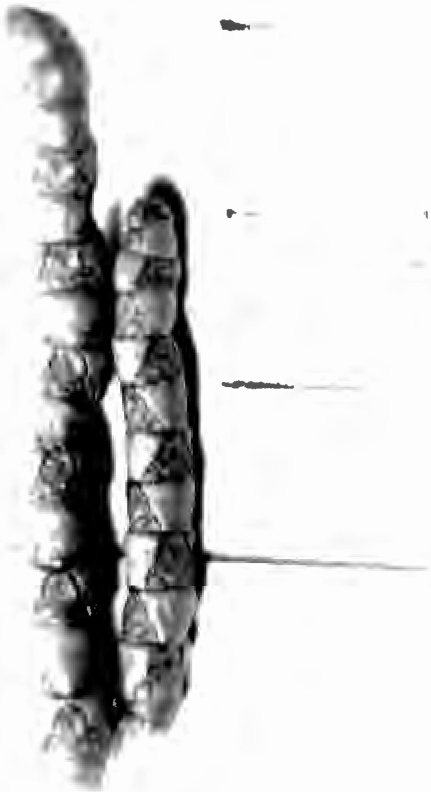


Fig 24 Salicornia Meyeriana
(1 division = 1 cm)

Few spirally thickened cells occur in the chlorenchyma.

Flowering period March - April; seeds ripe May - June.

Type specimen Moss 8765.

Minerton Adamson 928, 2853; Levyns; Moss 8765 (type), 8776.

The choise of the type specimen is very unfortunate, as it is so young, that it does not show the typical floral spike. A typical specimen is: Duthie Ashford Beach, Belvidere, Knysna.

A. capense Moss Journ. S. Afr. Bot. 14. 39. 1948.

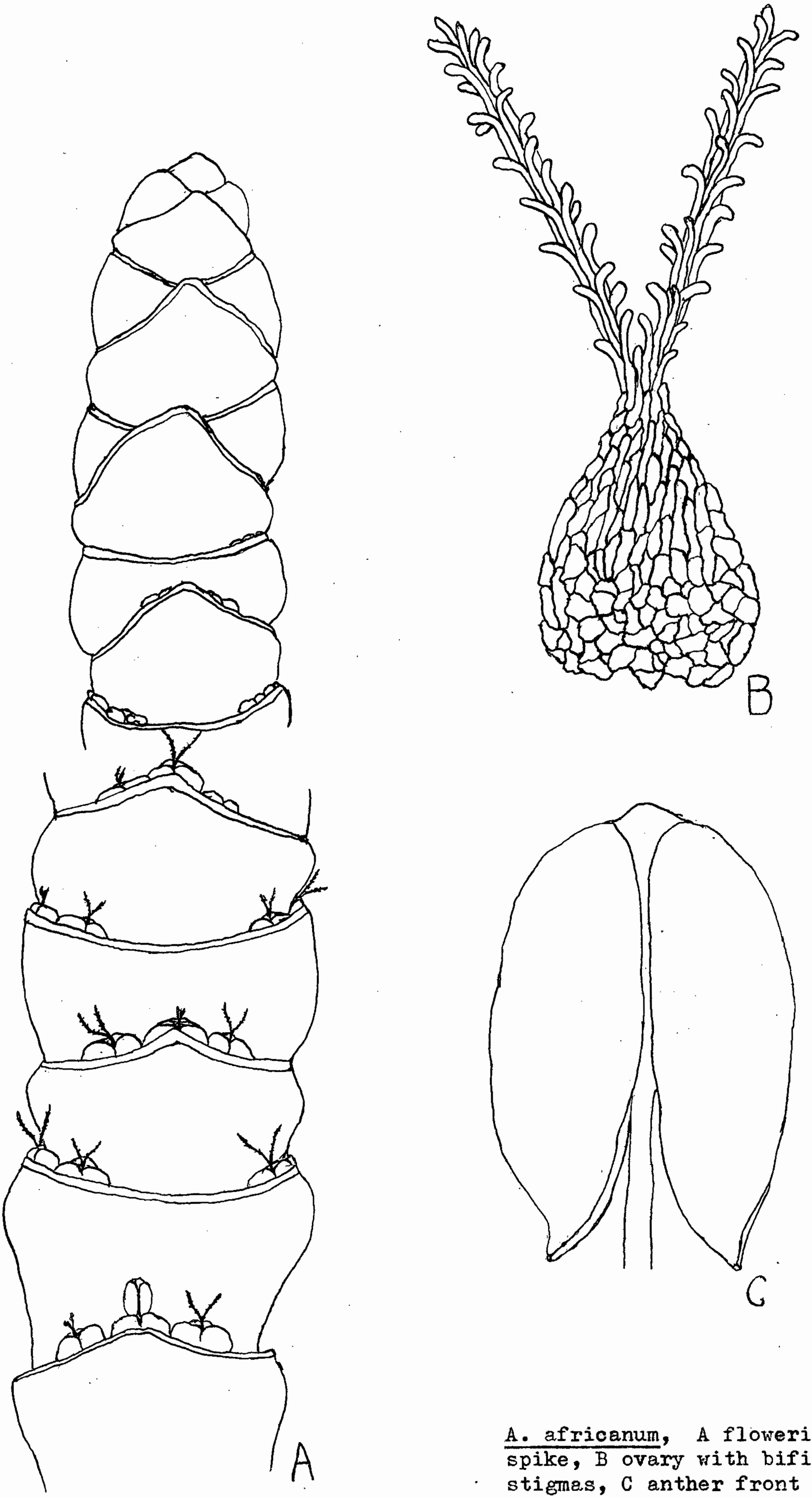
Small prostrate perennial with almost no secndary growth. Shoots dark dull green , fading to brown or brownish-red. Spontaneously rooting at the nodes. Barren segments obconical when young, later cylindrical/not very fleshy, measuring up to 1.5 cm long, and o.2 - o.3 cm wide with a narrow pale or redish rim.In fresh free leaf tips appressed, also in dry. Spikes are born terminal or terminal on subapical branches. Spikes cylindrical slightly tapering when young, up to 4cm long , o.3-- o.4 cm wide. Conspicuous cymules 3 flowered; the barren spaces between very small or absent. Flowers angular distincly separating . Central flower reaching a third way up in the lowests segment, but almost to the top higher up. Central flower slightly larger than the laterals. Stamens two, pollen sperical punctuate. Stigma bifid, fimbriate, spreading. Seeds oblongate covered with spreading hairs coiled at the tips. No endosperm. Spirally thickened cells occur in chlorenchyma.

Flowering period February - March; seeds ripe May.

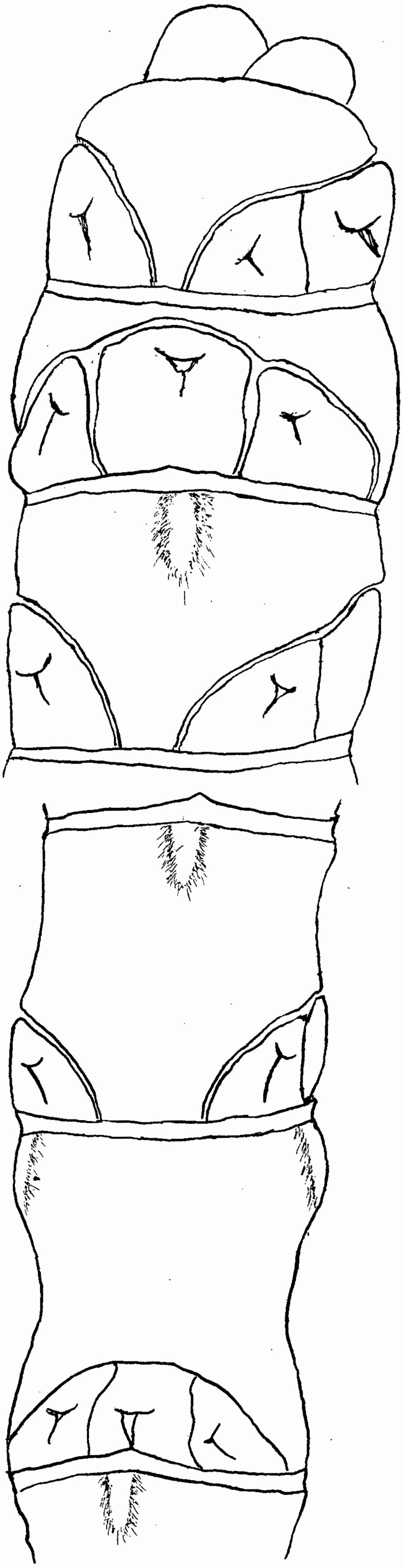
Type specimen Moss 11621.

Riet Vlei Pillans 3229 (barren); Uitvlugt W.Dod 148o; Milnerton Moss 11621 (type); Adamson 847; Raapen burg W. Dod269o (barren), 359o. Noordhoek Moss 3133; Pillans 3144.

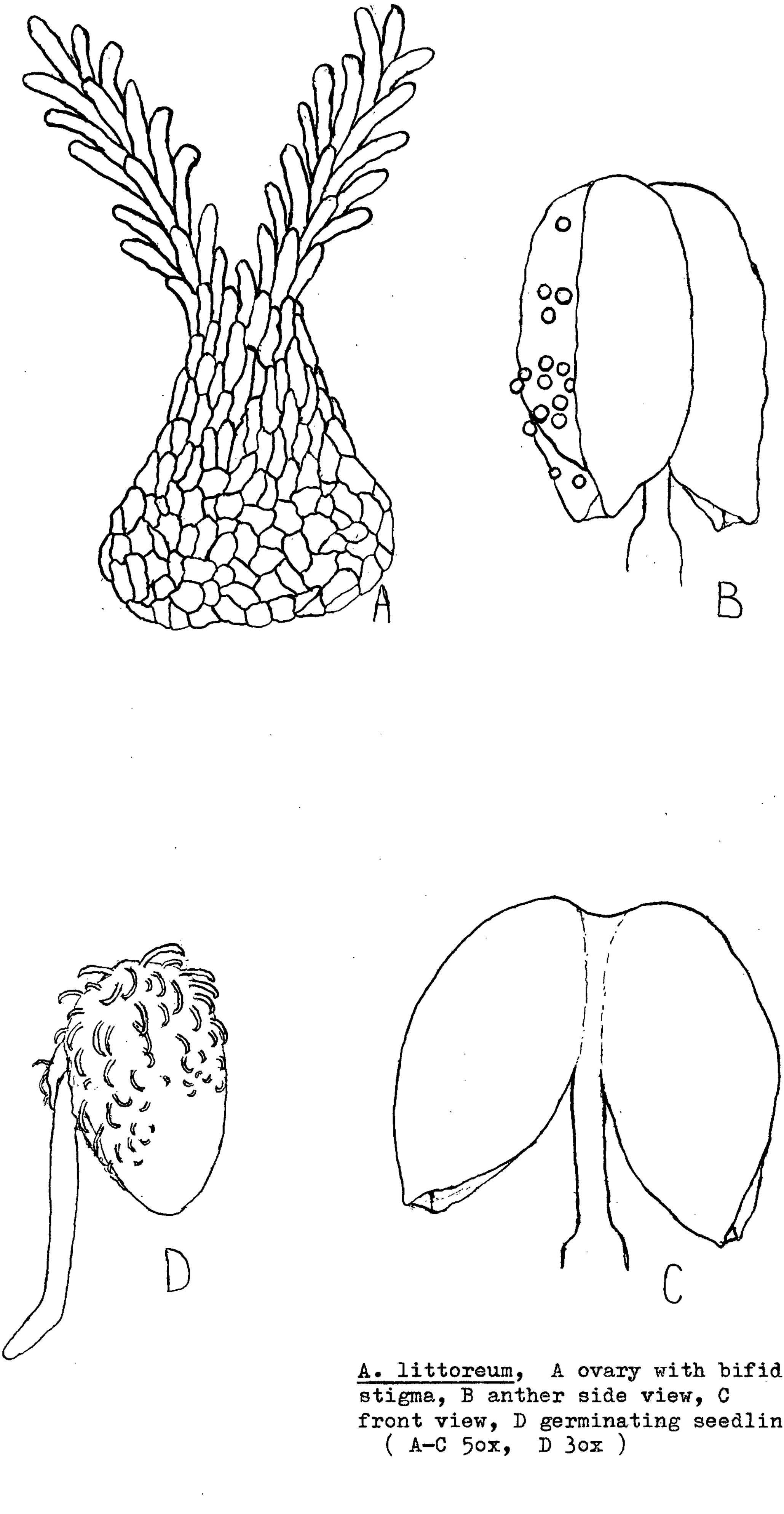
Distribution on the Cape Peninsula .. see p 24.



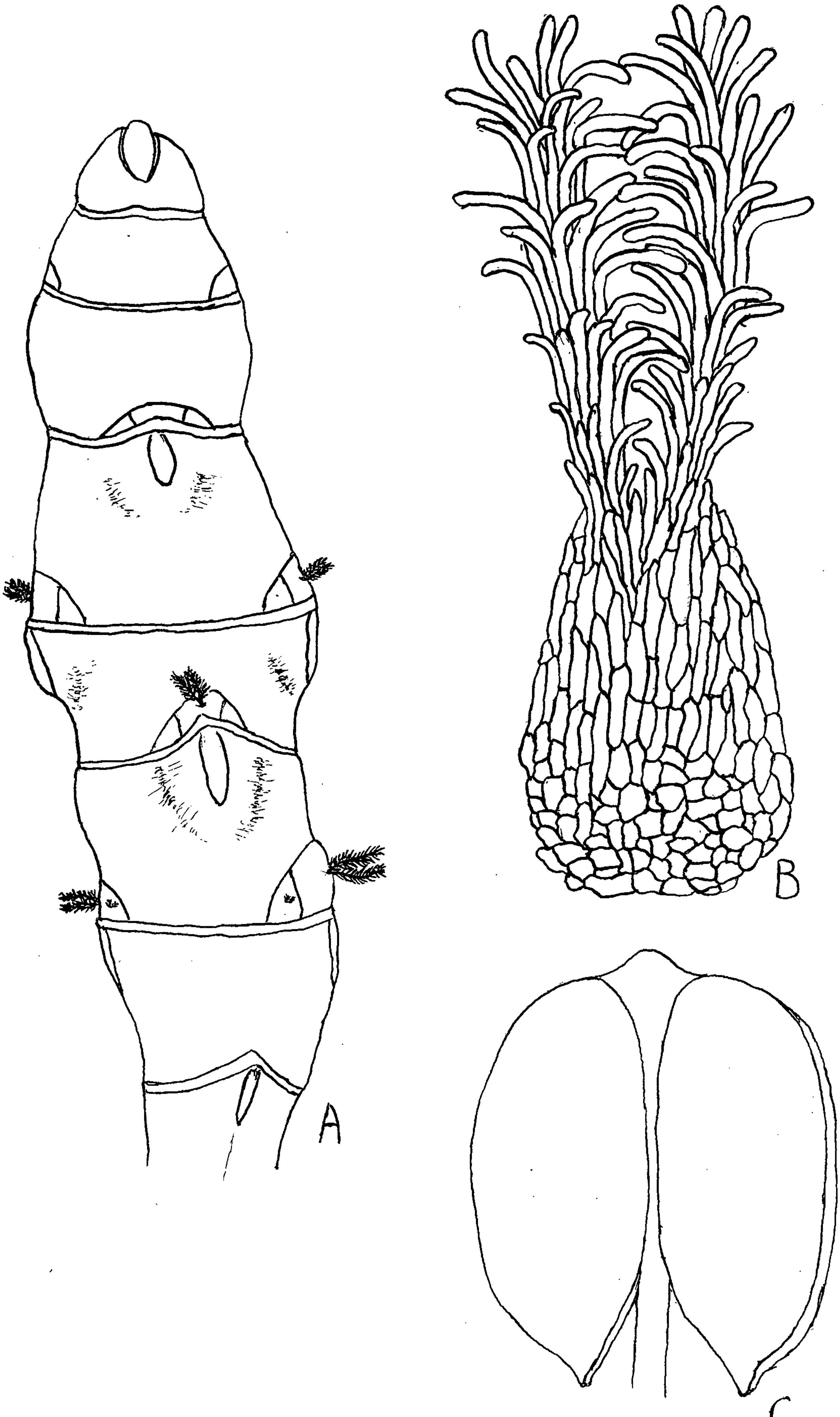
A. africanum, A flowering spike, B ovary with bifid stigmas, C anther front view. (A 15x, B,C 50x)



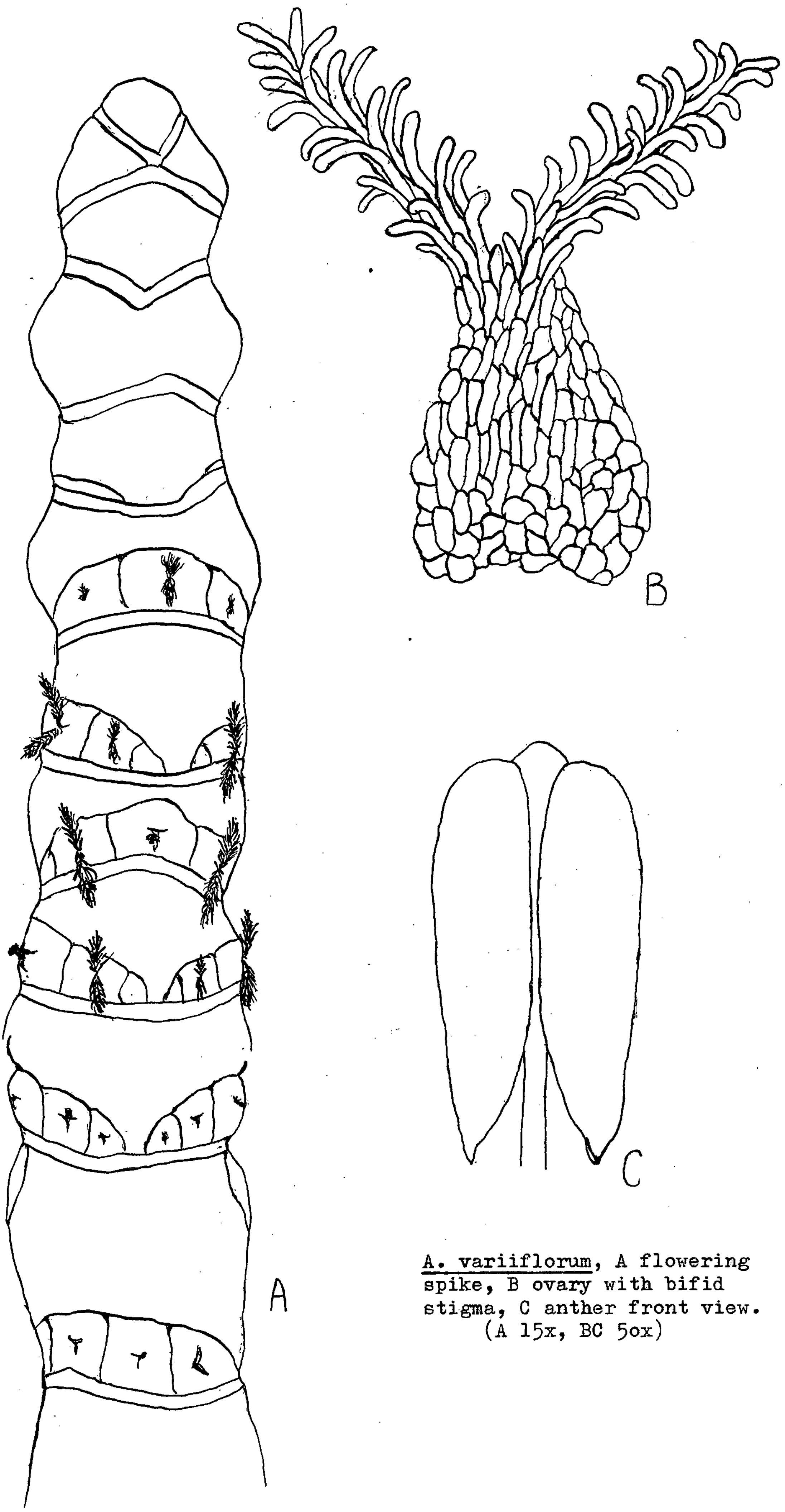
A. littoreum,
matuer spike (15x)



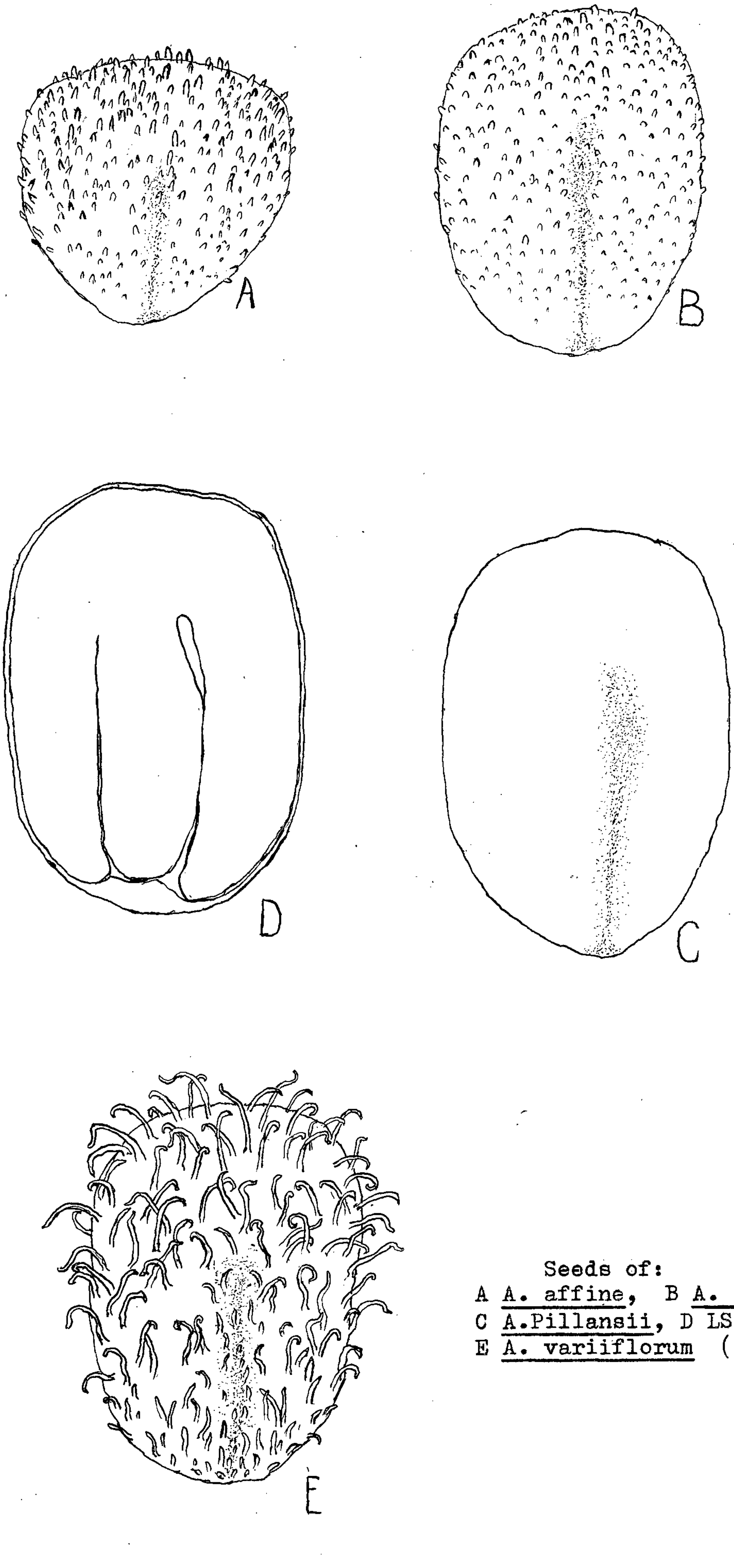
A. littoreum, A ovary with bifid
stigma, B anther side view, C
front view, D germinating seedling
(A-C 50x, D 30x)



A. Pillansii, A flowering spike, B
ovary with interlocked stigmas,
C anther front view.
(A 15x, B,C 5ox)



A. variiflorum, A flowering spike, B ovary with bifid stigma, C anther front view. (A 15x, BC 50x)



Seeds of:
A A. affine, B A. africanum
C A.Pillansii, D LS of C
E A. variiflorum (5ox)

Distribution of the Species on the Cape Peninsula and Vicinity.

This distribution has been made up from all herbarium material available, but it includes quite a number of localities, which are dried up nowadays, because the rivers have been canalized or otherwise disturbed, and is no longer found there. Such localities are Salt River - Black River banks or the mouth of Sand Vlei near Muizenberg.

Furthermore probably because identification was always difficult, these plants have been very poorly collected in comparison with its abundance even on a better known area like the Cape Peninsula. Especially from the Cape Flats only few localities are known, but still the distribution of the specie is clear enogh to show general tendencies.

There are two elements:
(1) The 'sea shore element' only represented by A. littoreum, which occurs predominantly among rocks just above the high tide level. This species is found all around the Cape Peninsula mainly or preferable on rocky points or rock ledges into the sea. It does not occur at Milnerton or any sandy beaches. Furthermore it does not occur away from the sea.

(2) All the other species belong to a sort of 'inland element', occuring at salt pans, river mouthes or along lagoons. The name does not imply, that it is only found in the inland, but that it well does occur there. It must be emphasized that they have not been seen among rocks or gravel, and it seems not to be the saltiness, that exede their tolerance range of the sea, but it is too exposed.

They occur on the Cape Flats from Rietvlei south to Muizenberg, Kalk Bay, and over to the west only in the Noordhoek-Kommetjie area. A. variiflorum occurs only at Milnerton, but again the very similar A. perenne var. radicans covers the whole area, but the former is placed into this group, because of its preferance of that type of environment.

Remarkable is its absence of places with 'idealcondition' like Witsands or Schusters Bay or Hout Bay even. Here the mountains and not saline environment may have served as an perfect barrier, wheras Brakkloof between Fishhoek and Kommetjie provided these conditions.

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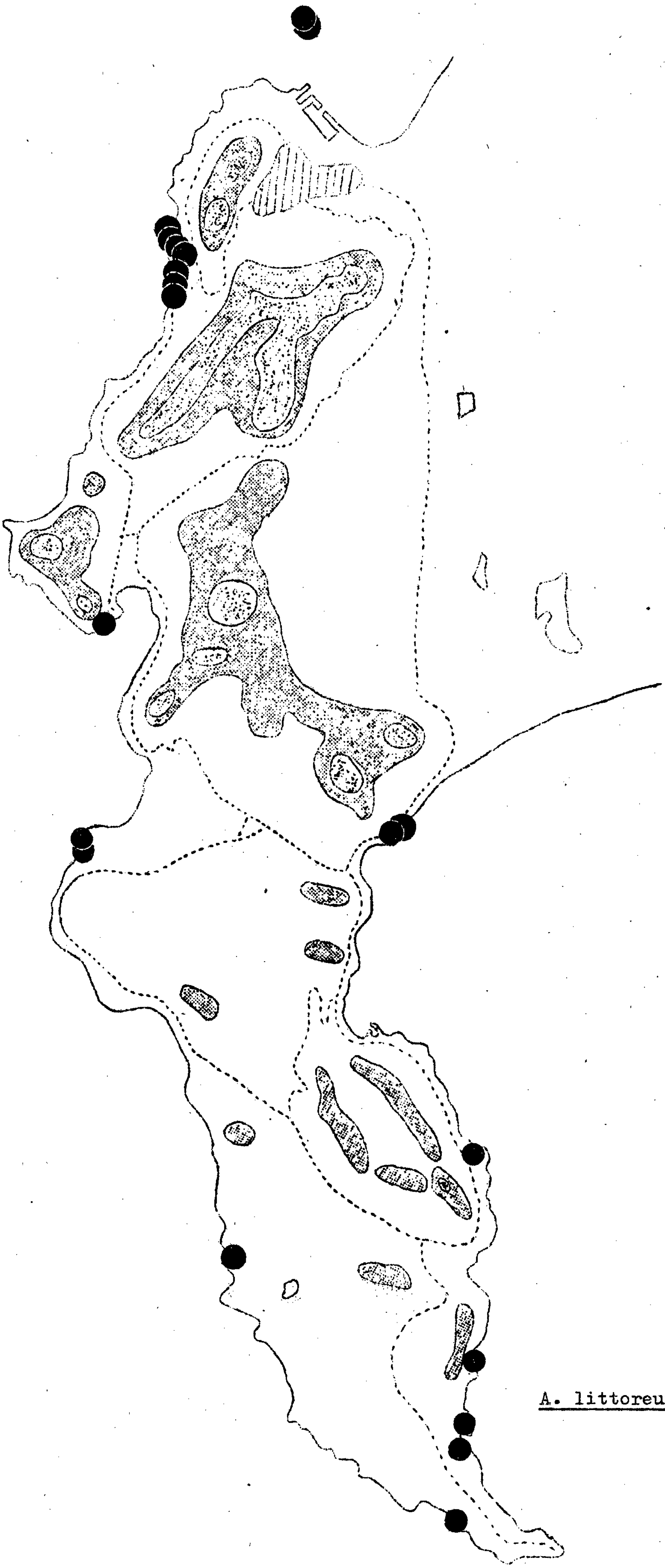
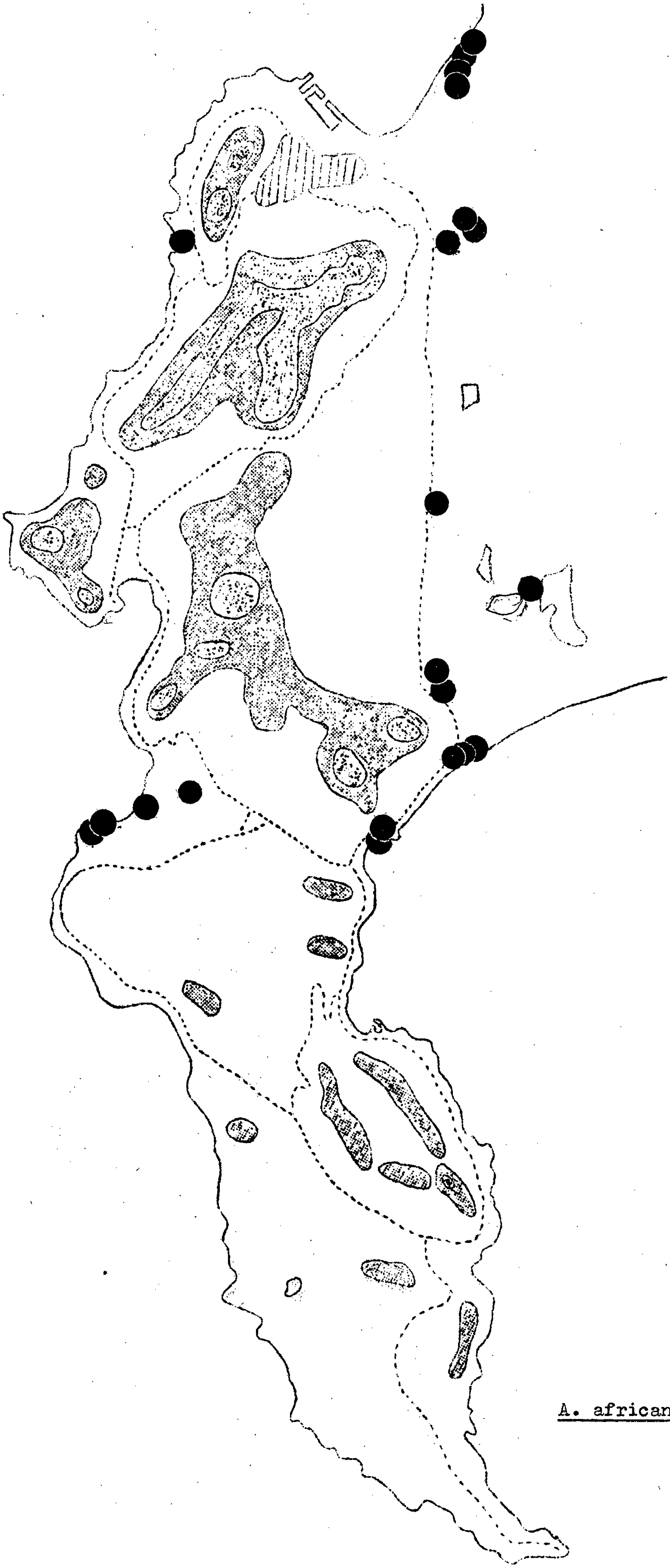
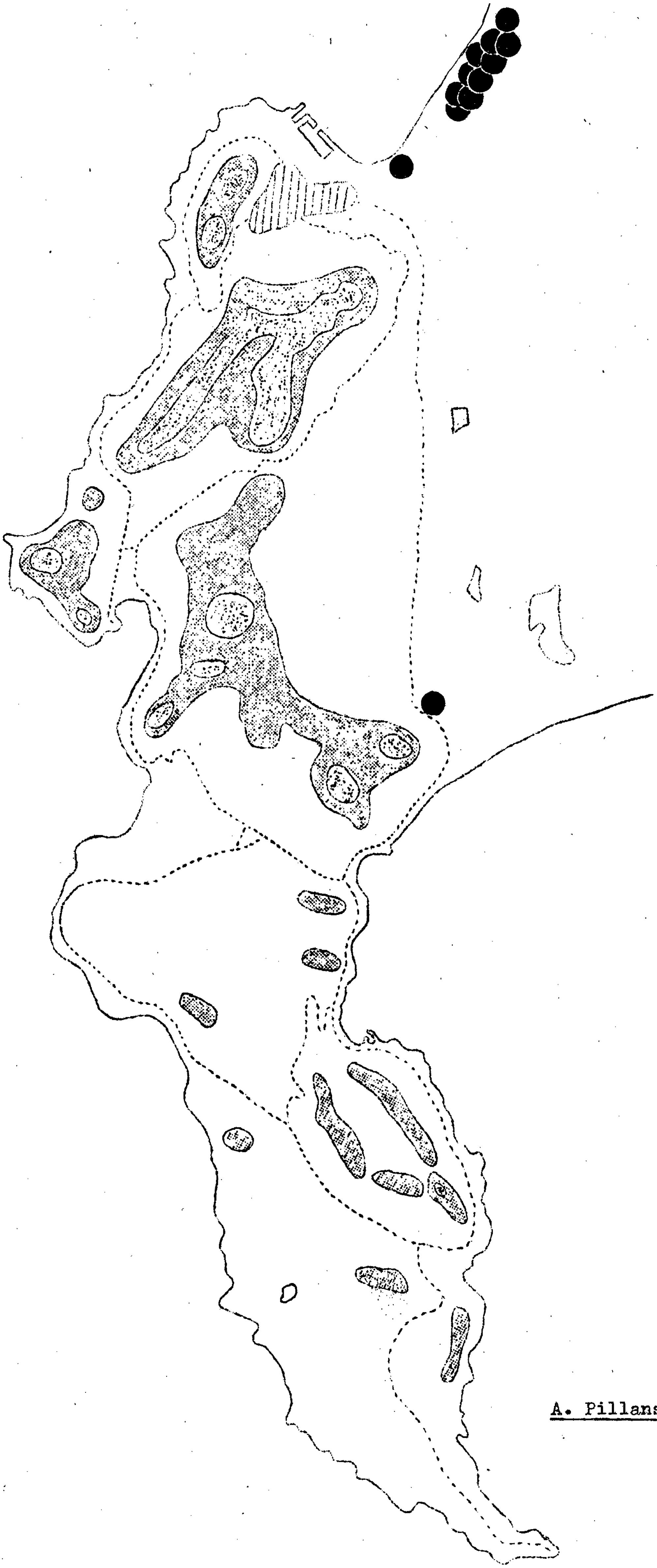


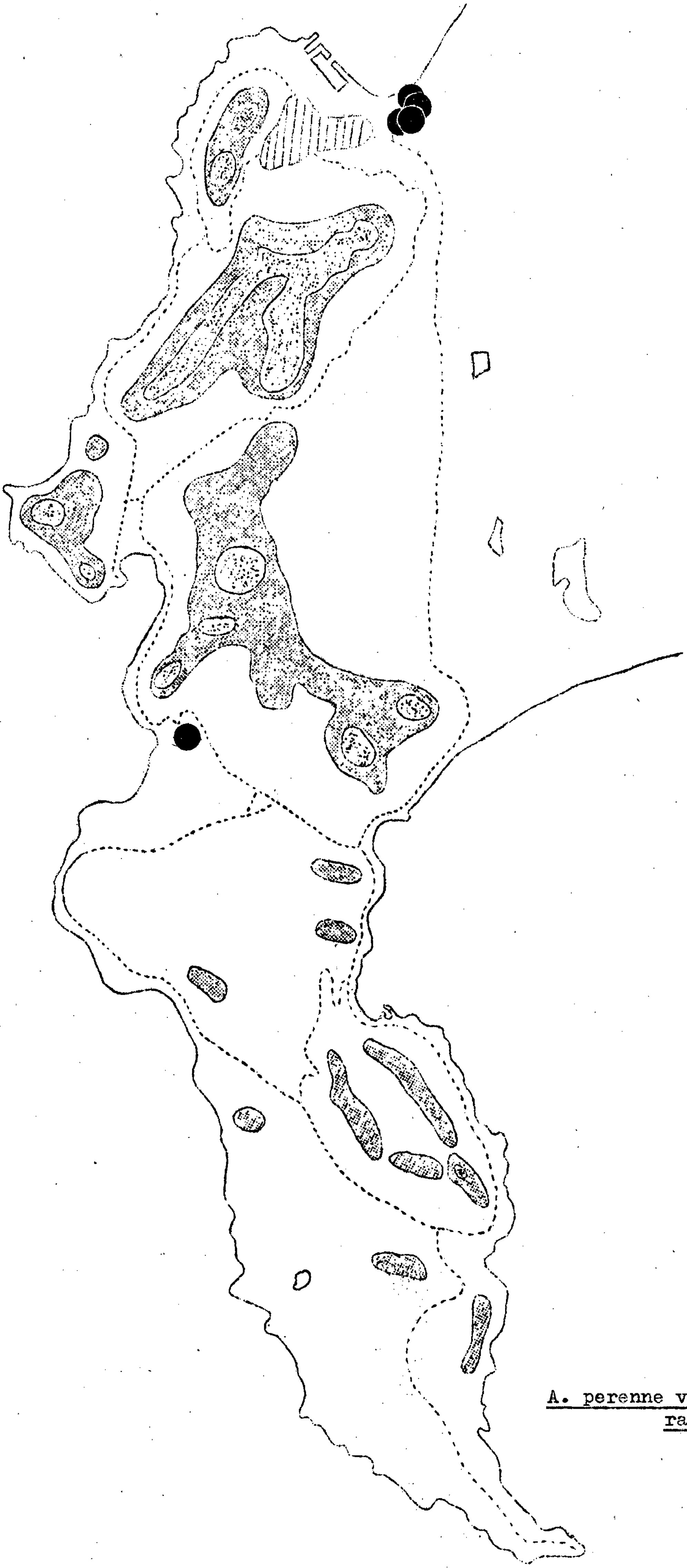
A. littoreum.



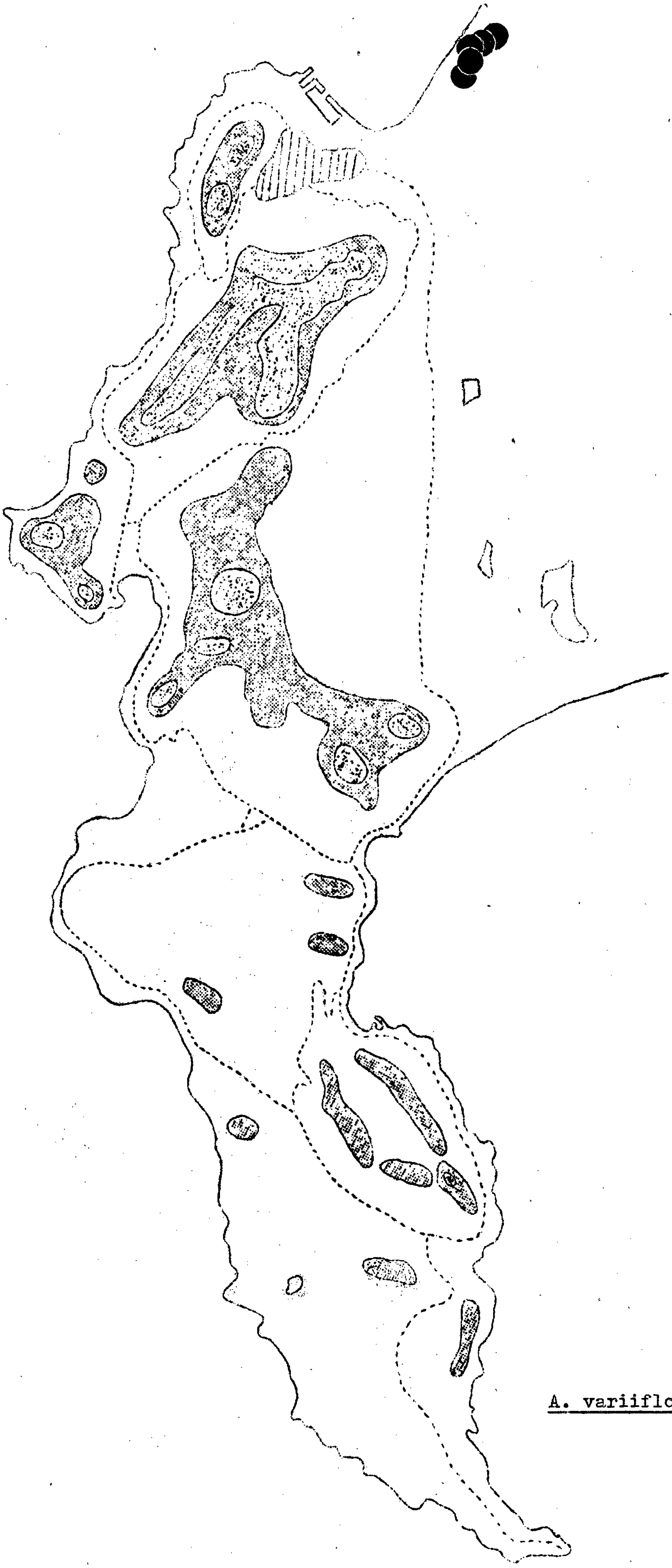
A. africanum



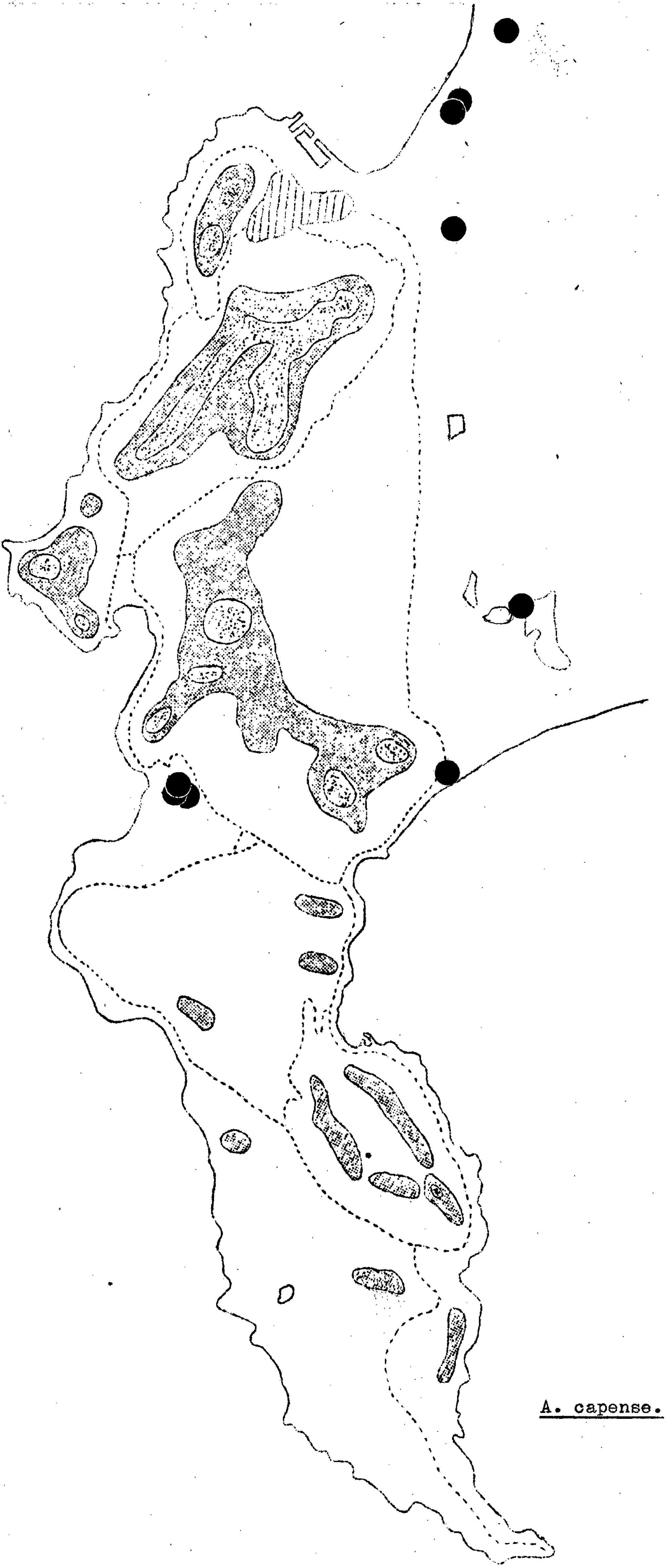
A. Pillansii



A. perenne var. radicans



A. variiflorum.



A. capense.