Flower.

The flower is always trimerous. Perianth. The shape of the perianth segments, which are always free, varies even on a single inflorescence. The outer three segments are firm in texture, usually linear to lanceolate, slightly pointed at the apex, and narrower than the inner whorl. The latter are oval with more or less rounded apices. The outer segments are more or less densely hairy on the back, being covered with soft, silky hairs (H. argentea Bak.) to stiff, upward-pointing bristles (H. multiceps Buch.). The inner segments are either glabrous or slightly pilose, or have a few scattered hairs on the mid-rib. On the inner sides the segments are always deep yellow, with the single exception of H. membranacea Bak., which is a pale whitish-yellow in colour. The flowers open very wide on clear, sunny days when the time is favourable for pollination. Under these conditions they are almost star-shaped, which accounts for their popular name of "sterretjies" or little stars. Androecium. The six stamens occur in two whorls, the filaments being attached to the bases of the perianth segments. Nel reports that the two whorls are of unequal lengths in certain species, but, although this occurs occasionally, I have not observed it frequently, nor is it a constant character. The shapes of the anthers are very interesting, and are found to vary remarkably little within the individual species. They range from linear to lanceolate, are always sagittate at the base, and either have fissures or are complete at the apices. When present these fissures grade from the very minute (H. acuminata Bak.) to those which are visible to the naked eye as in H. filiformis Bak. and H. membranacea Bak. When complete at the apices the anthers are obtusely rounded. Dehiscence takes place by means of two lateral fissures. The filaments are very simple in structure. Perfectly cylindrical forms are only found in H. filiformis Bak. and H. membranacea Bak. In all the

other species the filaments range from conical to triangular. (See Plates II, III). Gynoecium. Usually the three parts of the stigma are aggregated together to form a cone, the receptive portion being slightly papillate (H. Rooperii Moore, H. argentea Bak., H. filiformis Bak.). Nel reports that H. orbiculata Nel has free stigmas. Only H. membranacea Bak. has a capitate stigma borne on a long slender style. When present, the style is either cylindrical (H. longifolia Bak.) in which case it is longer than the stigma or of equal length, or, as it becomes shorter the base broadens, until it is almost triangular as in H. obtusa Burch. The ovary is hairy, and either round or club-shaped, with 4 - 20 ovules in two rows on the central placenta. The number of ovules generally seems to vary with the number of flowers in the inflorescence, i.e. the more flowers there are the fewer seeds each flower is required to produce, and vice versa, Fruit. The capsule is very much the shape of the ovary, dehiscence being circumscissile. The seeds are small, round, light and black, with the surface either dull or shiny.

Plate I illustrates typical flower parts: (a) outer segment. (b) inner segment. (d) anther complete at apex. (d) anther with apical fissure. (e) stigma, style, ovary and bract.

V. ECOLOGICAL OBSERVATIONS.

Hypoxis is a common member of the pre-rain, spring, and summer veld flora, and is one of the first plants to flower after veld burning. Although most species are distinctly xeromorphic, they are found to flourish in damp and dry grasslands, the smaller forms such as H. membranacea Bak., H. argentea Bak. and H. filiformis Bak. being characteristic of moister areas. The large corm affords not only a firm anchorage, but a valuable reservoir of food and water in

times of drought. It is these reserves which must be called upon too, to produce pre-rain flowers and foliage. The roots penetrate very deeply to the lower, moister strata of the soil, thereby not only nourishing the plant, but, with the added character of contractility, holding it down so firmly in the soil that it is enabled to grow on the steepest slopes. Field observations reveal that Hypoxis often favours a sloping habitat, being well able to resist the forces of wind and storm water. The deeply embedded bulb also enables the plant to pass unharmed through veld fires. Since the heat has little effect beyond a depth of ± 1/10" the subterranean organs remain uninjured and soon send up new shoots.

The leaf is very interesting from an ecological point of view. Two main types occur, the definitely xeromorphic leaf, and the large, lanceolate, glabrous type as in H. oligotricha Bak. and H. colchicifolia Bak. The latter group are not very abundant in the Transvaal, being unfitted to stand up to the rigours of the climate, but the former flourish in great abundance. The leaves are often very narrow, and so fibrous (H. costata Bak.) that they are used by the natives for rope-making. Anatomical study reveals the fact that there is relatively little chlorophyllose tissue, and a heavy preponderance of sclerenchyma. The majority of leaves and peduncles are densely clothed with hairs which prevent excessive transpiration, and stomata are few, and sometimes occur on the lower lamina only, the leaves in those cases often being recurved. e.g. H. villosa Bak. In H. obtusa Burch. the older leaves exhibit a distinct spiral twist, which enables the surface to avoid the direct rays of the sun. The flowers are attractive to pollinating bees and other insects on account of their bright colour and the nectar at the bases of the perianth segments. The flowers close at night, and small insects which become trapped have been seen to emerge from the flowers covered with pollen in the early morning. Beetles have been noticed to prefer the flowers of H.rigidula

Bak. to those of H. Rooperii Moore when these two are found growing together. The pollen grains are too heavy for wind pollination, but the seeds are very light, and are dispersed from the circumscissile capsule by wind and water.

VI. NOTE ON THE SPECIES CONCEPT.

It is apparent to every systematist with a knowledge of both past and current literature on his subject, that much of the prevailing confusion in the sphere of plant nomenclature is due to the many and diverse shades of opinion held by different authors on what constitutes a species. The early systematists accepted the dogma of Linnaeus that "the number of species is as many as the different forms created in the beginning", but, with the development of modern ideas on the theory of evolution, systematists are faced with a far more complex situation.

The taxonomist looks for individuals which have certain essential characters in common. The geneticist demands for a species a group of biotypes isolated from all others by incompatibility barriers. The phytogeographer adds geographical reservations, and the cytologist demands a common chromosome garniture. It is only by co-operation between workers in all these spheres of investigation that systematics can be placed on a reliable and more or less constant basis. Certain geneticists claim that the species concept should be purely genetical, but the thorough genetical analysis of a genus is the work of a life-time, in the case of trees, perhaps the work of centuries. Genetics cannot be accepted as the only master key to systematics, but it certainly cannot be disregarded. Lack of co-operation between geneticists and taxonomists is probably due to the fact that the geneticist starts with a supposedly homogeneous population and looks for differences, whereas the taxonomist starts with a supposedly heterogeneous population and looks for similarities.

A little mental adjustment is required on both sides.

Perhaps the most satisfactory conception of a species is that of the phylogeneticist. Accepting the evolution theory, we have definitely precluded the possibility of treating the species as the basal unit of taxonomy. The fundamental unit must be the different lines of evolution. "A taxonomical-phylogenetical line of evolution is a sequence of generations, the individuals of which descend from the individuals of the previous generation, and within each generation group themselves according to the law of probability with regard to all essential features, and further form a closed sphere of combinations reacting avitally or incompatibly with all other shheres of combinations with which it comes into contact." (Faegri, 1935). A species, then, is a momentary realisation of such a line. Only by regarding the species as an expression of the line of evolution can we keep our concept in conformity with the demands of the theory of evolution.

Thus it is not the species concept which is arbitrary, but the choice of essential characters for delimitation, these characters varying according to the law of probability. Since the features which can be used to distinguish between species are different in every genus, it must be left to the investigator to decide, on morphological, cytological, ecological, genetical and geographical evidence. A detailed discussion, based on the foregoing theory, of the diagnostic characters used in classifying the genus Hypoxis follows.

VII. AN ANALYSIS OF CERTAIN DIAGNOSTIC CHARACTERS.

The subterranean organs in Hypoxis afford little assistance to the systematist. Although the shape and size of the corm varies, these variations are subject to the type of environment, and are never specifically constant. Baker separates H. kraussiana Buch. from H. filiformis Bak. on

the difference in diameter of the corm, but this has been found to be an arbitrary and inadequate basis of division.

The leaves are very plastic organs, and the utmost care must be exercised before any leaf character is regarded as definite. Species can never be demarkated on a single leaf character. Factors which may be of use if carefully employed are hairiness, size, and number of veins. Particularly with regard to leaf hairiness further research must be carried out on genetical lines. An anatomical study of the leaves revealed the fact that the number and size of the vascular bundles is constant for certain groups of species. This is a valuable piece of information used in compiling the key. The difference in number and size of veins is usually visible to the naked eye, but in very hairy leaves it is useful to have the added confirmation of anatomical study. The leaf arrangement is simple in all species except H. Rooperii Moore where it is very distinctly trifarious. (See Plate XXII). This is an excellent character by which the field worker can distinguish the species immediately, but in the herbarium it is naturally less easily recognised.

Baker employs the inflorescence as one of his chief means of differentiation, and this free use of a very variable character detracts considerably from the value of his key. We cannot say, for instance, that H. acuminata Bak. has a racemose inflorescence when in three cases out of ten it consists of three flowers on the same level. Again, we cannot consider H. parvifolia Bak. to have a cymose inflorescence when the two flowers occur sometimes on the same level, and sometimes one above the other. The inflorescence can occasionally be used for distinguishing between two or three species, but not for dividing the whole genus into big groups.

It is in the flowers, superficially so very much alike, that the chief and most reliable differences between the species are to be found. The genus can be divided into two almost equal sections on the anthers, half being cleft at the

apices, and half entire. The apical fissures are more easily recognisable in some species than in others, for example in H. membranacea Bak. the fissures are visible to the naked eye, while in H. hemerocallidea F. et Mey they are relatively small, The presence or absence of fissures, however, is very definite and constant in every species examined except H. Rooperii Moore, where apical fissures have been observed in some specimens, but not in others. (See Plates II and III. The numbers cited correspond with the numbers of species as provided in the key). Another valuable diagnostic character in the flower is the relation in length between the style and stigma. In some species they are of equal lengths, or the style is longer than the stigma (H. longifolia Bak.), in others the style is very short or absent. (H. argentea Bak.). This relationship is found to hold, no matter what the age of the flower may be. Baker divides the genus into two equal halves on the size of the perianth limb, those in which the perianth limb is ¼ - ⅜" in diameter, those in which it is ½ - ¾" long. This is a thoroughly artificial and unsatisfactory system, also used in certain instances by Nel. The size of the perianth limb is not even constant in any two flowers on the same inflorescence.

Nel attempts to divide up the genus into what he calls "natural groups". The writer is unable to agree with many aspects of this division, but hesitates to suggest a better arrangement until this work is presented as a complete monograph, when more will be known about the affinities of certain doubtful species. For the purpose of this paper a division into groups was unnecessary, since limiting the number of species for analysis makes possible the production of a simple, and, it is hoped, not too cumbersome key. The Transvaal species alone certainly do not fall into any natural system of groups.

Nel correlates the type of inflorescence with the presence or absence of a[illegible]l fissures in the anthers. He

regards the type of inflorescence found in H. Rooperii Moore as intermediate between the cyme and the raceme, because the lower petioles are very long, and associates with this the fact that some of the anthers are cleft at the apex, while others are complete. According to Nel's hypothesis all species with corymbose inflorescences have anthers with apical fissures, while those with racemose inflorescences have their anthers complete at the apex. Unfortunately this analysis does not hold true. Among the forms which have apical fissures, the inflorescences of H. filiformis Bak., H. hemerocallidea F. et Mey., H. orbiculata Nel and H. acuminata Bak. alone cannot be described as corymbose, while among those which have anthers complete at the apex, H. colchicifolia Bak., H. multiceps Buch. and H. neliana Schinz. are decidedly corymbose or subcorymbose. The genus will have to be divided up along very different lines, or the present analysis considerably modified if a reliable system of subdivision is to be found.

VIII. METHODS EMPLOYED.

Most of the herbarium material of Hypoxis available in South Africa has been examined in detail. Collections have been made as extensively as possible by and for the writer in the Transvaal, but field observations have been restricted largely to the Witwatersrand. A considerable number of specimens have been collected and planted, so that they will be available for genetical and ecological experiment in future years. In the case of H. orbiculata Nel, H. interjecta Nel, H. patula Nel and H. cordata Nel, the only named specimens are the type sheets at Kew and the Berlin Museum. Until it is possible to examine these sheets, Nel's descriptions must be relied upon.

The work this year has centred mainly round the examination of available literature and material, and the

compilation of revised descriptions. Detailed descriptions of most species have not been given since Baker's publication in 1896. In many cases only a very limited amount of material was available at that time, and it is now essential that details be supplied and certain amendments made to the earlier summaries. Special emphasis has been laid on the dissection of as many flowers as possible, the accurate measurement of all floral parts, and of the leaves and underground organs. All available literature and notes on herbarium sheets with regard to geographical distribution have been condensed. In this way it is hoped that sufficient accurate detail has been made available to satisfy the extensive demands of modern systematics.

IX. KEY TO THE TRANSVAAL SPECIES.

Anthers with apical fissures.

i. Filaments filiform

Stigma capitate .....H. membranacea 1.

Stigmas 3, concrete, conical .....H. filiformis 2.

ii. Filaments subulate

a. Style longer than stigma or equal in length.

Plants minute, leaves not exceeding 1½" in length .....H. parvifolia 3.

Well grown plants leaves over 12" long.

Leaves hairy.

Inflorescence corymbose, leaves not more than 1/6" wide .....H. longifolia 4.

Inflorescence racemose, leaves not less than 1" wide .....H.hemerocallidea 5.

Leaves glabrous .....H. Buchanani 6.

b. Style shorter than stigma or absent.

Inflorescence a 6-8 flowered raceme.

Stigmas free .....H. orbiculata 7.

Stigmas concrete .....H. Rooperii 23.

Inflorescence corymbose, if subracemose not more than 4-flowered.

Leaves 6-20 nerved, approximately equally thickened.

Leaves 12 or more, densely hairy, 4-6" long and ⅜" wide .....H. villosa 8.

Leaves 6-10, loosely hairy, 10" long, and ⅜" wide .....H. acuminata 9.

Leaves narrow, nerves unequally thickened, 2-4 being more prominent.

Leaves terete .....H. kraussiana 10.

Leaves linear

Leaves thin in texture, veins slender .....H. angustifolia 11.

Leaves firm, strongly veined.

1-2 pedicels, leaves shortly pilose, 6" long and 1/12" wide .....H. argentea 12.

2-4 pedicels, leaves densely silky, 10" long and ½" wide.H. Gerrardii 13.

Anthers complete at the apex.

1. Inflorescence corymbose, if subracemose, flowers less than three in number.

Leaves glabrous .....H. colchicifolia 14.

Leaves hairy

Flowers 2-4, definitely corymbose, leaves densely covered with stellate hairs .....H. [illegible] 15.

Flowers 2, one pedicel always longer than the other, leaves sparsely hairy .....H. neliana 16.

2. Inflorescence racemose, many-flowered.

a. Leaves glabrous

Leaves not more than ⅜" wide ....H. interjecta 17.

Leaves not less than 1⅜" wide, filaments subulate

Peduncle 3-4" long .....H. latifolia 18.

Peduncle 6-8" long .....H. oligotricha 19.

b.Leaves glabrous on the surface and fimbriate on the margins and mid-vein .....H. costata 20.

c.Leaves hairy.

Leaves not more than 5" long .....H. patula 21.

Leaves not less than 9" long.

Lower pedicels ½-1" long .....H. Rooperii 22.

Lower pedicels less than ½" long.

Leaves lanceolate to oblong-lanceolate .....H. obtusa 23.

Leaves linear.

Leaves narrower than ⅛" ....H. rigidula 24.

Leaves ⅛-⅝" in width .....H. cordata 25.

X. REVISED DESCRIPTIONS OF SPECIES.

I. HYPOXIS MEMBRANACEA BAK.

Baker in Journ. Linn. Soc. xvii, 106, 1878 !

Baker in Flora Capensis vi, 1896 !

= H. parvula Baker in Journ. Linn. Soc. xvii, 113, 1878 !

= H. brevifolia Baker in Flora Capensis vi, 1896 !

Corm ⅛-⅓" in diameter with a long neck and brown membranous tunics; roots very fine, sometimes branched, up to ½" in length. Leaves 4-8, lanceolate, membranous, 1½-4" long, and up to ½" broad, thinly clothed with long soft hairs. Peduncles 1-2, very slender, flexuous, hairy; bracts minute, linear. Flowers 1-2, pedicels ½-2" long. Perianth limb ⅛-¼" long, segments oblong-lanceolate, whitish-yellow inside, the outer green and lightly hairy on the back; stamens 1½ lines long, anthers basifixed, lanceolate, sagittate at the base, 1 line long, with very deep apical fissures; filaments ¾ line long, filiform; stigma capitate, style long and slender; ovary turbinate ⅛" long, pilose, capsule small, turbinate.

Distribution:

Cape Province: Alexandria, Clydesdale, East London, Griqualand

East, Kei Mouth, Kentani, Komgha.

Natal: Bergville, Howick, Liddesdale, Lion's River, Nottingham Road, Tugela, Umzimkulu, Weenen.

O.F.S.: Springfontein.

Swaziland: Havelock concession.

Transvaal: Barberton.

HABITAT: Grows among grass in damp places and seems to flourish where the soil is rich in humus.

AFFINITIES: C.E. Moss (in M.S.) was of the opinion that H. membranacea should form a new sub-genus which he calls Pseudo-Hypoxis. This he divides into two species:

1. Pseudo-Hypoxis membranacea which has leaves and peduncles characterised by stellate hairs. The following sheets are quoted:

Gerrard	1835	Natal! (Type of H. membranacea Bak.)
Tyson	2880	Clydesdale!
Rudatis	1196	Alexandria!
Pegler	109	Kentani!
Schlechter	6634	Umzimkulu!
Wood	3940	Liddesdale! (Type of H. brevifolia Bak.)
Sanderson	1854	Natal! (Type of H. parvula Bak.)

2. Pseudo-Hypoxis hypoxidoides which has no stellate hairs.

Moss 15429 Woodbush!

Saltmarshe in Herb. Galpin 1049, Havelock Concession, Swaziland!

Since only about 12% of the specimens examined lack stellate hairs, and in about 20% they are very scanty, it seems unnecessary to subdivide Pseudo-Hypoxis. There is, however, much to be said for raising the status of H. membranacea from a species to that of a subgenus. It differs from the other species in the shape and texture of the leaves, the pale colour of the flower, the filiform filaments, and the long style and capitate stigma. H. membranacea appears to have advanced far beyond any other members of the genus, and to

stand on quite a different level. This problem will be handled with greater certainty when extra-African material has been examined.

PLATE IV. a. Habit Photograph, natural size.
b. Inflorescence, 1½ times natural size.

II. HYPOXIS FILIFORMIS BAK.

Baker in Journ. Linn. Soc. xvii, 109, 1878!
Baker in Flora Capensis vi, 1896!
= H. caespitosa Baker in Bull. Herb. Boiss. Ser.II, 1, 858.

Corm ½-⅝" in diameter with a long neck and dark brown membranous tunics; roots straight, unbranched, contractile, 2" long. Leaves 6-8, setaceous, strongly ribbed, rigid, usually 4-6" long, but ranging from 3-10", and under a line in diameter, bright green, loosely hairy. Peduncles 1-2, very slender, 2-5" long, loosely hairy, bracts setaceous. Flowers 1-2, rarely 3; perianth limb ¼-⅓" long, segments oblong-lanceolate, pale yellow, the outer green and hairy on the back; anthers lanceolate, deeply sagittate, with marked apical fissures, 1¼ l. long, filaments filiform, 1 line long, concrete, style very short, ovary turbinate ⅛-1/6" long, densely hairy. Capsule ¼" in length; seeds small, round and black.

DISTRIBUTION:

Cape Province: Kokstad, Stockenstroom, Queenstown,

Natal: Durban, Inanda, Lidgetton, Lion's River, Mohlamba Range, Van Reenen, Vryheid, Zululand.

Basutoland: Leribe.

Swaziland:

Transvaal: Barberton, Carolina, Duiwel's Nek, Ermelo, Frankenwald, Haenertzburg, Lydenburg, Middleburg, Nelspruit, Piet Retief, Pretoria, Witbank, Witwatersrand (Bedford Farm, Elandsfontein, Houghton Estate, Witpoortjie, Benoni), Woodbush.

HABITAT: Most common in damp grass, but also found in dry and

rocky places. Flowers in very early spring on burnt plots, later in unburnt veld.

AFFINITIES: H. filiformis resembles H. kraussiana Buch. superficially when it is well grown, but differs from it in having filiform filaments, whereas those of H. kraussiana are subulate.

PLATE V. a. Habit photograph, natural size.
b. Inflorescence, 1½ times natural size.

III. HYPOXIS PARVIFOLIA BAK.

Baker in Flora Capensis vi, 1896!

Corm oblong, ¼" in diameter. Leaves 3-4, lanceolate, moderately form in texture, hairy, 1-1½" long, ⅛" wide. Peduncles usually 2, very slender, longer than the leaves, 1-1½" long. hairy. Flowers 1-2, segments oblong in the outer whorl, oblong-lanceolate in the inner whorl, bright yellow inside, the outer three hairy outside, ¼" long; stamens ⅓ the length of the perianth segments, anthers 1½ l. long, oblong-lanceolate, sagittate at the base, cleft at the apex; filaments ⅓ l. long, subulate; stigmas three, concrete, conical; style equal in length to the stigma; ovary turbinate, very hairy, ⅛" long.

DISTRIBUTION:

Transvaal: Barberton, Middleburg, Pretoria.

A rare and clearly defined species.

Note: Throughout his monograph Nel refers to this species as H. parviflora Bak. The plant he has in mind is, however, definitely H. parvifolia Bak. since he refers to its type sheet, Galpin 1059.

PLATE VI. Habit sketch, x 1½.

IV. HYPOXIS LONGIFOLIA. BAK.

Baker in Bot. Mag. t. 6035!

Baker in Journ. Linn. Soc. xvii, 115, 1878!

Baker in Flora Capensis vi, 1896!