Drawings of Scandinavian Plants 21-24
Rubus L. Subgen. Rubus

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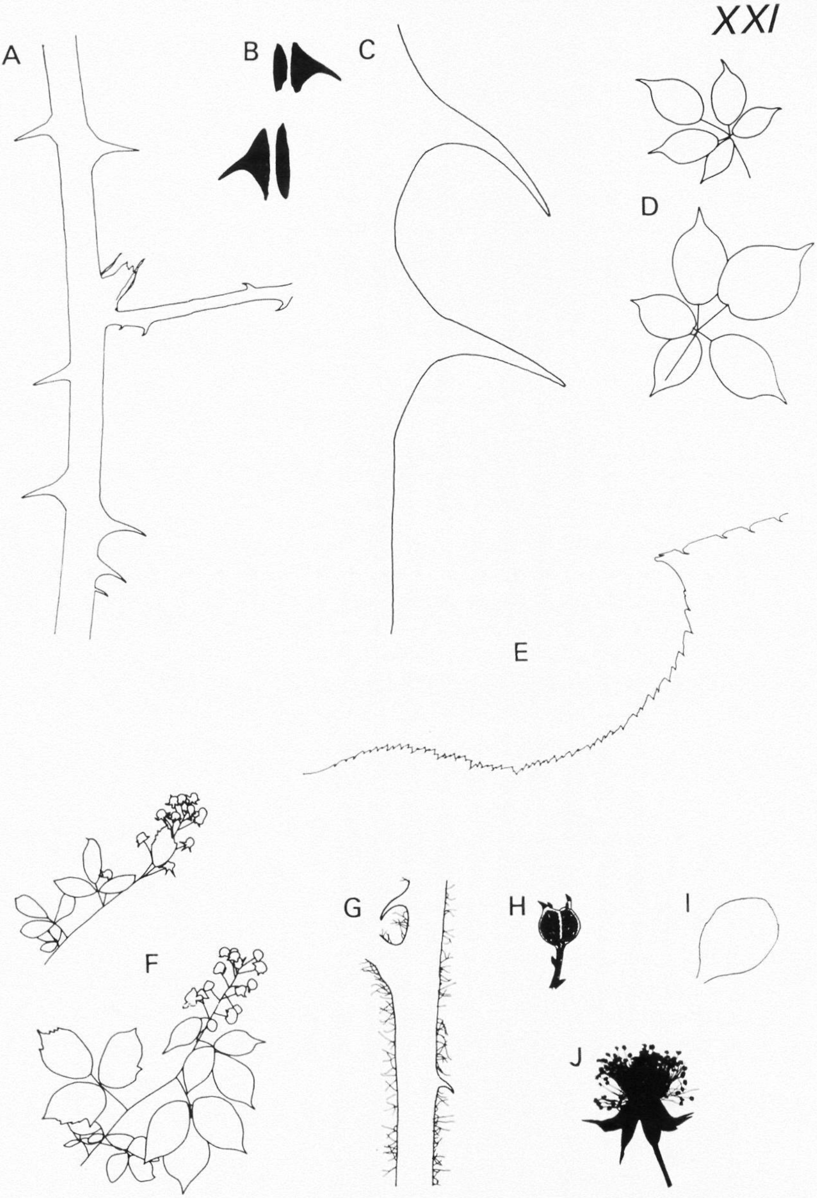
Rubus sulcatus VEST ex TRATT 1823

Stem erect, glabrous; *prickles* 7—10 mm long, strong, patent or slightly bent, base 5—7 mm long, broad; *leaves* 5-foliolate, pubescent beneath; *terminal leaflet* cordate—ovate, long-acuminate; *inflorescence* subracemose, lax, long, densely hairy, glands absent; *flowers* 3—3.5 cm across; *sepals* greyish green with a white-felted border, prickles absent; *petals* white, broadly obovate; *filaments* about 6 mm long.

Normally, the stem is thick, sulcate, slightly recurved, and more than 1.5 m tall; the prickles are sparse, and of the same colour as the stem; the leaflets have a flat surface and are strongly nerved below; the basal leaflets have at least 2 mm long petiolules; the inflorescence has few, small prickles, and contains about 10 flowers; the sepals are acuminate; the petals are 5. *R. sulcatus* is mainly found near the coast. The species occurs in Norway from Oslo to Kristiansand, in Sweden rarely in the west and south, but is more frequent along the east coast up to Stockholm, and in Denmark mostly in the south, common only in very limited areas.

GENERAL LEGEND FOR THE PLATES

First-year growth (*primocane*): A. Stem with prickles. 1 : 1. — B. Prickles, drawn from the side and from above. 1 : 1. — C. Stem with prickles, glands, and hairs. 4 : 1. — D. Leaves (without serration and petiole diameter shown). 1 : 8. — E. Margin of a terminal leaflet with a petiolule. 1 : 2. — *Second-year growth* (*floricane*): F. Inflorescences (without prickles, serration of the leaves, and axis diameters shown). 1 : 8. — G. Rachis with prickles, glands, and hairs. 4 : 1. — H. Floral bud with prickles. 1 : 1. — I. Petal (without hairs). 1 : 1. — J. Flower (without petals, glands, and hairs). 1 : 1.

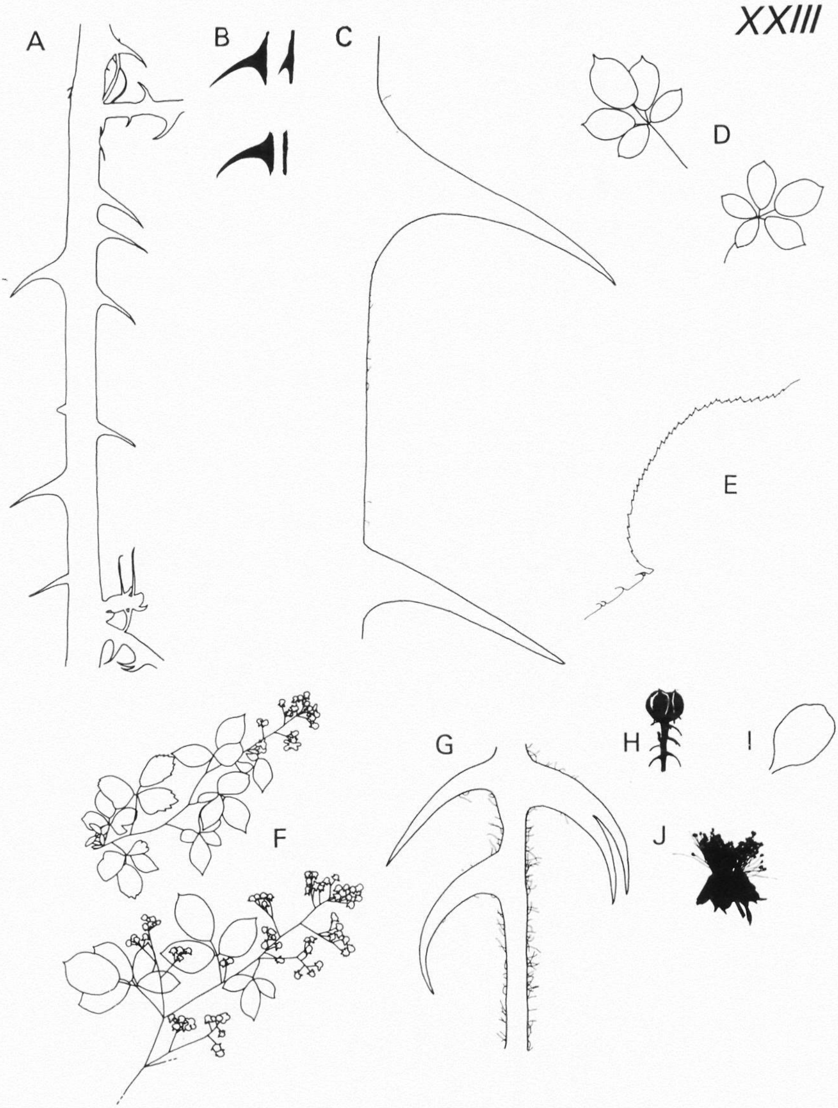


Pl. XXI. *Rubus sulcatus* VEST ex TRATT.

Pl. XXII. *Rubus plicatus* WEIHE & NEES. — Remark: J is seen from an oblique angle.

Rubus plicatus WEIHE & NEES 1822

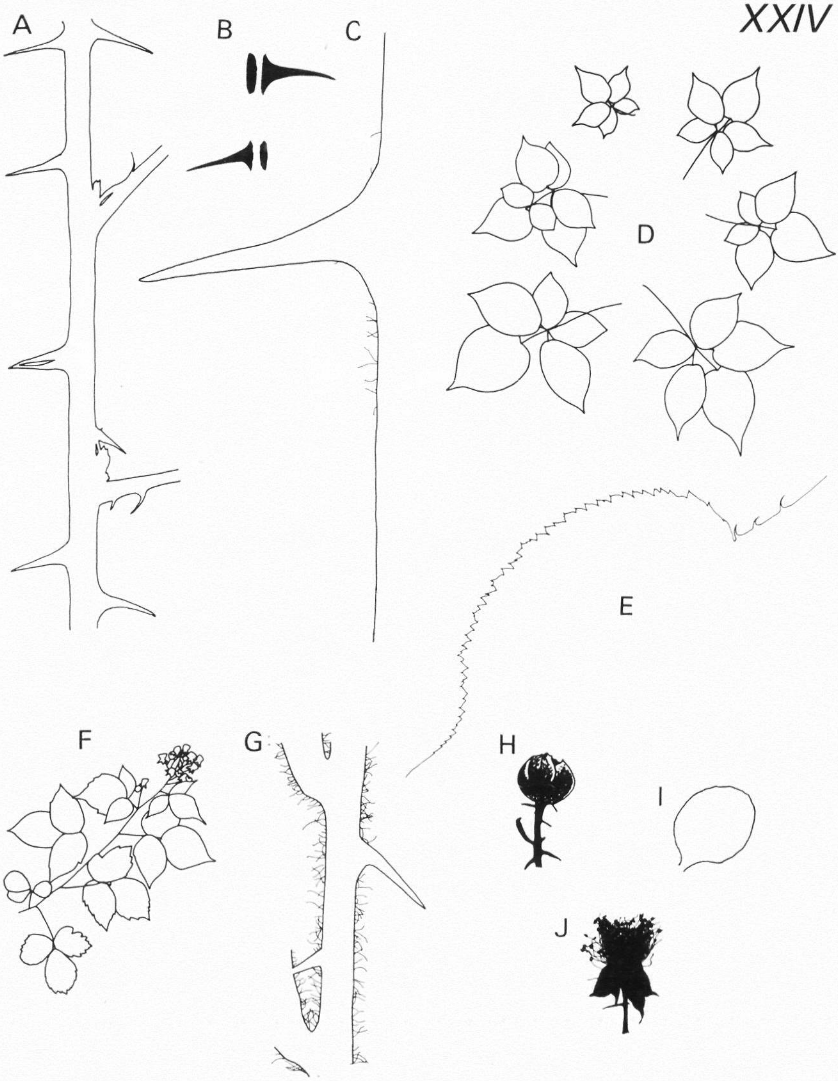
Stem erect, glabrous; *prickles* 5—8 mm long, falcate, base 3—4 mm long, relatively narrow; *leaves* 5-foliolate, hairy on both sides, often densely hairy below; *terminal leaflet* broadly obovate—cordate; *inflorescence* racemose—corymbose, leafy, glands absent; *flowers* about 2 cm



Pl. XXIII. *Rubus nitidus* Weihe & Nees.

across; *sepals* green with a white-felted border, prickles usually absent; *petals* pink—white, obovate; *filaments* about 4 mm long.

Normally, the stem is 1—1.5 m long, branched, recurved, ridged, and red; the prickles are red with pale yellow tips; the leaflets are plicate; the basal leaflets have no or very short petiolules; the inflore-



Pl. XXIV. *Rubus affinis* WEIHE & NEES. — Remark: E refers to a 5-foliolate leaf.

scence has rather few prickles; the petals are 5 or more; the fruits are black, firm, and flavourous. *R. plicatus* seems to prefer poor soils, and often forms thick brush on stony meadows. The species is rather common in most parts of Denmark, and near the coast of south-western

Sweden, but rather rare along the east coast up to Stockholm. In Norway the species follows the coast from Oslo to Sogn.

Rubus nitidus Weihe & Nees 1822

Stem erect, glabrous; *prickles* 7—10 mm long, patent or slightly bent, base 3—6 mm long, narrow; *leaves* 5-foliolate, hairy beneath; *terminal leaflet* oblong; *inflorescence* usually long and broad with many flowers, prickles large, hooked, often numerous, glands absent; *flowers* about 2.5 cm across; *sepals* green with a white-felted border, prickles numerous; *petals* pink—white, broadly obovate with an elongate, narrow base; *filaments* about 5 mm long.

Normally, the stem is ridged, 1—2 m tall, recurved—arched, the prickles at first are pale yellow; the leaves are dark green, shining, the leaflets have a flat surface, and are small except the basal ones, which have no or short petiolules; the inflorescence is leafless; the sepals are small; the fruits are small, ripening late. *R. nitidus* grows along streamlets and in meadows. In Sweden the species occurs in a limited area in the south, namely north-western-most Skåne, and in Denmark on the island of Bornholm.

Rubus affinis Weihe & Nees 1822

Stem erect, glabrous; *prickles* 8—10 mm long, patent, strong, slender, base 3—7 mm long, rather narrow; *leaves* 5 (7)-foliolate, sparsely hairy above, densely hairy below, sometimes grey-tomentose; *terminal leaflet* cordate, acuminate; *inflorescence* long, leafy, terminating in a leafless, dense corymb, prickles scattered, long, straight, glands absent; *flowers* 2.5—3 cm across; *sepals* greyish green, tomentose, with a white-felted border, some prickles at the base; *petals* white—pink, broadly obovate; *filaments* 5—6 mm long.

Normally, the stem is 2—3 m long, arching—recurved, strong, and ridged; the leaves are large; the leaflets have relatively short petiolules; the basal ones often without petiolules; the sepals are deflexed. *R. affinis* grows in moist meadows. The species is known from Västervik on the eastern coast of southern Sweden, and from Bogø south of Sjælland in Denmark.

In the next paper, I shall deal with *R. laciniatus* Willd., *R. selmeri* Lindeb., *R. sprengelii* Weihe, and *R. axillaris* Lej.

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The Floral Anatomy and Relationships of Oliniaceae

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ABSTRACT

The floral anatomy of two species investigated of *Olinia* shows a number of interesting features. Vascular bundles pass through the septa from the ovary wall into the axile zone almost throughout the length of the ovary. There are numerous anastomoses of the bundles in the ovary wall and they are especially abundant near the top of the ovary. The homology of the petaloid scales alternating with the petal lobes is discussed in detail, and a probable suggestion is presented that they might be a product of fusion in pairs of adjacent stipules of the petals. Also the possible affinities of *Oliniaceae* with *Thymelaeaceae, Melastomataceae,* and *Rubiaceae* are discussed.

INTRODUCTION

Oliniaceae is a monogeneric family restricted to Africa. There are about ten species of the single genus, *Olinia.* The leaves are opposite and decussate and sometimes described as exstipulate (e.g., in HUTCHINSON 1967 p. 23) although their stipulate nature has been satisfactorily explained by WEBERLING (1963 p. 121). The flowers are regular, bisexual and epigynous. The hypanthium or floral tube, often referred to as the calyx tube (e.g. HUTCHINSON loc. cit.), bears on its upper margin: *1.* an extremely reduced calyx represented by a narrow rim with five blunt teeth or lobes, the latter being sometimes absent even; *2.* five large spathulate petal lobes; *3.* alternating with the petals, five stamens with a prominent connective; and *4.* five flattened reduced scales just above the insertion of the stamens and hence alternating with the petals.

The stamens are bent downwards and outwards, so that the anthers, which are actually introrse originally, are directed towards the outside. They are more or less hidden by the scales above them. The ovary is inferior, usually five-locular, but sometimes with only four carpels and four loculi. Each loculus usually has two superposed pendulous ovules arising on axile placentas. The ovules are bitegmic, hemianatropous, and crassinucellar, with a bundle of elongated cells, apparently of the character of a hypostase, in their basal part. The embryo sac formation is of the Polygonum type, and endosperm formation is Nuclear (MAURITZON 1939 pp. 42—45; DAVIES 1942 p. 192). The fruit is drupaceous and has a single seed per loculus.

The affinities of this family are controversial and the view often held is that it is probably related to *Thymelaeaceae*. The scales superposed to the stamens are usually regarded as ligular structures.

FLORAL ANATOMY OF OLINIA CYMOSA THUNB.

Studied material: FRIES, NORLINDH & WEIMARCK no. 660 from the Port Elizabeth area, South Africa.

The vascular tissue of the pedicel forms a continuous cylinder (Fig. 1 A) which breaks up beneath the ovary into a number of strands for the ovary wall. These branch further and continue doing so irregularly throughout the length of the ovary. The ovary wall thus contains a large number of irregularly disposed bundles, which while branching also have irregular anastomoses between them (Fig. 1 B—F).

Even from near the base of the ovary, some bundles of the ovary wall give rise to prominent branches which run through the septa inwards into the axile zone and this process continues throughout the length of the ovary (Fig. 1 B—F). Some of these inward branches, which for convenience are referred to here either as the marginal bundles or the ventral bundles of the carpels, arise from strands which are opposite the loculi (and hence corresponding either to carpellary dorsals or to strands on the same radius) while others arise from bundles opposite the septa. Thus in the axile zone of the ovary an indefinite number of bundles is formed and they also anastomose among themselves irregularly.

Near the middle of the length of the ovary, the dorsal bundles of the carpels are separated out by a branching of five bundles of the ovary wall opposite the loculi into inner and outer branches, the former being the dorsal bundles of the carpels (Fig. 1 D). Five other bundles of the ovary wall also divide into inner and outer branches, resulting in an outer ring of ten bundles. To the inside of this ring there are numerous anastomosing and irregularly arranged strands formed by haphazard division of the bundles of the ovary wall (Fig. 1 D—G). The ten bundles of the outer ring are the main traces for the perianth tube (floral tube).

As already mentioned, bundles of the ovary wall send prominent inward branches into the axile zone through the septa. Some of these are branches of the dorsal bundles of the carpels or bundles on the same radius and they travel tangentially in the ovary wall for some distance, and then turn inwards to enter the septa. Others arise from strands on septal radii and travel radially inwards. Branches of some of the bundles in the axile zone enter the ovules. Traces for the lower set of ovules often arise near the level of origin of the traces for the upper set, and run downwards into those ovules (Fig. 1 Q). The loculi fuse in the centre with each other near the top of the ovary, and the ventral bundles of the axile zone form by fusions five small bundles which run in the inwardly projecting, separated septa (Fig. 1 E—F). The dorsal bundles of the carpels also run inwards.

At the top of the ovary where the septa separate from one another, the ovarian cavity is continued upwards as a hollow stylar canal. This is surrounded by the five carpellary dorsal bundles and the five reduced ventral bundles alternating with them (Fig. 1 G). The style separates from the floral tube (Fig. 1 H), and the ventral bundles fade away in its basal region, leaving the dorsal bundles to run upwards into the stigma. The style becomes solid in its upper part.

The floral tube receives not only the ten main bundles but also a number of scattered small accessory bundles which are the reduced upward extensions of the anastomosing vascular plexus in the upper region of the ovary wall (Fig. 1 G—H). The ten main bundles form an outer ring while the accessory bundles are in a zone towards the inside.

Fig. 1. *Olinia cymosa*. — A—G: Transections from pedicel to top of the ovary at successively higher levels. Explanation in the text. — H: Transv. sect. just above separation of style and floral tube, showing numerous accessory bundles in the latter. — I: Transv. sect. a little below the actual insertion of the stamens. — J—L: Origin of stamen trace (st), petal marginal traces (pm) and scale trace (sc). Bundles marked p are petal midribs, opposite which staminodal ridges with minute vascular bundles are seen. — M—N: Separation of the base of the scale. — O: Transv. sect. at slightly higher level, passing through the basal part (with a single bundle) and the terminal recurved part (with three bundles) of the scale. — P: Transv. sect. showing petals and incurved scales. (The V-shaped inner structures with three bundles are the terminal downwardly curved parts of the scale. The basal part of it with a single bundle is seen to the outside of it.) — Q: Long. sect. through ovary, diagrammatic, showing a loculus and a septum in surface view. — R: Diagrammatic representation of the course of vascular bundles (broken lines for stamens, scales and petals). — S: Long. sect. through stamen and scale.

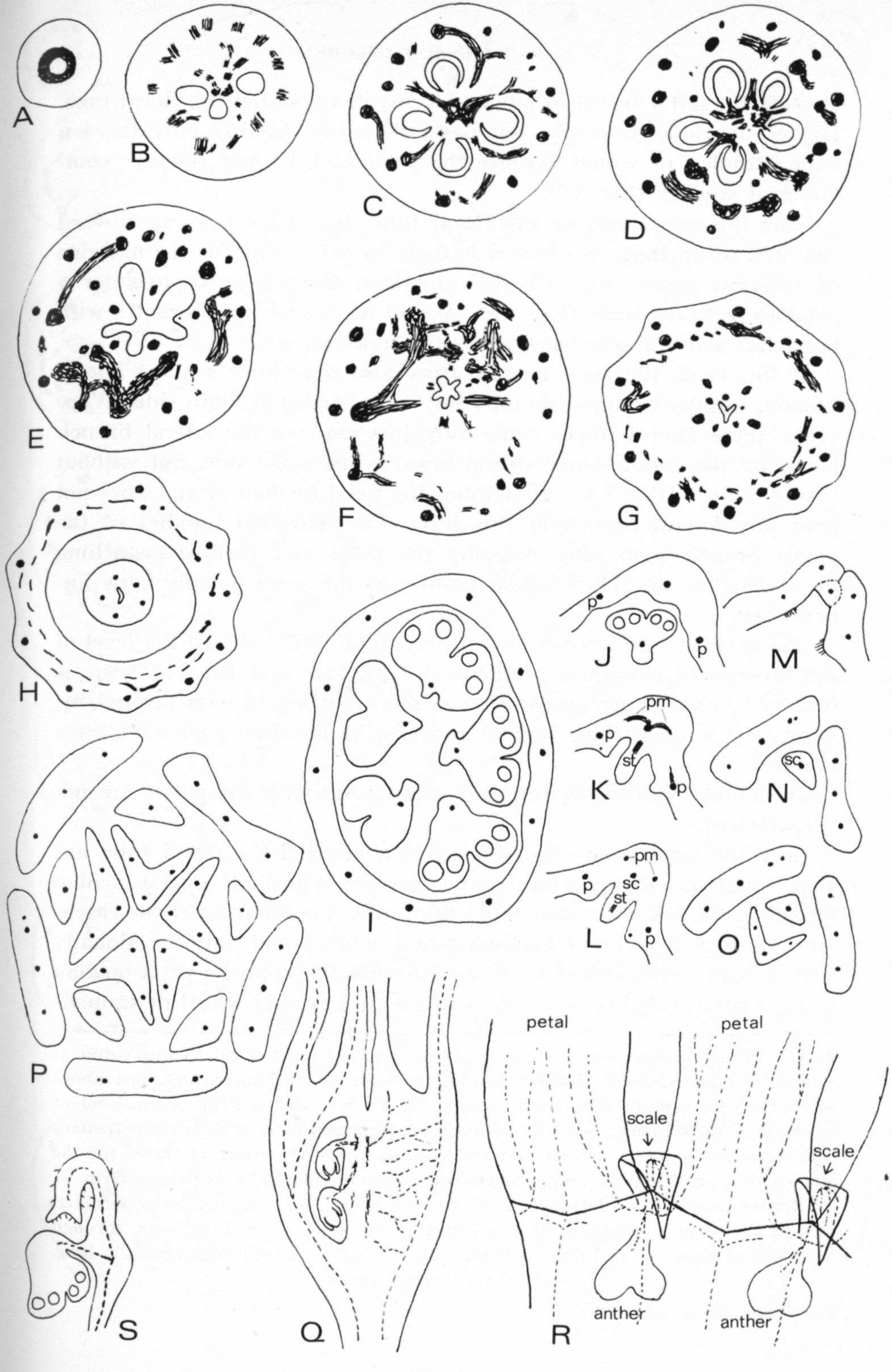
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Fig. 1.

Most of the latter travel in tangential directions within the floral tube. Higher up these accessory bundles fade away, leaving only the ten main bundles, of which five are the petal midribs and five are commissural strands (Fig. 1 I).

Near the upper end of the floral tube, the latter bear an inward staminal trace; they also bear a branch on either side for the margins of adjacent petals (Fig. 1 J—L), and then move inwards to enter a petaloid recurved scale (Fig. 1 M—O and R—S), which alternates with the petals and is situated just above the stamens.

At this level, the petal median trace also may have a short lateral branch, usually on one side only but occasionally on both sides. Very often, these lateral traces come only just close to the lateral branch borne by the commissural strand towards the same side, but without fusing with it (Fig. 1 K). Sometimes the petal median strand does not bear any lateral branch at this level. The marginal bundles of the petals branch soon after entering the petal and further branching occurs higher up. The median bundle of the petal usually runs unbranched.

The scale bundle bears a lateral branch on either side at the level of the downward curvature of the scale (Fig. 1 P and R). The scale is incurved and a transverse section at this level would pass through its basal part with a single bundle and also its terminal part with three bundles.

The blunt minute calycine teeth alternating with the petals are not vascularized.

Near the level where the stamens are inserted the floral tube has short longitudinal ridges on its inner surface opposite the petal median bundles (Fig. 1 K—L). Sometimes these ridges contain a slender vascular bundle with a blind beginning and a blind end, but occasionally with a faint indication of a connection with the opposite petal median trace. These probably represent vestiges of a second whorl of stamens

Fig. 2. *Olinia usambarensis.* — A—G: Transv. sect. from pedicel to ovary top at successively higher levels. Explanation in the text. — H: Transv. sect. just above separation of perianth tube from style. — I: Transv. sect. a little below level of insertion of the stamens. — J—N: Transv. sect. through flower with a tetracarpellary ovary and pentamerous corolla and androecium. — O—Q: Origin of traces for the stamen (st), petal margin (pm) and scale (sc). Bundle marked p is petal midrib. — R: Transv. sect. above detachment of base of scale. The recurved hairy terminal part of the scale is opposite the basal part of the scale. — S: Long. sect. through stamen and scale. — T: Long. sect. through a petal. — U—V: Diagrammatic long. sect. views through ovary.

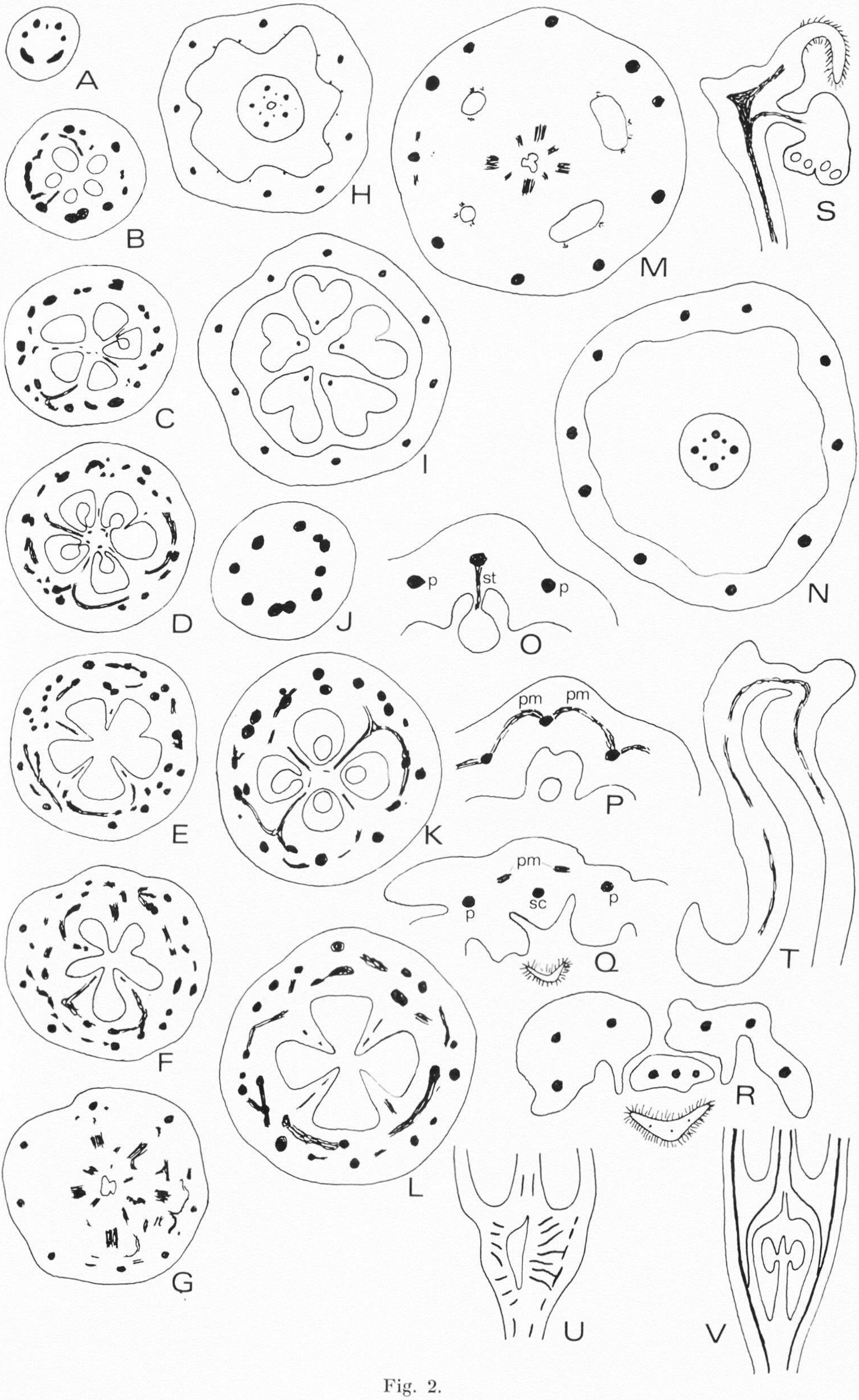

Fig. 2.

which in the ancestral condition might have been well developed. The inner surface of the floral tube bears a number of hairs opposite these ridges (Fig. 1 M).

FLORAL ANATOMY OF OLINIA USAMBARENSIS GILG

Studied material: SYNGE no. 1712 from Mt. Kenya, Kenya.

In this species many flowers are seen with only four carpels (Fig. 2 J—N) instead of the usual five. However, in both the tetra- and pentacarpellary flowers, the perianth and the androecium are pentamerous.

The general features of floral anatomy are as in *O. cymosa,* but there are some noteworthy differences and only these will be pointed out in the following account. The traces that run into the axile zone from the ovary wall through the septa are fewer and more slender (Fig. 2 A—D). In the axile zone also, the bundles formed by them are very few and insignificant in size (Fig. 2 C—D). The septa separate from one another, i.e. the locules fuse, just above the level of the axile placentas, which is near the middle of the length of the ovary (Fig. 2 E). The upper part of the ovary is thus unilocular with inwardly projecting partial septa. Even in this region, septal bundles continue to move inwards and five (or four, depending on the number of carpels) of these enter the style along with a corresponding number of dorsal bundles alternating with them (Fig. 2 F, G, and H). These ventral bundles, however, disappear in the basal part of the style, as in *O. cymosa.* The accessory bundles that enter the floral tube and run in its basal part are very few and insignificant in size as compared with those of the other species.

The scales alternating with the petals are more hairy (Fig. 2 R—S). As in *O. cymosa,* the commissural bundle of the floral tube (alternating with the petal midribs) bears a staminal trace inwards at first; a little higher up it bears a lateral branch on either side (Fig. 2 O—Q), and then moves inwards to enter the scale (Fig. 2 Q—R).

At the same level where these lateral branches are borne, the petal median bundle also bears a lateral branch on either side. Unlike those of *O. cymosa,* these are quite prominent and there is a fusion of these with the lateral branches of the commissural bundle travelling towards them (Fig. 2 P—Q). The fusion product of these two lateral branches travels upwards to become the lateral bundle of a petal (Fig. 2 Q—R). The scale bundle bears a lateral branch on either side soon after entering the scale (Fig. 2 R). In *O. cymosa,* this branching occurs at a much higher level.

The staminodal ridges are also much more prominent than in *O. cymosa* (Fig. 2 O—Q), and they may end in a minute, blunt, free stub, representing a greatly reduced staminode. In this species, the occurrence of a vestigeal bundle in the staminodal ridge, however, is extremely rare.

Also in *Olinia usambarensis* there is an obscurely five-lobed calyx rim. Although this does not have any definite vasculature, there is an acute curvature of the commissural bundle of the corolla at this level (with the angle outwards, towards the calyx lobe) and in some preparations a minute vascular stub projects towards the calyx lobe from that angle, but without entering it (Fig. 2 S). It is reasonable to conclude that the five-lobed rim is the reduced calyx, the vasculature of which has disappeared.

DISCUSSION

The occurrence of the petaloid scales on the same radii as the stamens complicates the interpretation of the floral organization in *Oliniaceae.* The narrow rim which sometimes has five blunt, small teeth alterating with the petals is the calyx. The vascular supply of this has apparently disappeared earlier in evolution. There are various cases in which reduction or elimination of the vascular supply to an organ occurred earlier than the disappearance of the organ itself, just as there are also examples where the external form of the organ has disappeared, but its vascular supply in a reduced state still persists (ARBER 1939; RAO 1953). In *Crucianella stylosa* and species of *Asperula* belonging to *Rubiaceae,* the calyx is completely obsolete. Some other members of *Rubiaceae* have a rim-like calyx, with, however, a well-developed vascular supply (RAO et al. 1964). *Melastomataceae* is another family in which some species have a reduced calyx.

The large spathulate perianth members then are the petals. The stamens superposed by incurved hairy scales alternate with the petals. These scales are often interpreted as ligular in nature but ligules should be opposite the members on which they are supposed to be present. Hence the scales of *Olinia* cannot be ligules of the petals because they alternate with them. They cannot be interpreted as ligules of the sepals either, because the corolla intervenes between them.

There are, however, a few other alternatives for consideration.

1. They may be compared with the staminal appendages of *Melastomataceae,* where they may be adaxial or abaxial, and vascularized or not. But in *Melastomataceae* they are definitely appendages of the connective and if vascularized, it is a branch from the bundle in the connective that supplies them. WILSON (1950) interpreted the stamen of *Melastomataceae* as the evolutionary remnant of an ancient branch system. The scales of *Olinia* are not directly connected with any part of the stamen, including the filament. They are placed just above the point of insertion of the stamens. Hence they cannot be compared with the connective appendages of *Melastomataceae.* But it should be remembered that in *Melastomataceae* also the leaves are opposite and decussate, the flowers peri- or epigynous, the calyx sometimes reduced to a rim, the petals free, and the stamens typically in two whorls, and sometimes with staminodes.

2. The scales of *Olinia* may be interpreted to be of the nature of a staminal corona of the type seen in *Asclepiadaceae,* but the abovementioned objection that these scales are away from the stamens and not attached to them even partly would hold good here also.

3. The scales can be regarded as of the nature of stipules of the petals. They are on the same circumference and are detached from one another at the same level. Each scale is the product of fusion of adjacent stipules of different petals. This origin can be compared with that of the interpetiolar stipules of *Rubiaceae.* The vascular bundle of the scale has a common origin with the marginal bundle of the petal and this can also support the stipular theory. The "petaloid scales" of *Thymelaeaceae,* which may be in pairs and opposite the sepal lobes, or isomerous and alternating with the sepal lobes in which case they are often cleft at the base, or polymerous without any relation to the sepal number, have been variously interpreted as petals, scales, glands, staminodes, outgrowths, squamellae, and stipules. HEINIG (1951) favours the view that they are stipular appendages of the sepals. As there is evidence of rudimentary stipules of the leaves of *Olinia,* this is a very probable suggestion and the scales might be interpreted as being formed by the fusion in pairs of adjacent stipules of the petals. As mentioned in the introduction, WEBERLING has proved the leaves to be stipulate. A stipular explanation is also the only one which would be in accord with the positions of the stamens and the scales.

The androecium of *Olinia* is obviously derived from a condition with two whorls of stamens. The presence of staminodal rudiments and vestigeal vasculature is an indication of this. It is the inner androecial whorl that has disappeared.

The gynoecium shows the peculiar origin of numerous marginal bundles of the carpels throughout the length of the ovary. They move through the septa into the axile zone to function as the ventral bundles. The ovary wall has many irregularly disposed bundles with numerous anastomoses. An origin of the ovular supply from some bundles of the ovary wall moving inwards through the septa is seen in some *Rubiaceae* like *Mussaenda, Gardenia, Catesbaea,* and *Hoffmannia* (Rao 1964), although the condition is not identical with that in *Olinia*. The majority of *Rubiaceae* are bicarpellary but there are some which are pentacarpellary. Morphologically, the placentation in *Olinia* is axile and the anatomical evidence indicates a derivation from the parietal type. The traces that supply the lower set of ovules in *Olinia* often descend from a higher level. *Rubiaceae* has some members in which the ovules are supplied by downward traces. According to Heinig (1951), also the axile placentation in *Thymelaeaceae* is derived from a parietal one.

Olinia has bitegmic ovules, while the members of *Rubiaceae* have unitegmic ones. The glandular tapetum of the former is of binucleate cells, while in the latter it is of uninucleate cells. Eames (1961) does not attach much signification either to the number of integuments or to the vasculature *within* the ovule. On the other hand, *Oliniaceae* and *Rubiaceae* agree in the ephemeral nature of the middle layer of the anther wall, in the type of embryo sac, in the ephemeral antipodals, and in the nuclear endosperm.

The pollen grains in *Oliniaceae,* according to Erdtman (1952 p. 298), are 3-colporate. The colpi in *Olinia cymosa* alternate with 3 pseudocolpoid grooves, but such grooves are lacking in the pollen of *Olinia usambarensis* (=*O. volkensii*). The grains are oblate spheroidal to spheroidal, without a distinct sexine pattern. The pollen grains, also according to Erdtman (loc. cit.), are similar to those in *Melastomataceae* and *Penaeaceae,* but similar 3-colporate pollen grains, among other types, are found also in, e.g., the eurypalynous *Rubiaceae.*

With regard to anatomical features *Olinia* shows resemblence to *Rubiaceae* in a number of characters, e.g. the vestured pits of the vessels (see Metcalfe & Chalk 1950), but *Rubiaceae* lacks intraxylary phloem which is said to occur in *Olinia* and the stomata of *Olinia* are not of Rubiaceous type. The trichomes in *Olinia* are unicellular, simple and rather thickwalled.

Melastomataceae, Thymelaeaceae and *Rubiaceae* are three families which show resemblances in some features to *Oliniaceae*. Some points about *Melastomataceae* have been discussed above. The illustrations given by MORLEY (1953) are mostly longitudinal sections of flowers and they are too diagrammatic and too few to be useful in correlating with his descriptions. In *Melastomataceae* the ventral traces are said to arise towards the top of the loculus and turn sharply downwards. The departing ventral bundles may form an irregular reticulum. At the top of the ovary some strands pass inwards between the locules. MORLEY says that these veins are difficult to interpret and they may be lateral carpel traces or continuations of the ventrals from the placenta to the dorsal, or some "purely secondary developments". In any case there is no real resemblance in floral vasculature between *Melastomataceae* and *Oliniaceae,* apart from the fact that the staminal appendages of the former are not at all comparable to the petaloid scales of the latter.

The flower of *Thymelaeaceae* is usually accepted to be apetalous. That of *Olinia* has petals, if the five-lobed rim externally is interpreted as a calyx. This is also in accord with the positions of the androecial members. The present authors feel that a relationship with *Rubiaceae* is possible and worthy of consideration with due reservation based on the differences pointed out above.

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New and Little Known Stapeliads from Southern Angola

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ABSTRACT

The author presents a list of Stapeliads collected in southern Angola in 1968. Diagnoses of three new taxa are given: *Stapelia parvula* KERS, *Stapelia Schinzii* BERGER & SCHLECHTER var. *angolensis* KERS, and *Huernia montana* KERS. The first mentioned species is related to *Stapelia Juttae* DINTER, while *Huernia montana* KERS shows affinity to *Huernia Volkartii* GOSSW,. a plant endemic to Angola, and to *Huernia stapelioides* SCHLECHTER, a species from Swaziland and the Transvaal. The following species are reported as new to Angola: *Duvalia polita* N. E. BR. and *Tavaresia grandiflora* (K. SCHUM.) BERGER. Moreover, the discovery near Moçamedes of two new localities for *Tavaresia angolensis* WELW. mean a considerable southward extension (680 km) of the known distribution of this species.

INTRODUCTION

In 1968 (end of May—June) the author travelled from S.W. Africa up to the southern parts of Angola, where botanical collections were made in the Huila and Moçamedes districts. Due to heavy rainfall, road conditions were extremely bad. The author's travelling companion during this adventurous trip was Mr. WILLY GIESS, Jr., Windhoek.

To the author's knowledge, only seven species of Stapeliads were known previously from Angola. Our knowledge of them is very meagre in most cases. In S.W. Africa, however, this group is quite wellknown and is represented by a large number of taxa. The paucity of records from Angola certainly do not mean that the Stapeliads are especially rare there, at least not in the dry southwestern parts of the territory. The author got the impression that they occur almost as frequently there as in most parts of S.W. Africa. Our knowledge of the Stapeliad flora of Angola is still very fragmentary and many new discoveries are certainly to be expected.

In order to facilitate the drying of the herbarium specimens, the plants were treated with paraffin before pressing. Living samples of each plant were also collected and these specimens are now grown in Stockholm. The herbarium material is kept at the Museum of Natural History, Stockholm (S).

The taxa have been arranged according to WHITE & SLOANE 1937. In the following, this work has been abbreviated as "W & S 1937".

Stapelia parvula KERS spec. nov.

Planta minuta basi valde ramosa. *Caules* erecti 1.5—4 cm longi, 5—7 mm lati, quadrangulares, virides, minute puberuli; anguli obtusati, ambitu oblongo-quadrangulato; *spinae* ascendentes, parvae, dilatentes. *Flores* 3-fasciculati. *Pedunculi* ad 1.5 cm longi, bracteis subulatis 1 mm longis. *Pedicelli* 1.5—2 cm longi, 5 mm crassi, minute puberuli, sub anthesi horizontaliter extensi, post anthesin erecti. *Sepala* subulata 2 mm longa, extus minute puberula, viridia. *Corolla* rotata, parvula, 5—6.5 mm diametro, extus viridis et minute puberula, intus atrobrunnea; *lobi* ovati—triangulati, apiculati, leviter rugosi, ad 2 mm longi, basi c. 2 mm lati, apicem versus minute puberuli, margine ciliis linearibus hyalinis brevissimis asperatis; annulus rotundatus et leviter crassiusculus, glaber, rugosus, 2—3 mm diametro. *Corona exterior* nigra, super discus adpressa, 5-lobata, lobis obtusis. *Corona interior* nigra, 5-lobata, lobis oblongis, apice truncatis vel emarginatis, supra antheras incumbentibus. *Folliculi maturi* c. 4 cm longi, 3 mm crassi. *Semina* 3 mm longa, apice pilis 5 mm longis induta.

Typus speciei: KERS n. 3458, 25.IV.1968, Angola, Moçamedes distr., at Saco do Giraul, c. 10 km N of Moçamedes (Holotype S).

Icon.: Fig. nostra n. 1.

Stapelia parvula is a very inconspicuous plant and has the smallest flowers so far recorded in this genus. The plant is minutely puberulous in all parts except within the corolla where it is almost completely smooth. The apical parts of the corollar lobes are faintly puberulous. The tiny and odourless flowers are dark brown and are directed upwards. The comparatively long and slender pedicels are spread horizontally at anthesis. The minute and flat top of the style appears strikingly white as contrasted with the black corona and the dark brown corolla. The flower is flat when fully expanded but the margins of the lobes finally become slightly recurved. The united portion of the corolla is somewhat thickened to a rounded annulus which is glabrous and markedly rugose. The shallow and minute corollar tube is concealed from above by the spreading lobes of the outer corona. The upper faces of the outer lobes of the corona are slightly concave at their bases and these are briefly connected by a minute rim. The inner lobes of the corona rise from the rounded sinuses of the outer corona. The lobes lack dorsal gibbosities or projections and their apical parts almost completely cover the anthers (Fig. 1).

I consider this new species best placed with *Stapelia* sect. *Podanthes* (HAW.) BERGER, though the Corona is rather similar to that of certain species of *Caralluma*. In this section of *Stapelia* we undoubtedly find its closest relations. Thus, *Stapelia parvula* shows a clear affinity to *Stapelia Juttae* DINTER, *S. portae-taurinae* DINTER & BERGER, *S. similis* N. E. BR. and *S. kwebensis* N. E. BR. var. *longipedunculata* BERGER. All these species are members of a chain of closely allied taxa (cf. W & S 1937 p. 462). Of the species mentioned, *S. parvula* is particularly similar to *S. Juttae*. This new species gives the general aspect of a much diminished *S. Juttae,* from which it differs essentially — apart from its small size — in the corona and in the slightly raised annulus.

This species was discovered in the southernmost part of the desert coastal plateau, which rises from the sea just north of Moçamedes. The species grows amassed in dense tufts in some narrow fissures on a single low rocky ridge.

Some living specimens were brought to Stockholm, and they have succeeded well and have flowered in the greenhouse at the Botanical Institute (October 1968).

Only one collection of *Stapelia* seems to have been reported before from Angola. This report refers to an undescribed species which was collected by WELWITSCH (n. 4263) "in dry hilly places by the Giraul river" in the Moçamedes district (HIERN 1898 p. 698). Although WELWITSCH's sample had no flowers, HIERN considered that it represented a new species of *Stapelia* belonging to the section *Tromotriche*. WELWITSCH possibly collected his specimens not very far from where *S. parvula* was found, and some phrases in HIERN's description of the plant remind the present author of his new species. But WELWITSCH's unnamed *Stapelia* cannot be identical with *Stapelia parvula* as the

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Fig. 1. *Stapelia parvula* KERS. — A: Specimen with a flower just before opening. — B: Peduncles, pedicel and mature fruits. — C: Flower seen from above. — D: Corona (×10). — E: Seedling (×3). — A, C and E drawn from living specimens grown in Stockholm. B and D drawn from KERS n. 3458.

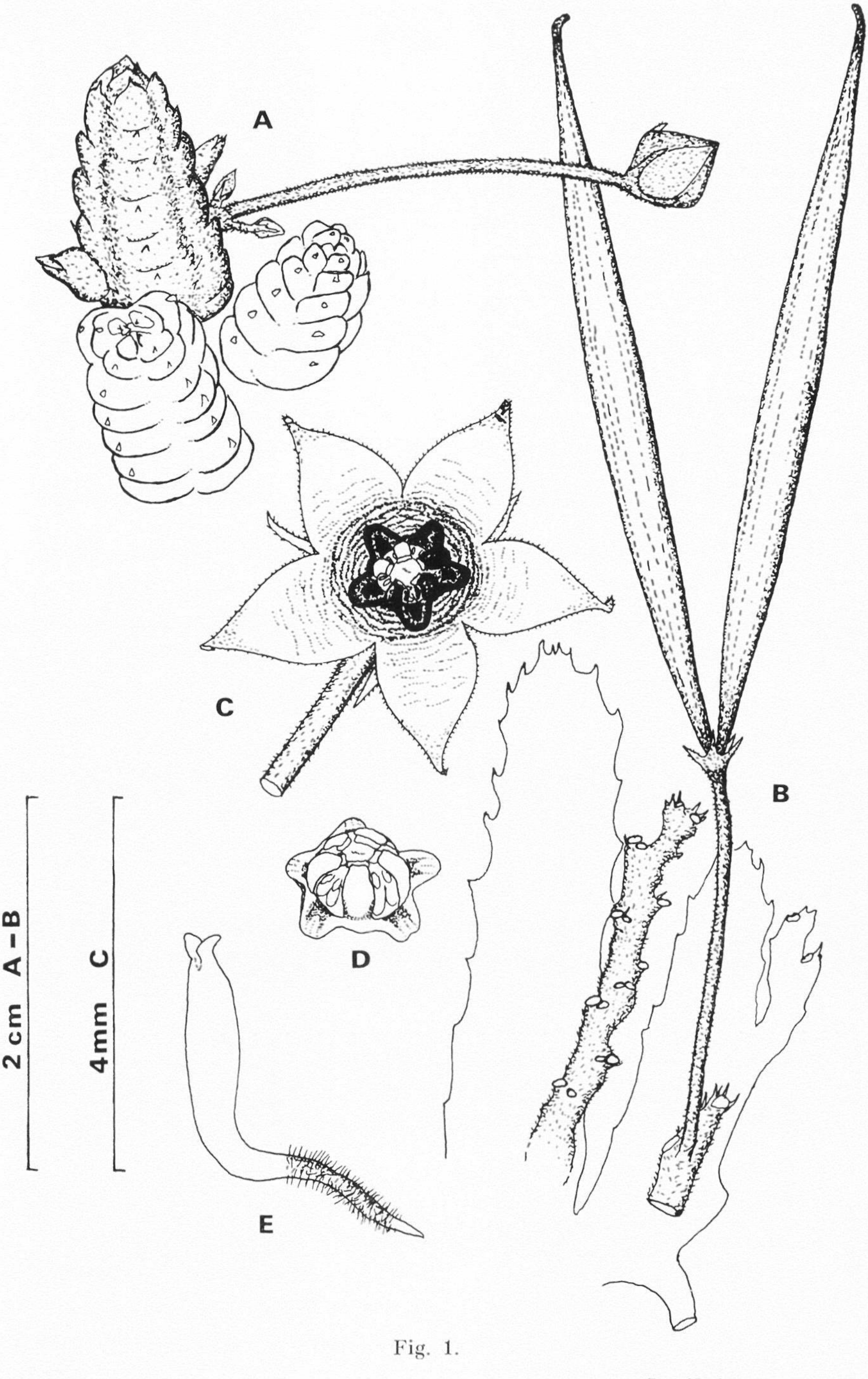

Fig. 1.

former has much taller stems (4—6 in. high) and much longer follicles (4.5 in. long and 0.5 in. thick) (HIERN 1898 p. 699).

Stapelia Schinzii BERGER & SCHLECHTER var. **angolensis** KERS var. nov.

Differt a typo floribus minoribus (8—9 cm diametro), caulibus gracilibus (5—7 mm crassis, 6—7 cm altis) et ramis saltem junioribus atropurpureo—violaceis.

Typus varietatis: KERS n. 3441, 3.V.1968, Angola, Moçamedes distr., 10 km NE of Vila Arriaga, along the road Moçamedes — Sá da Bandeira; on low rocks (Holotype S).

In habit this variety looks quite different from *Stapelia Schinzii*, but the flowers are, though different in size, similar in both taxa. In var. *angolensis* the corolla has the same proportions as in var. *Schinzii* with the lobes tapering into the characteristic, slender tips. The margins of the corolla have vibratile hairs up to the lobe-apices, but most densely in the sinuses. The hairs are 4 mm long and narrowly spindle-shaped with the broadest portion at about $^1/_3$ from the apex. The inner corona is almost identical with that of *Stapelia hirsuta* var. *affinis* (as illustrated in W & S 1937 p. 594), and it does not show essential differences from that of var. *Schinzii*. The flowers range from 8 to 9 cm in diametre while in var. *Schinzii* they are stated to be 11—12 cm (14—18 cm in specimens of var. *Schinzii* from S.W. Africa in Herb. S).

The difference between var. *angolensis* and var. *Schinzii* is more apparent in the vegetative parts than in the flowers. In var. *angolensis* the stems are more slender; the branches are 5—7 mm broad, while they become 1.5—2 cm broad in the type. The young stems are decumbent and fusiform. The longitudinal grooves of the stems are shallow and the transverse section of the old stems forms an almost perfect square. The stems are 4- (rarely 6-) angled and the teeth are inconspicuous in lateral view. This new variety is particularly characterized by the peculiar colour of the stems which are uniformly dark violet—purplish, in the narrower portions almost dark grey. In var. *Schinzii* the stems are usually dull green throughout or they may show some dark violet patches forming an irregular pattern.

The author knows var. *Schinzii* from the field and from herbarium collections [leg. WANNTORP in 1968 (S)], but also from specimens collected in S.W. Africa which are now grown in Stockholm.

Stapelia Schinzii s. str. occurs from Lake Ngami in Botswana and further westwards to the central parts of S.W. Africa. As this species is not known from the northernmost parts of S.W. Africa, the Angolan variety seems to be well isolated geographically from the main population.

The author found this Angolan variety near Vila Arriaga on the lower slopes of the Chela Mountains. The specimens occurred frequently in shallow soil on some low dry rocks, situated between the main road and a small stream. The specimens were flowering abundantly, but the handsome flowers had a very unpleasant odour.

Duvalia polita N. E. Br. var. **polita**

Huila distr., just NW of Humbe, along the road Rocadas—Sá da Bandeira. Growing under *Colophospermum mopane,* on a plain of hard loamy sand. The vegetation formed a mosaic pattern composed of 'islands' with Mopane, Baobab, *Fockea multiflora* and *Sansevieria,* and bare sandy patches with annual grass and *Portulaca hereroensis* Schinz (scarce) and shallow, dried-up water depressions with e.g. *Sphaeranthus epigaeus* Schinz. [Kers n. 3242, 18.IV.1968 (S)].

NOTE. This species was not known from Angola before (cf. the literature quoted). It has been recorded from S.W. Africa (northern parts), the Transvaal, Natal, Botswana, and Mozambique (W & S 1937 II p. 753). Specimens from this Angolan locality are cultivated in Stockholm and have flowered there.

Tavaresia angolensis Welw.

A. Moçamedes distr., c. 4 km S of Moçamedes, on the coastal sandy plain, near the road to Porto Alexandre. Locally frequent under *Euphorbia* spec. cf. *virosa.* One specimen is grown in Stockholm. [Kers n. 3459, 25.IV.1968 (S)].

B. Moçamedes distr., at Saco do Girual, c. 10 km N of Moçamedes. On the coastal plateau. A few specimens were observed in some rock fissures where they grew near *Stapelia parvula* Kers. On this locality *Tavaresia* had no flowers. In the vegetative parts this plant does not differ from the above mentioned specimens, so the author believes his identification is correct. One specimen is grown in Stockholm.

NOTE. The author's specimens from near Moçamedes differ in some details from the description given for *Tavaresia angolensis,* but without doubt they belong to this species (W & S 1937 p. 1101). *Tavaresia angolensis* is stated to have 5- (rarely 7-) angled stems, while the author's specimens have 8 (rarely 9) angles. The following observations refer to the specimens from Moçamedes, and may contribute to our knowledge of the variation of the species. The erect stems are up to 13 cm long and are 2.5 cm in diametre. The solitary flowers appear successively from short peduncles, which reach 1 cm in length. The flowers are 7.5 cm long and 3 cm wide. The lobes are not recurved but are directed almost straight forward in line with the corolla tube. The sepals are 5—7 mm long. The pedicels of the flowers are c. 2 cm long and 1 mm thick, but in the ripe fruits they become 10 cm long and 4 mm thick. The pods are 11.5 cm long when ripe. The full length of the outer corona is 1.5 cm and its apical knobbles are pear-shaped.

Tavaresia angolensis WELW. was previously known from "several points along the coast of Angola, from Luanda north to Ambritz" (W & S 1937 p. 1102). Between those northern localities and the southern ones at Moçamedes there is a large gap of about 680 km. Very likely this species also occurs along the Atlantic coast within the intervening area, though we still lack records there. Probably this 8—9-angled form will be found to merge into the northern typical form somewhere along the coast.

Tavaresia grandiflora (K. SCHUM.) BERGER

Huila distr., Namacunde, c. 9 km N of the border of S.W. Africa. Growing at the base of a tree, just outside the small village (Mopane shrub vegetation).

NOTE. Only one single specimen was observed. It had no flowers. This specimen is now cultivated in Stockholm. No flower has appeared yet, but the author has no doubt as to its identity with *T. grandiflora.* This Angolan specimen has 9—11-angled stems (c. 8 cm tall). *Tavaresia grandiflora* seems not to have been reported previously from Angola. The species has a wide range of distribution embracing Rhodesia, Botswana, the Transvaal, Cape Province and the northern parts of S.W. Africa (W & S 1937 p. 1107).

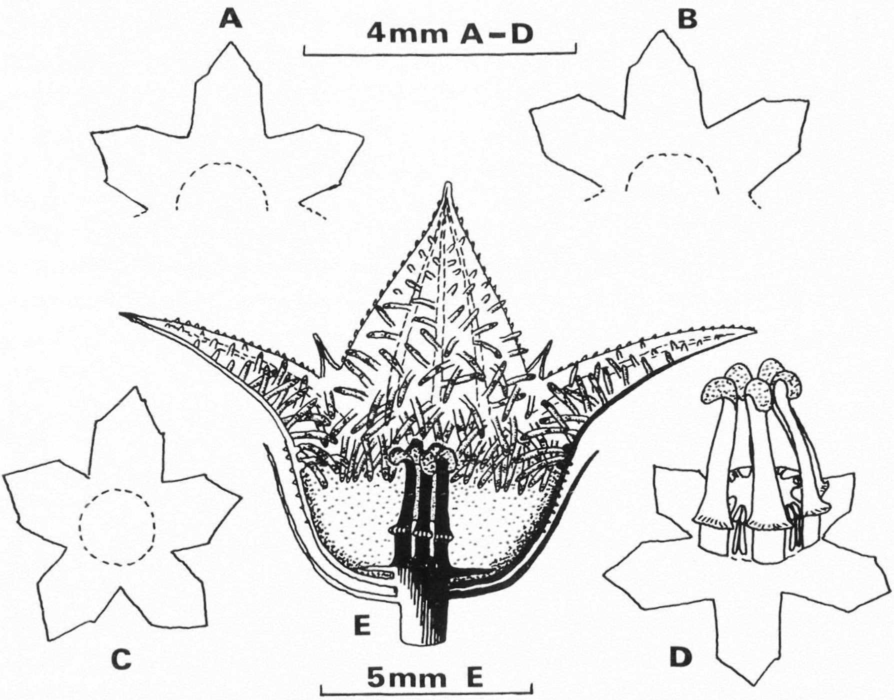

Fig. 2. *Huernia montana* KERS. — A—D: Outline of the outer corona in four different flowers. — E: Dissected flower showing the corona, the papillate surface of the corolla and the smooth annulus. — A—E drawn from KERS n. 3460.

Huernia montana KERS spec. nov.

Species nova *H. stapelioidis* SCHLECHTER et *H. Volkartii* GOSSW. affinis, differt *a priore* floribus minoribus, 2 cm diametro (3—3.7 cm in illa), lobis coronae exterioris apice acutis (in illa truncatis), a *posteriore* lobis coronae exterioris quadrangularibus acutisque (in *H. Volkartii* anguste lanceolatis), caulibus crassis brevibusque (in *H. Volkartii* gracilibus), etc.

Typus speciei: KERS n. 3460, 30.IV.1968, Angola, Huila distr., Chela Mtns at c. 2000 m, c. 24 km NW of Sá da Bandeira along the road to Tundevala, near the plateau. Growing on shallow soil on dry rocks bordering a stream which forms a small cataract here (Holotype S).

Icon.: Fig. nostra n. 2.

Stems erect, richly branched at the base, branches 2—5 cm high and up to 1.5 cm broad, 5-angled, dull violet when young, later becoming dull green and violet-tinted. Angles acute, tapering into teeth, whose apical portion becomes whitish and pungent when old. *Peduncles* from the lower parts of the stems, up to 5 mm long. *Bracts* 3—5 mm long, subulate, 1-nerved. *Pedicels* 1 cm long and 1.5 mm thick, dull purplish. *Flowers* 1 or 2, seldom 3 together, inconspicuous, borne close to the ground. *Sepals* 5 mm long, subulate from an ovate base, 1-nerved adpressed to the corolla. *Corolla* broadly campanulate with the tube widening upwards and passing into the spreading lobes, 2—2.2 cm in diametre (tube 7 mm long, lobes 7 mm long and 6—7 mm broad at base). The tube is dark brownish without and minutely asperous in the upper parts; the inside is smooth in the lower parts and forms an annulus with a sharp boundary upwards against the papillate exposed surface. The exposed interior parts of the tube are abundantly covered with 2—3 mm long papillae and these decrease in size and number toward the apices of the lobes where they are only 0.5 mm long. Papillae whitish below, tipped and often banded dark brown. *Outer coronal lobes* 1.6 mm long, 1.5 mm broad at base, quadrangular with acute apices, margin entire or provided with some minute teeth at the base of the apical tapering part, black (or dark brown?), closely adpressed to the corolla. *Inner coronal lobes* erect, 3 mm long, considerably exceeding the anthers, very dark brown to nearly black, with a distinct dorsal crest in the lower portions about halfway up the staminal column, flattened, apically thickened into recurved, knob-like and minutely papillated tips (Fig. 2).

This new species is closely related to *Huernia stapelioides* SCHLECHTER and *H. Volkartii* GOSSW. especially to the latter. Thus, *Huernia montana* combines certain characteristics of these two species and is intermediate in others. *Huernia montana* shows the same vegetative characters as *H. stapelioides* (cf. W & S 1937 p. 901, fig. 949) and differs from *H. Volkartii* in this respect (cf. op. cit. p. 908). On the other hand, the flowers are similar in *H. montana* and *H. Volkartii*. The shape of the outer coronal lobes is intermediate between *H. stapelioides* and *H. Volkartii*; in the former species the lobes are quadrangular with truncate apices, in the latter species they are stated to be linear — narrowly lanceolate and apically acuminate. In *H. montana* the lobes are quadrangular with acute apices (cf. Fig. 2). The inner coronal lobes are flattened in *H. montana* and have a prominent dorsal transversal ridge. These latter features which are also found in *H. stapelioides* should not occur in *H. Volkartii* (W & S 1937 p. 908).

In *Huernia montana* the flower is inconspicuous and has a dull, dark brown colour and looks similar to that of *H. Volkartii* (W & S 1937 p. 907).

The two closely allied species *Huernia montana* and *H. Volkartii* are endemic to Angola, where both species are confined to the high western escarpment area. *Huernia montana* has so far been collected only from the Chela Mountains, a high table mountain near Sá da Bandeira, while *H. Volkartii* occurs 400 km further north, near Vila Nova de Sela. The closely related species *Huernia stapelioides* is geographically separated from those Angolan species by a considerable interval, and it has a fairly wide distribution embracing Swaziland and the northern parts of the Transvaal Province.

Apart from *Huernia montana* and *H. Volkartii,* only one more species of this genus is known from Angola, viz. *Huernia similis* N. E. BR. This species is also endemic to Angola, and it is known from the Cuanza Norte district (W & S 1937 p. 838; GOSSWEILER & MENDONÇA 1939 p. 206).

Unidentified specimens

Besides the above mentioned specimens, the author collected three sterile Stapeliads which have not yet flowered in Stockholm. The identification of these requires floral material. One of them was found at Naulila along the road from the Raucana Falls to Rocadas, and may be *Duvalia polita* N. E. BR. The stems are quite similar to those of the author's *Duvalia polita* from near Humbe. At the camp at Namacunde the author found, besides *Tavaresia grandiflora,* a Stapeliad growing hidden under a dense Mopane shrub. According to the vegetative characteristics, this plant certainly represents a *Caralluma* and the flower buds are borne characteristically clustered at mid-stem. The stems match those illustrated as *C. Vansonii* BREMEK. & OBERM., a species supposed to represent a form of *C. lutea* N. E. BR. (W & S 1937 p. 364, Plate IV). The author's third specimen may belong to *Stapelia* and has 4-angled and rather slender stems, up to 9 cm tall. It was collected c. 40 km NE of Moçamedes along the road to Caracul and Sá da Bandeira and was found in the desert at the foot of a hill near Raposeira. The author has no herbarium material of these sterile plants so far.

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Studies in the Viscaceae IV

Embryology of Eubrachion (Hook. et Arn.) Engl.

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ABSTRACT

Eubrachion ambiguum is a hemiparasite infecting *Syzygium* species. The unisexual flowers are trimerous, and are borne on the same spike.

The anther wall comprises an epidermis, endothecium, a single middle layer and a single layered glandular tapetum. Endothecium develops fibrous thickenings. The tapetum and middle layer degenerate before dehiscence while epidermis and endothecium persist. Ovules, in the true sense, are absent but instead a mamelon is present; in the centre of which a multicellular archesporium develops. No parietal cell is cut off. Development of the embryo sac conforms to the Allium type. The endosperm is *ab initio* Cellular, no haustorium is present and mature endosperm is "top" shaped. Division of zygote is transverse. The development of embryo is of the Solanad type. A very long tortuous suspensor is persistent even at the dicotyledonous stage of embryo. The pericarp comprises (1) leathery epicarp, (2) mesocarp formed of crest and viscid layer, and (3) endocarp of parenchyma. Vascular zone is found outside the viscid layer.

INTRODUCTION

The *Viscaceae* s. str. (Barlow 1964) comprises 11 genera and nearly 400 species distributed in the tropics, extending to the subtropics and even to the temperate regions of the world. The family is well represented in temperate Europe, tropical Africa, America, Asia, Australia, and New Zealand. In India, there are four genera, (*1*) *Viscum* (10 species) distributed in temperate Himalayas, Deccan peninsula, Bengal, Bihar, Nilgiri hills, Andaman Islands, Assam, and Travancore, (*2*) *Arceuthobium* (2 species) in Kashmir and Assam, (*3*) *Ginalloa* (2 species) in South Andaman Islands, and (*4*) *Korthalsella* (1 species) occurring in the South Indian hills.

Most of the embryological work on this family has been done on *Arceuthobium* (Johnson 1888; Heinricher 1915 a; Thoday & John-

SON 1930; DOWDING 1931; COHEN 1963; JONES & GORDON 1965; BHANDARI & NANDA 1968 a, b). Some work also exists on the embryology of *Viscum* (PISEK 1924, STEINDL 1935; SCHAEPPI & STEINDL 1945), *Phoradendron* (BILLINGS 1933) and *Korthalsella* (RUTISHAUSER 1935, 1937; CORREA 1958).

The genus *Eubrachion* includes two species, *E. ambiguum* and *E. andalgalense,* which are hemiparasites infecting *Syzygium* spp. of the *Myrtaceae* and have a restricted distribution in South America. Whatever little work that exists on *Eubrachion* (ABBIATTI 1943) relates only to the morphology and parasitic habit and there is no literature, whatsoever, on its embryology. Therefore, the present investigation was undertaken.

MATERIAL AND METHODS

The material of *Eubrachion ambiguum* was obtained by Professor B. M. JOHRI through the courtesy of Dr. A. T. HUNZIKER, Argentina. The fixed material was dehydrated in alcohol-xylene or tertiary butyl alcohol series and imbedded in rubber-wax. Prior to sectioning, the embedded material was trimmed to expose some tissue and soaked in water for 4—5 days. The sections were cut 5—15 μ thick and the preparations were stained in a safranin —fast green combination.

Dissections of endosperm and embryo were made under stereoscopic binocular after treating the material with 5 % KOH for a few minutes. They were stained with acetocarmine and made permanent in euparal by passing through acetic acid — tertiary butyl alcohol series.

OBSERVATIONS

External Morphology

Eubrachion ambiguum is a monoecius hemiparasite, 1—2 ft. in height. The main axis is devoid of any leaves and bears the branches of limited growth which are completely covered by compactly arranged leaves (Fig. 1 A). The leaves are highly reduced, peltate, leathery, simple, entire and exstipulate with acute apex and a very small stalk. A number of side branches are replaced by the inflorescence, which is a spike (Fig. 1 A, B). Spikes are alternate, except at the apex of axis where they are aggregated. The inflorescence bears a few sterile bracts at the base and the rest are fertile bearing flowers in their axils. The side branches as well as inflorescences fall off leaving numerous persistent scars on the main stem. The flowers are unisexual and are compactly arranged on the inflorescence axis, the lower being the male

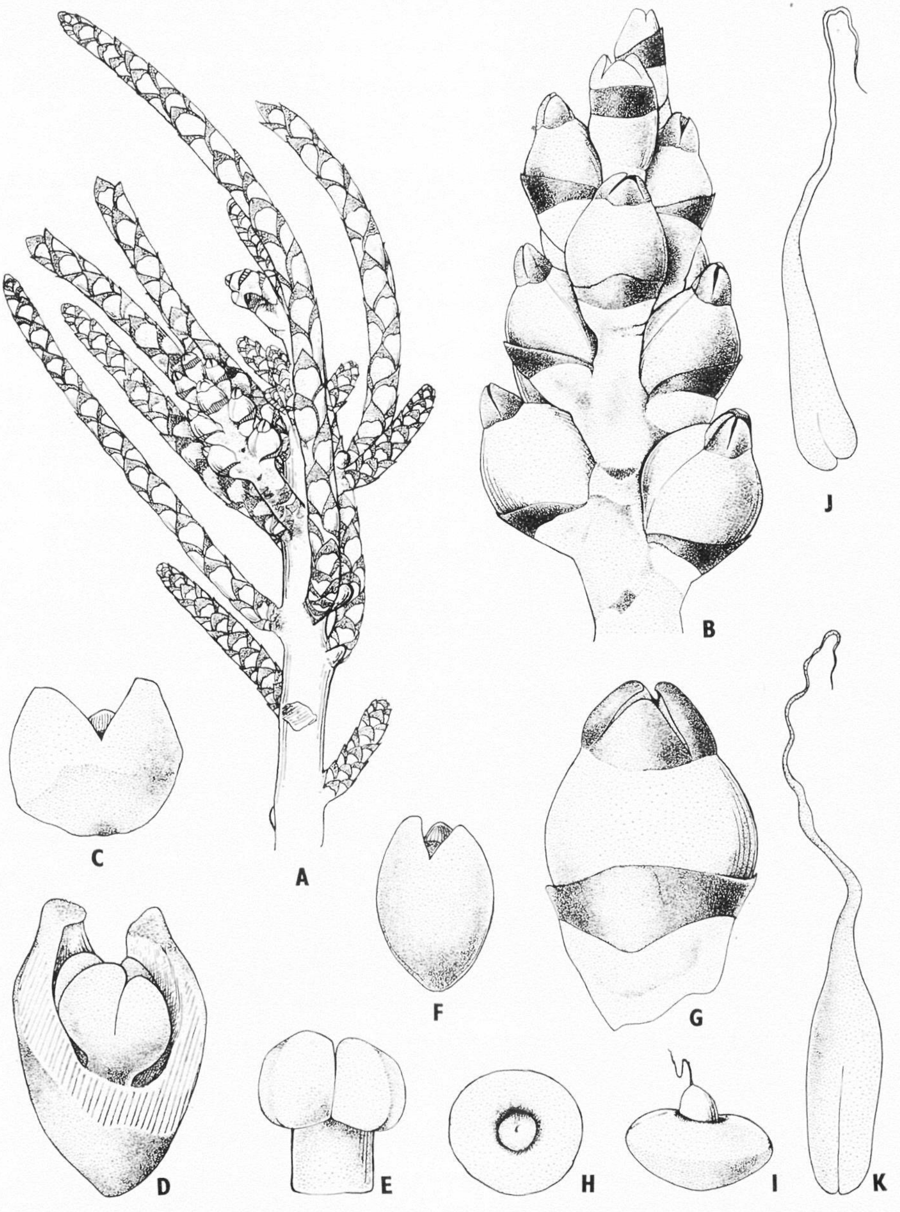

Fig. 1. *Eubrachion ambiguum*, external morphology. — A: A twig bearing the shoots of limited growth and inflorescences. — B: An inflorescence showing a number of fruits. — C, D: Male flowers, D with one petal removed to show the stamens. — E: Single stamen showing a short filament and broad anther. — F: Female flower. — G: A mature fruit. — H, I: "Top" shaped mature endosperm, polar and lateral views, respectively. — J. K: Mature embryo, showing large, coiled suspensor. — A ×2.5, C, D, F—I ×20, E ×50, J, K ×100.

and the upper the female flowers. Occasionally they occur without any definite distribution. Both the male and female flowers are sessile, trimerous and actinomorphic (Fig. 1 C, D, F). Some of the mesophyll cells of the perianth contain calcium oxalate crystals, while its epidermis is covered by a thick cuticle.

The male flowers are 1—2 mm in length, caducous and subtended by a bract. The perianth consists of three tepals (Fig. 1 C, D) and the lobes are more or less oval in shape. The three stamens are slightly fused with the tepals at the base and are inserted. They are antitepalous, dithecous, broad and massive with very short filaments (Fig. 1 E). The anthers are basifixed showing lateral dehiscence.

In the epigynous pistilate flowers the three tepals are fused with the ovary for more than half their length and are free only at the apex surrounding the style (Fig. 1 F). The ovary is inferior, bicarpellary and unilocular (LAWRENCE 1952). The ovules, in the true sense, are absent and are represented by the placental-ovular complex, called the mamelon. The style is short, tipped with globose bifid stigma.

The fruit is a one-seeded viscid berry (Fig. 1 G) enclosing a "naked seed". The mature endosperm is "top" shaped (Fig. 1 H, I) enveloping the embryo partially. The mature embryo has a long, coiled suspensor (Fig. 1 J, K).

Microsporogenesis and Male Gametophyte

The anther wall at the mature pollen grain stage comprises epidermis, endothecium, a middle layer and a glandular tapetum (Fig. 2 A, D). The epidermis keeps pace with the developing anther and persists even at the time of dehiscence (Fig. 2 C, G). The endothecial cells show considerable enlargement, both radially and tangentially (Fig. 2 E) and characteristic fibrous thickenings are developed at the 2-celled stage of the pollen grains (Fig. 2 F, G). The cells of the middle layer become tangentially compressed (Fig. 2 A, D) and eventually degenerate just before dehiscence (Fig. 2 B, C, F, G). The tapetum is 1-layered, glandular and has large richly cytoplasmic cells even at the 2-celled stage of pollen grains (Fig. 2 A, D). The tapetal cells may be uni- to tetranucleate (Fig. 2 H—M) and the nuclei in some of the cells fuse to form polyploid masses (Fig. 2 J, L). The tapetum degenerates *in situ* just before the pollen grains are shed.

The nucleus of the microspore divides (Fig. 2 N, O) and the resulting generative cell, which is somewhat spindle shaped, does not show a

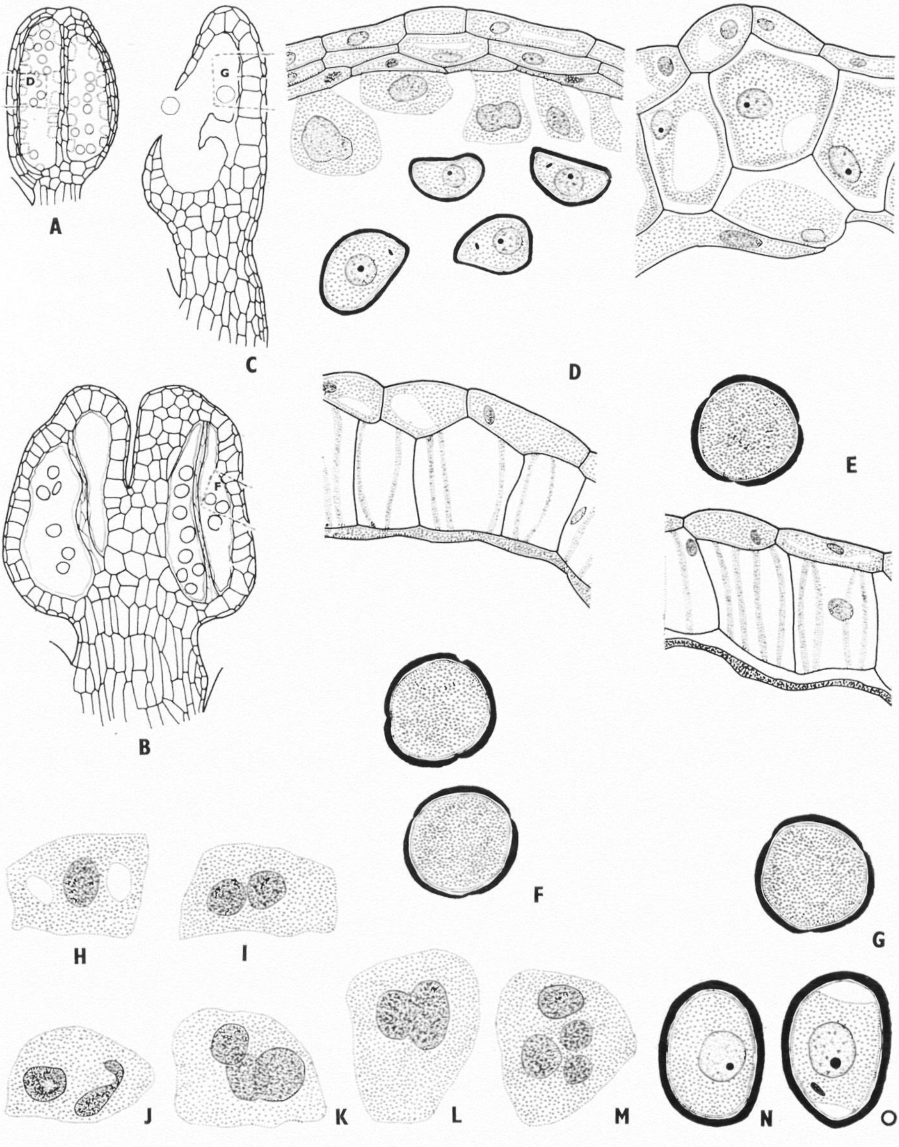

Fig. 2. *Eubrachion ambiguum*, anther. — A—C: L.s. anthers, diagrammatic figures for D, F, G. — D: Magnified portion of A; the tapetum and middle layers are intact, pollen grains are 2-celled. — E: Enlarged portion of an anther showing degenerated tapetum and enlarged endothecial layer. — F: Magnified part of B, the endothecial layer has developed fibrous thickenings. — G: Magnified portion of C; showing the anther wall at dehiscence. — H—M: Tapetal cells showing uni- to tetranucleate condition. — N, O: Uni- and bi-celled pollen grains, respectively. — A—C ×115, D—G ×635, H—O ×950.

clear cytoplasmic sheath around it when stained with safranin-fast green. The pollen grains are shed at the 2-celled stage. They are tricolpate with a thick smooth exine and a thin intine (Fig. 2 F, G). At the time of anther dehiscence, the adjacent microsporangia become confluent due to dissolution of the intervening septum (Fig. 2 C) and dehisce laterally.

Megasporogenesis and Female Gametophyte

A group of hypodermal archesporial cells, with dense cytoplasm and prominent nuclei, differentiate in the centre of mamelon (Fig. 3 A, G). Out of these only 1—3 function as megaspore mother cells (Fig. 3 B, H) without cutting off any parietal cells. The non-functional archesporial cells either divide in all planes to add to the tissue of the mamelon or degenerate as such (Fig. 3 H, J, K). All the megaspore mother cells may lie in one row or may be found in one row above the other (Fig. 3 B, H, C, I). Cytokinesis following Meiosis I in the megaspore mother cells results in a dyad, of which the upper one is usually smaller (Fig. 3 D, J). The upper dyad cell degenerates as such (Fig. 3 E, K), although occasionally it may also undergo Meiosis II and develop further up to 4-nucleate stage of embryo sac (Fig. 3 M). By this time, the cells lining the stylar canal interlock and block the passage, thus preventing the upward growth of the developing female gametophyte.

The functional lower dyad cell undergoes Meiosis II resulting in a two-nucleate embryo sac (Fig. 3 L). The upper dyad cell often persists at this stage (Fig. 3 L). The nuclei of the two-nucleate embryo sac do not necessarily move to the poles but may remain in the centre (Fig. 3 K). Two successive mitoses result in a four-nucleate (Fig. 3 M, N) and then an eight-nucleate embryo sac in which the chalazal quartet

Fig. 3. *Eubrachion ambiguum,* development of female gametophyte and fertilization (*ant*, antipodal cells; *dd,* degenerating dyad cell; *lbd,* lower binucleate dyad; *m,* mamelon; *pn,* polar nucleus; *pr,* perianth lobe; *pt,* pollen tube; *sy,* synergid; *vs,* vascular supply; *z,* zygote; ♂2, male gamete 2). — A—F: Diagrammatic figures for G—K, P. — G: L.s. mamelon showing archesporial cells. — H, I: Same, showing megaspore mother cells: in H, the megaspore mother cell at the top is at diakinesis whereas in I, one is at metaphase and the other at diakinesis. — J: Dyad cells, the upper cell smaller than the lower. — K: Same, showing the upper degenerated dyad cell. — L: Two-nucleate embryo sac. — M: Both the cells of a dyad showing 4-nucleate stage. — N, O: Four- and 8-nucleate embryo sacs. In O, the antipodal cells have been organised. — P: A fully organised embryo sac showing triple fusion. — A—F ×35, H—P ×520.

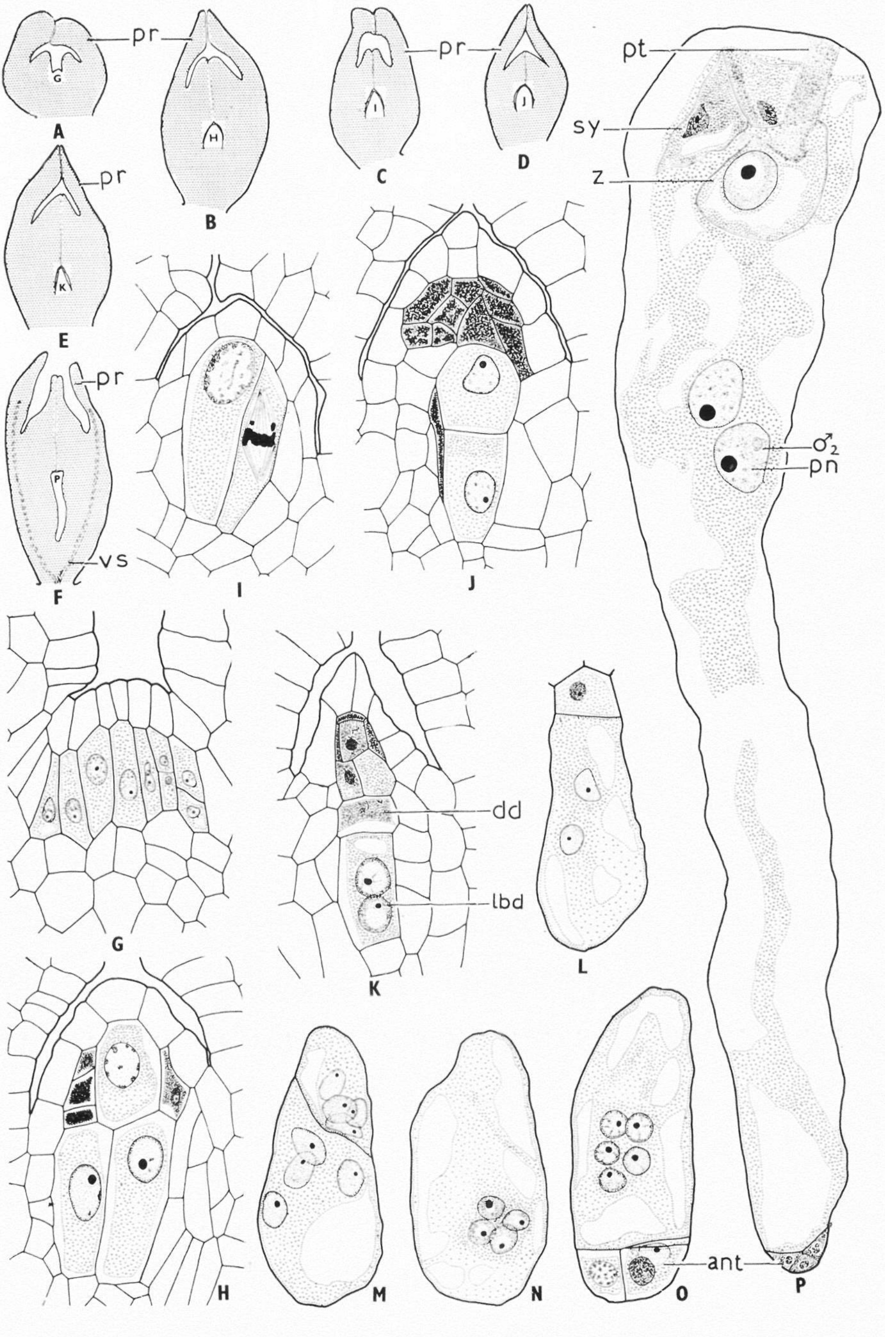
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Fig. 3.

organises earlier (Fig. 3 O). The nuclei in the mature gametophyte organise into an egg apparatus, two polar nuclei and three antipodal cells (Fig. 3 F, P). Hence, the development of the female gametophyte conforms to the Allium type. The mature embryo sac is straight and elongates downwards considerably; it does not grow out of the mamelon. The egg is usually larger than the synergids which lack the filiform apparatus. The polar nuclei are nearly of the same size (Fig. 4 P). The synergids and the uninucleate antipodal cells are persistent.

Twin embryo sacs are common but one of them soon degenerates, either at this stage or during the early stages of endosperm development.

Fertilization and Endosperm

Syngamy precedes triple fusion. The second male gamete fuses first with one of the two polar nuclei (Fig. 3 P), and the resultant diploid nucleus fuses with the second polar nucleus resulting in triple fusion. Since the two polar nuclei are of the same size, it is difficult to decide whether the male gamete fuses first with the upper or the lower polar nucleus.

The division of the primary endosperm nucleus precedes that of the zygote and is followed by a transverse wall resulting in chalazal and micropylar chambers of the same size (Fig. 4 A). Hence the endosperm is *ab initio* Cellular. A few early successive divisions in the two chambers are transverse resulting in a filamentous endosperm (Fig. 4 C, D). Longitudinal divisions then set in (Fig. 4 B, D) and the cells of the endosperm elongate considerably (Fig. 4 B—E). The divisions in different planes are more frequent towards the lower part of the endosperm and gradually decrease towards the upper where only trans-

Fig. 4. *Eubrachion ambiguum*, development of endosperm (*ant*, antipodal cells; *cc*, chalazal chamber; *cr*, crest; *em*, embryo; *en*, endocarp; *end*, endosperm; *mc*, micropylar chamber; *pe*, proembryo; *per*, pericarp; *pr*, perianth; *ps*, primary suspensor; *ss*, secondary suspensor; *sus*, suspensor; *sy*, synergid; *vl*, viscid layer; *vs*, vascular supply; *z*, zygote). — A: Two-celled endosperm showing transverse division to form micropylar and chalazal chambers; antipodal cells and synergids are persistent. — B, C: Four-celled endosperm. In B, longitudinal division has set in the middle cell. — D—F: Stages in development of endosperm. In E, F, the endosperm has become conical because of rapid growth at the chalazal end. — G: L.s. mature fruit showing the enclosed "naked" seed. — H: Mature endosperm enclosing the dicotyledonous embryo. — I: A part of the mature endosperm tissue enlarged to show the starchpacked cells. — A—F, I ×245, G ×60, H ×120.

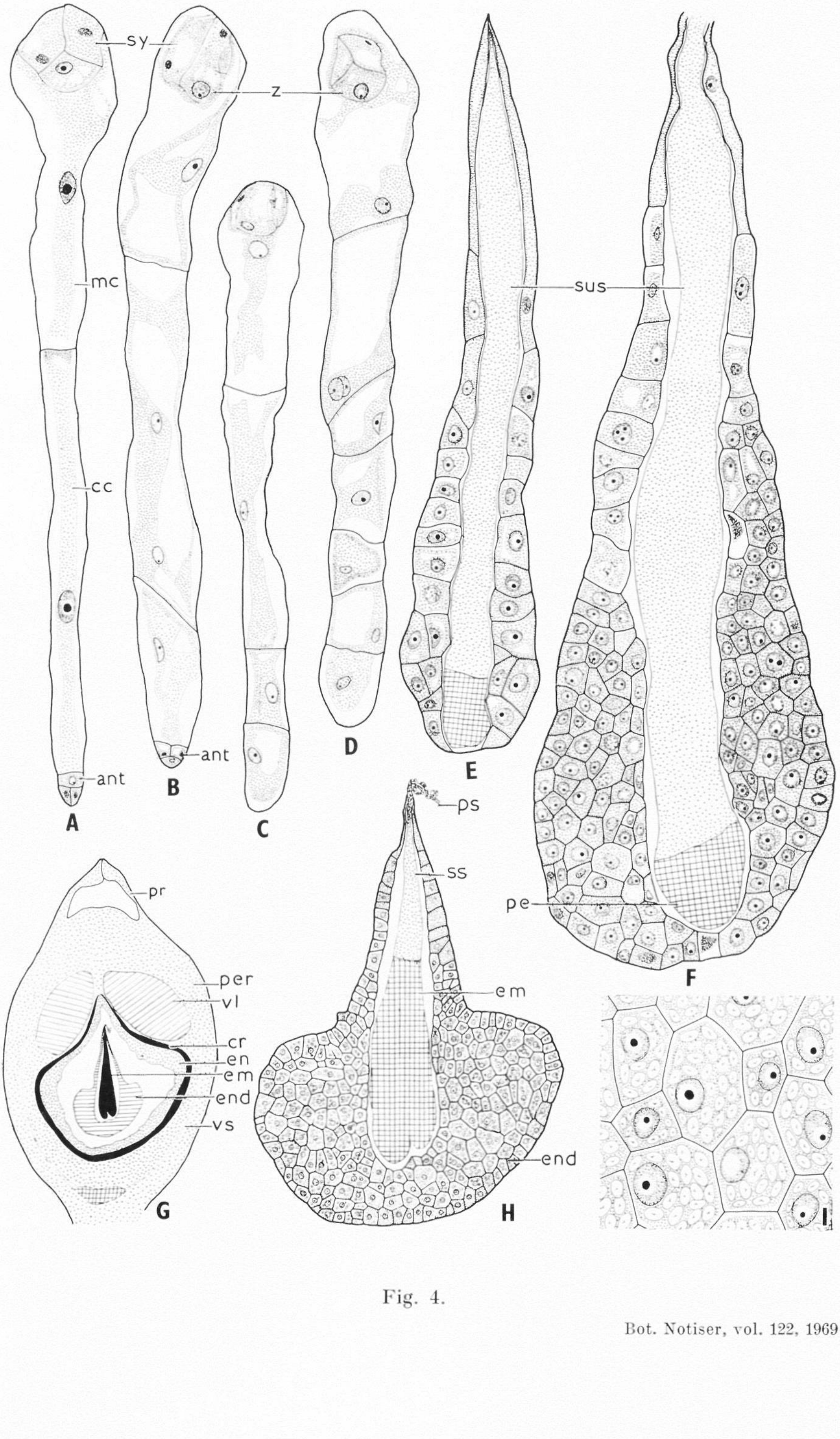
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Fig. 4.

verse divisions occur resulting in a tapering endosperm, multilayered at the base and gradually becoming 1-layered above (Fig. 4 E, F). The multilayered lower portion encloses the embryo while the upper part surrounds the suspensor (Fig. 4 E—H). Due to unequal growth in the lower region, the endosperm becomes "top" shaped (Fig. 4 G, H). The cells of the mature endosperm below the cotyledons and those surrounding the suspensor lack starch grains (Fig. 4 H), while the rest of them contain plenty of starch grains (Fig. 4 H, I).

Embryogeny

The zygote divides after the endosperm is well advanced and its division is transverse resulting in two cells, *ca* and *cb*. Of the two daughter cells, *cb*, divides transversely followed by *ca* (Fig. 5 A) resulting in a four-celled proembryo. Such transverse divisions in the derivatives of *ca* and *cb* give rise to a uniseriate linear proembryo. The upper 3 or 4 cells enlarge considerably, become vacuolated and form the primary suspensor cells (Fig. 5 B). These cells undergo repeated anticlinal and periclinal divisions to give rise to the suspensor which carries the proembryonal mass right to the base of the endosperm. The uniseriate suspensor becomes biseriate (Fig. 5 C, D) and later multiseriate (Fig. 5 H). Secondary suspensor cells become differentiated from the uppermost cells of the proembryo (Fig. 5 C—H). In the mature embryo the suspensor becomes tortuous and coiled (Fig. 5 H).

The cell *ca* and its derivatives undergo transverse divisions. Soon longitudinal divisions set in, resulting in a biseriate proembryo. Such longitudinal divisions in all these cells result in a four tiered proembryo, each tier of four cells (Fig. 5 D). Later the divisions in various planes give rise to a globular embryo (Fig. 5 E). Periclinal divisions in the outermost layer of cells differentiate a protodermal layer surrounding the meristematic central mass of cells (Fig. 5 E—G), which subsequently increase in bulk. The protoderm is not continuous in the suspensor region and is differentiated only in the proembryonal part. The

Fig. 5. *Eubrachion ambiguum*, embryogeny (*cot*, cotyledons; *em*, embryo; em_1 and em_2, embryos 1 and 2; *pe*, proembryo; *ps*, primary suspensor; *ss*, secondary suspensor). — A: Three-celled proembryo, terminal cell is in division. — B—D: Stages showing the formation of biseriate embryo. — E—G: Stages showing formation of a globular embryo and differentiation of the protoderm. — H: L.s. dicot embryo. Note the suspensor, cotyledons and the rudimentary shoot apex. — I: An abnormal case of autonomous development of embryo. — J: Polyembryony. — A—G, I, J ×530, H ×235.

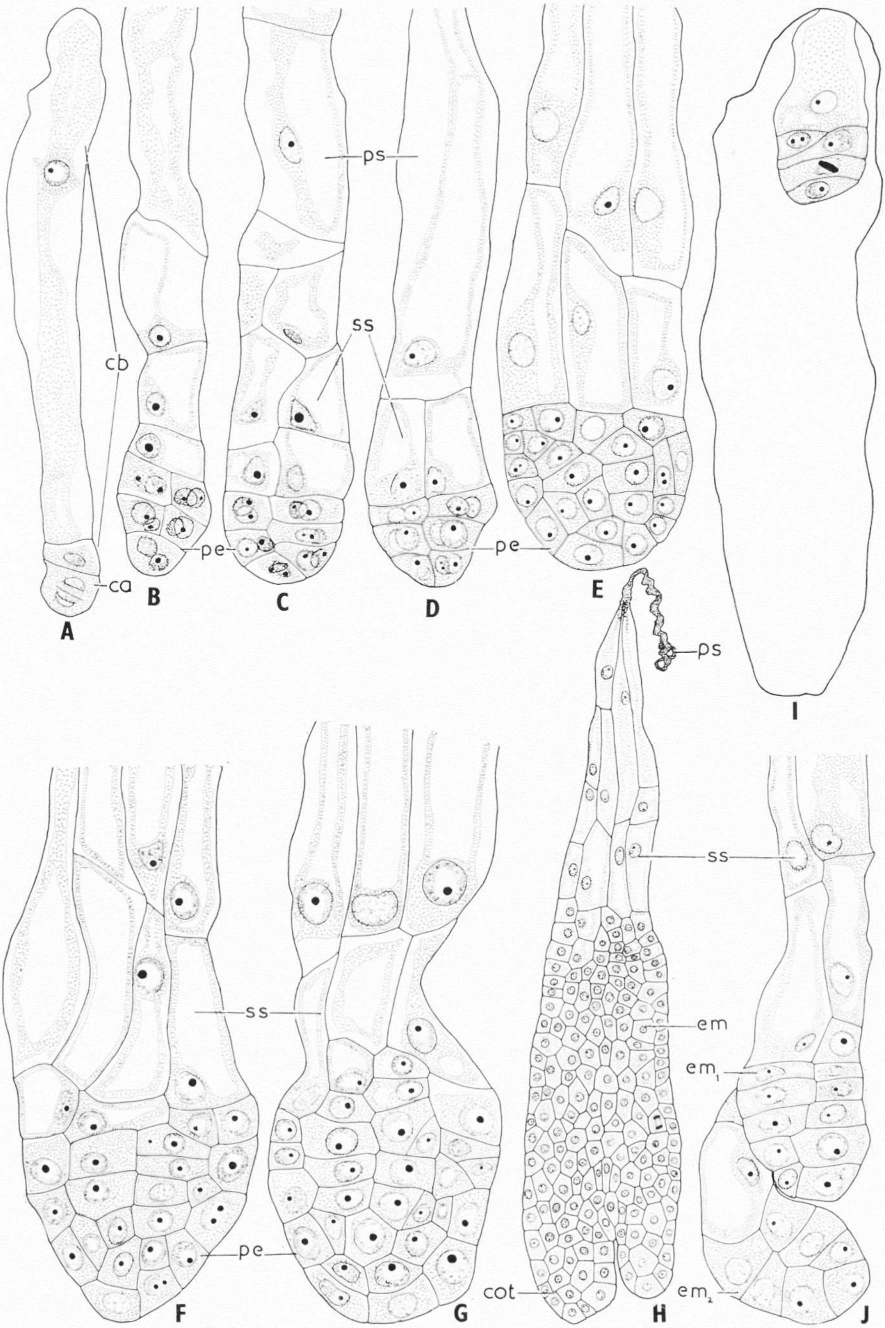


Fig. 5.

embryo elongates considerably and from its tip two cotyledons are differentiated, which enclose an incipient shoot apex. Due to basipetal growth of the endosperm, the embryo is shifted to a more central position (Fig. 4 H).

The mature embryo is cylindrical, straight, vertical and its major portion is formed by the hypocotyl-radicular axis and the two semicircular, thick, well developed cotyledons (Fig. 5 H). No root apex or root cap is differentiated in the mature dicotyledonous embryo (Fig. 5 H). The two cotyledons remain separate for sometime, but at maturity become adpressed against each other (Fig. 5 H).

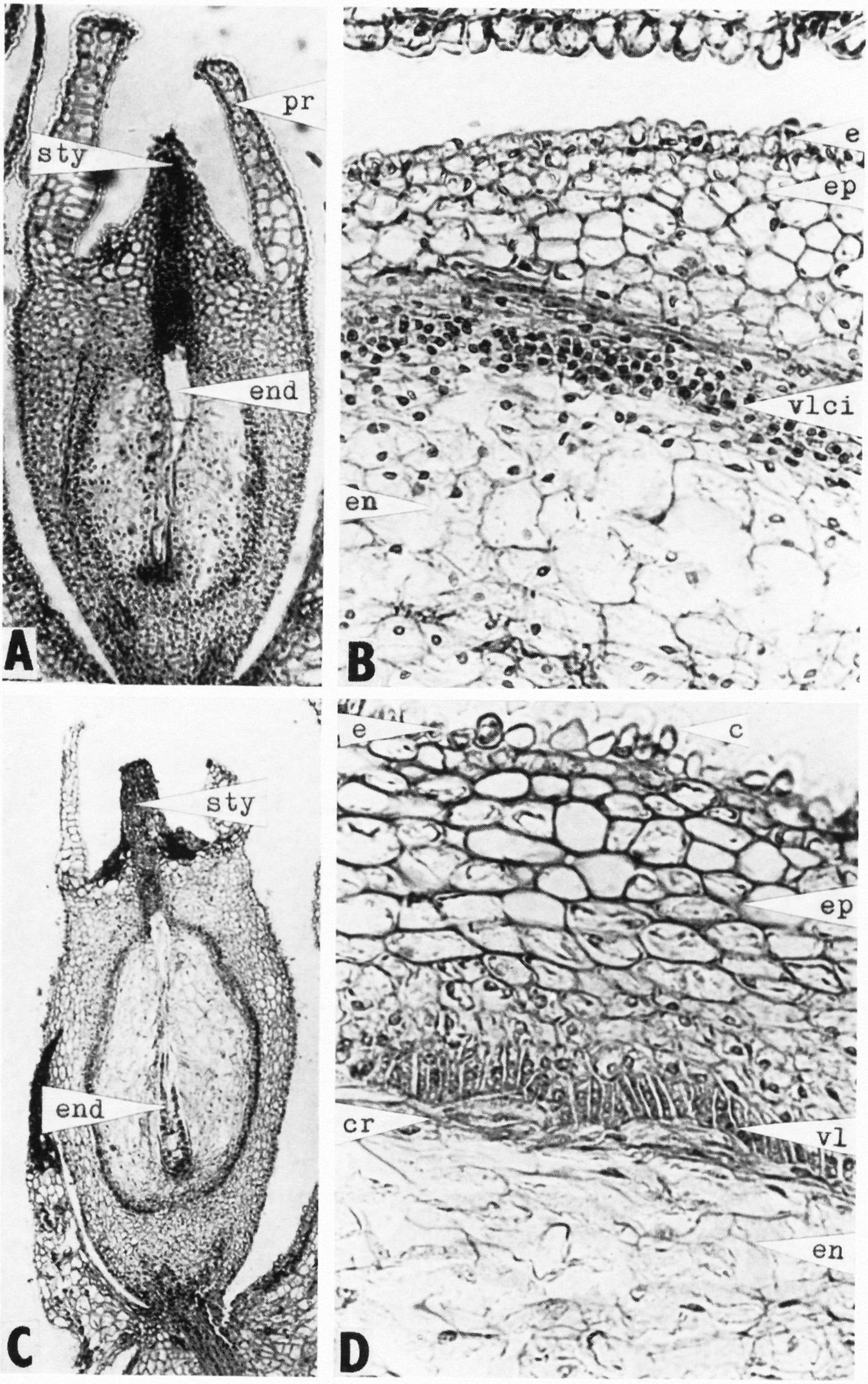
A solitary instance of a 5-celled embryo was noticed in an apparently empty embryo sac (Fig. 5 I). Neither the primary endosperm nucleus nor any endosperm tissue could be observed. Probably the embryo developed autonomously. Polyembryony is common. In one instance two embryos developed within an endosperm, each with its own suspensor (Fig. 5 J).

Fruit Development

At the embryo sac and early stages of endosperm, the ovary wall is 18—20 layers thick. It is parenchymatous and is transversed on either side by a vascular trace. Internal to the vascular bundles there is an annular cup comprising 3 or 4 layers (*vlci*) of small meristematic cells having large nuclei (Fig. 6 A, B), from which the viscid layer and crest would originate.

At the preglobular stage of the embryo, the first visible change is the radial elongation of cells of the second layer of meristematic zone in the upper half of the fruit. This layer (*vl*), which has cells with dense cytoplasm, a few vacuoles and large nuclei, is the progenitor of the viscid layer (Fig. 6 C, D). Two or three layers of meristematic cells (*cr*), internal to the viscid layer undergo axial elongation, become

Fig. 6. *Eubrachion ambiguum*, fruit development (*c*, cuticle; *cr*, crest; *e*, papillate epidermis; *en*, endocarp; *end*, endosperm; *ep*, epicarp; *pr*, perianth; *sty*, style; *vl*, viscid layer; *vlci*, viscid layer and crest initials). — A: L.s. young fruit at 4-celled stage of endosperm. — B: Portion of wall magnified from A; epicarp is 8—9 layered, parenchymatous; inner to it note the 4 or 5-layered meristematic zone and the parenchymatous endocarp. — C: L.s. fruit at preglobular stage of embryo; the style and stigma are degenerated. — D: A part of pericarp enlarged from C; number of layers of epicarp has increased to about 12, note the thick cuticle over papillate epidermis. The viscid layer initials have started elongating radially. — A ×75, B ×370, C ×45, D ×380.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highly vacuolated, and would differentiate into the crest in the mature fruit (Fig. 6 C, D). The parenchymatous cells internal to this zone constitute the endocarp (*en*). The cells of a layer outside the viscid zone remain small, degenerate in the mature fruits and their remnants are attached to the viscid layer (Fig. 6 C, D). Lower down, this layer along with the rest of the 2 or 3 layers of the parenchymatous zone, forms the crest.

At the globular stage of embryo, additional cuticle (*c*) is deposited on the highly papillate epidermis (*ep*). The number of layers of parenchymatous cells outside the viscid layer increases to 15 (Fig. 7 A). The cells of the viscid layer enlarge further radially and become vacuolated and possess large nuclei (Fig. 7 A, B). Later, they become extremely long, spirally twisted and filled with mucilage (Fig. 7 C, D). The viscid layer covers the upper half of the fruit and forms an annular zone around the upper part of endocarp at the apex of the fruit (Fig. 7 A, B).

At the dicotyledonous stage of embryo, 2 or 3 layers of cells, inner to the viscid layer, which constitute the crest, become compactly packed with tannin-like substances (Fig. 7 C, D). The viscid layer rests on this crest. The vascular zone is present outside the viscid layer. Next to the vascular zone are 6—8 layers of parenchymatous cells, forming the leathery exocarp (Fig. 7 C, D). At maturity, most of the cells of the endocarp degenerate, except a few layers attached to the crest (Fig. 7 C, D).

The mature fruit comprises the following well defined zones: (1) leathery epicarp, (2) vascular zone, (3) crest and viscid layer forming the mesocarp, and (4) the parenchymatous endocarp.

DISCUSSION

Male Flower and Anther

The male flowers of *E. ambiguum* are trimerous as in *Arceuthobium*. The central cushion, which is supposed to represent the vestigeal

Fig. 7. *Eubrachion ambiguum*, fruit development (*c*, cuticle; *cr*, crest; *em*, embryo; *end*, endosperm; *en*, endocarp; *ep*, epicarp; *pr*, perianth; *vl*, viscid layer; *vs*, vasculature). — A: L.s. fruit at globular stage of embryo. — B: Portion of pericarp enlarged; the viscid layer and crest have developed. The cells of the viscid layer have large nuclei. — C: L.s. mature fruit, the vasculature is outside the viscid layer. — D: A part of fruit wall enlarged; most of the cells of the endocarp have degenerated except a few layers attached to the crest. The cells of the crest are filled with tannin-like substances. Viscid layer is well-developed with spirally twisted cells filled with mucilage. — A ×45, B ×165, C ×40, D ×120.

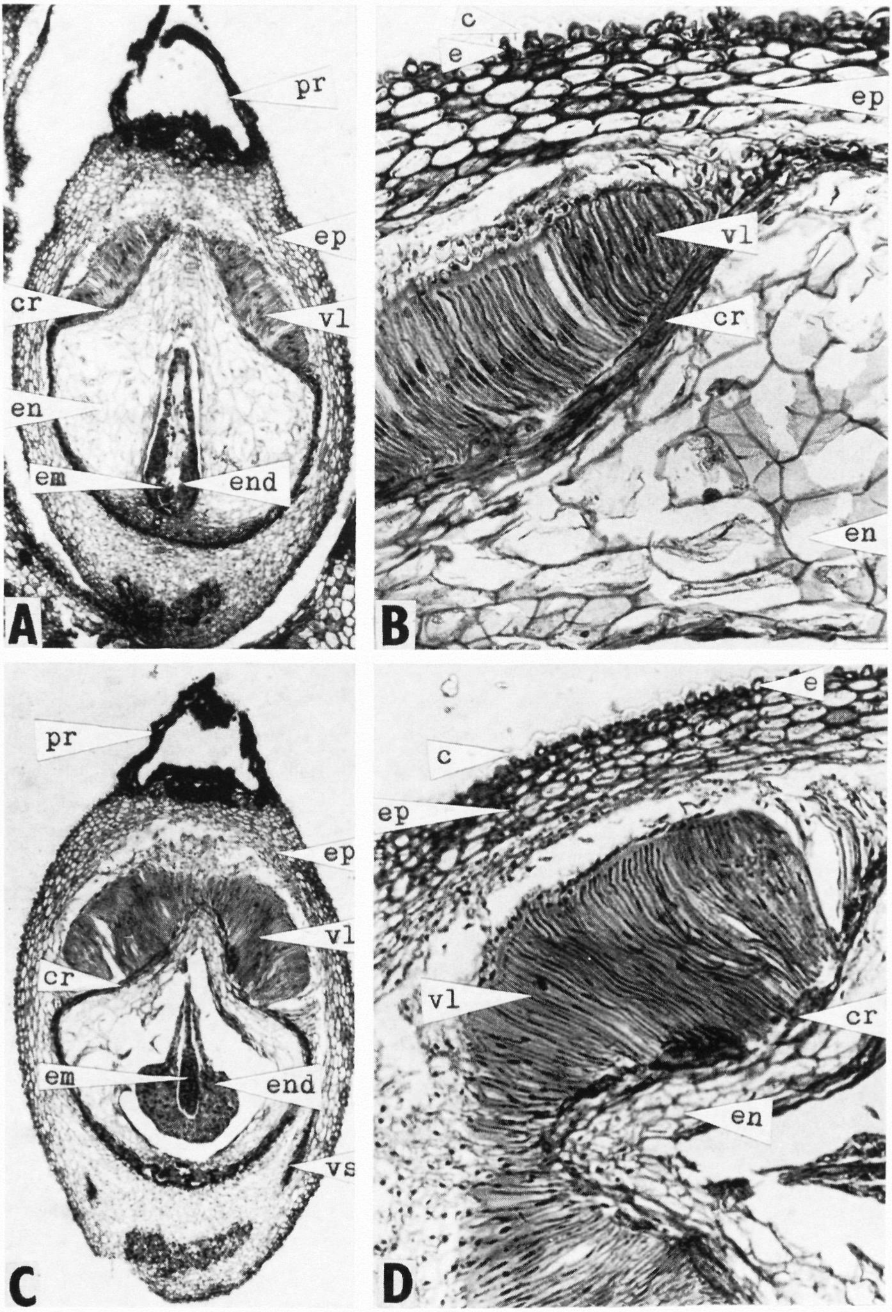
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Fig. 7.

carpellary tissue (DOWDING 1931; DATTA 1951) is absent in *E. ambiguum*.

The columella reported in *Arceuthobium* (HEINRICHER 1915 b; STÄDTLER 1923; PISEK 1924; DOWDING 1931; BHANDARI & NANDA 1968 a) is absent in *E. ambiguum*. There is some controversy regarding the nature and origin of archesporium and columella (BHANDARI & NANDA 1968 a).

In *E. ambiguum* (present study) the hypodermal layer of the anther wall as usual develops into the endothecium in contrast to *Arceuthobium* (THODAY & JOHNSON 1930; DOWDING 1931; BHANDARI & NANDA 1968 a), where the epidermis forms the epithecium.

Megasporogenesis and Female Gametophyte

In *E. ambiguum* the placenta and true ovules are lacking, instead a dome-shaped central mamelon is present in the ovarian cavity as in the other members (MAHESHWARI et al. 1957) excepting *Viscum* and *Notothixos*. The archesporium is multicellular in *Viscum* (STEINDL 1935) and *E. ambiguum* (present study) in contrast to other members where only two obliquely oriented archesporial cells develop, one each on the lateral sides (THODAY & JOHNSON 1930; BILLINGS 1933; STEINDL 1935; RUTISHAUSER 1935, 1937; JONES & GORDON 1965; BHANDARI & NANDA 1968 a, b). The presence of multicellular archesporium in the mamelon is a feature common in *Loranthaceae* (DAVIS 1966). In *Eubrachion* (present work) out of 6—8 archesporial cells, only 1—3 function as megaspore mother cells. As in most members of the *Viscaceae* the development of the female gametophyte in *E. ambiguum* is of the Allium type. A Polygonum type of embryo sac has been recorded in *Korthalsella lindsayii* and *K. salicornoides* (STEVENSON 1934) while in *Phoradendron* (BILLINGS 1933) and *Arceuthobium douglasii* (JONES & GORDON 1965) it is reported to be of the Adoxa type (tetrasporic). MAHESHWARI (1948) has strongly suspected these observations and stressed the need for a reinvestigation of the development of embryo sac in *Korthalsella* and *Phoradendron*. BHANDARI & NANDA (1968 b) have reinvestigated *Arceuthobium douglasii* and shown that the female gametophyte conforms to the Allium type and not the Adoxa type as reported by JONES & GORDON (1965).

The mature embryo sac is straight in *Eubrachion* (present work) and *Viscum* (STEINDL 1935; SCHAEPPI & STEINDL 1945), obliquely placed in *Arceuthobium* (JOHNSON 1888; THODAY & JOHNSON 1930; DOWDING

1931; JONES & GORDON 1965; BHANDARI & NANDA 1968 a, b), and bent in the form of a U in *Korthalsella* (RUTISHAUSER 1935, 1937), *Dendrophthora* (YORK 1909), *Ginalloa* (RUTISHAUSER 1937) and *Phoradendron* (BILLINGS 1933). In the last four genera, the embryo sac crushes the mamelon, comes out of it, and lies in the ovarian cavity even before it is fully organized. In *Arceuthobium pusillum,* a chalazal haustorial extension grows down into the base of the mamelon (THODAY & JOHNSON 1930) whereas in *A. minutissimum* (BHANDARI & NANDA 1968 a) the caecum develops as a lateral extension of the embryo sac. In the former species, perhaps it is the plane of sectioning which shows it as a basal extension or haustorium. In *E. ambiguum* (present work) no haustorium such as reported for *Arceuthobium* (see BHANDARI & NANDA 1968 a; JONES & GORDON 1965) is present.

In *E. ambiguum* (present work) syngamy precedes triple fusion. In *A. minutissimum* (BHANDARI & NANDA 1968 a), *Viscum album* (STEINDL 1935), and *E. ambiguum* (present investigation) the second male gamete fuses first with one of the polar nuclei, which then fuses with the other resulting in the primary endosperm nucleus. Such details are not available for most other members.

Endosperm

The endosperm in the *Viscaceae* is *ab initio* Cellular (present work; THODAY & JOHNSON 1930; BILLINGS 1933; STEINDL 1935; RUTISHAUSER 1937; JONES & GORDON 1965). In *E. ambiguum* (present investigation), *Viscum album* and *V. articulatum* (STEINDL 1935) the first and subsequent divisions are transverse giving rise to a uniseriate filamentous endosperm. Both the micropylar and chalazal chambers contribute to the endosperm proper. In *Eubrachion* (present report) and *Viscum* (STEINDL 1935) there is no haustorium whereas in *Arceuthobium* (JONES & GORDON 1965; BHANDARI & NANDA 1968 a), *Phoradendron* (BILLINGS 1933) and *Korthalsella* (RUTISHAUSER 1935) an endosperm haustorium is formed. The endosperm in *E. ambiguum* (present study) first becomes tapering due to a rapid growth in the chalazal part but the mature endosperm is "top" shaped. YORK's (1913) observations on *Dendrophthora opuntioides* and *D. gracile* are doubtful.

Embryo

The division of the zygote is transverse in *E. ambiguum* (present work), *Viscum album* and *V. articulatum* (STEINDL 1935) whereas in *Arceuthobium* (BHANDARI & NANDA 1968 a) it is vertical or obliquely so. In *E. ambiguum* (present investigation) the embryogenesis conforms to the Solanad type (JOHANSEN 1950) while in *Arceuthobium minutissimum* (BHANDARI & NANDA 1968 a) it conforms to the *Dendrophthora* variation of Piperad type (JOHANSEN 1950). Although the division of the zygote and its derivatives is transverse in *E. ambiguum,* the embryo becomes biseriate in earlier stages of development, a feature which is characteristic of the *Loranthaceae* and has not so far been recorded for the *Viscaceae.*

A suspensor is absent in *Arceuthobium* (THODAY & JOHNSON 1930; BHANDARI & NANDA 1968 a), *Korthalsella* (RUTISHAUSER 1935, 1937) and *Phoradendron* (BILLINGS 1933) whereas a short suspensor is reported in *Viscum* (STEINDL 1935; SCHAEPPI & STEINDL 1945). However, such a long suspensor comprising the primary and secondary suspensor cells persisting at the dicotyledonary stage of the embryo in *Eubrachion ambiguum* (present work) is yet another feature of *Loranthaceae.* The mature embryo has a rudimentary shoot apex and two cotyledons which become closely adpressed against each other. In *Arceuthobium* (COHEN 1963; BHANDARI & NANDA 1968 a) even cotyledons are rudimentary. Polyembryony, found occasionally in *E. ambiguum,* has not been reported for any other *Viscaceae* though this is common in the members of *Loranthaceae.*

Fruit

The structure of fruit is more or less similar to that of the other members of *Viscaceae.* It has a leathery coat, enclosing the mucilagenous viscid layer together with the parenchymatous zone. The viscid layer does not form a continuous dome in the fruit in *E. ambiguum* (present work) but is in the form of an annular collar around the endocarp in the upper part of the fruit. In *Arceuthobium minutissimum* (BHANDARI & NANDA 1968 a) and some other species (JOHNSON 1888; PEIRCE 1905; KUIJT 1960) the viscid layer forms a continuous dome-shaped structure.

The embryological features of *Eubrachion* are compared with those of the *Viscaceae* and the *Loranthaceae* in the following survey.

It is clear from that survey that *Eubrachion ambiguum* has a number of features such as (1) multicellular archesporium, (2) biseriate proembryo, (3) very long suspensor, and (4) polyembryony, common with the *Loranthaceae.* On the other hand it has also numerous characters resembling with the *Viscaceae.* It, therefore, probably is a connecting link between the *Loranthaceae* and *Viscaceae.*

Character	*Viscaceae*	*Eubrachion*	*Loranthaceae*
1. Flowers	Unisexual	Unisexual (L, V)	Unisexual or bisexual
2. Pollen	Spherical	Spherical (V)	Trilobate
3. Mamelon	Present or reduced; with 1 or more archesporial cells	Present; with multicellular archesporium (L, V)	Present; lobed, unlobed or reduced, archesporium usually multicellular
4. Embryo sac	Bisporic (Allium type); straight or curved at 4-nucleate stage, sometimes growing into the style	Bisporic (Allium type); straight, not growing into the style, twin embryo sacs frequent (V)	Monosporic (Polygonum type); several embryo sacs develop simultaneously reaching different heights in the style
5. Endosperm	Not composite	Not composite (V)	Composite
6. Embryogeny			
(a) Division of zygote	Transverse or vertical	Transverse (V)	Vertical
(b) Early ontogeny	Mass of cells	Two tiered (L)	Two tiered right from initiation
(c) Suspensor	Absent	Long and tortuous (L)	Long and tortuous
7. Polyembryony	Not reported	Present (L)	Present
8. Fruit	Viscid layer inside the vascular bundle	Viscid layer inside the vascular bundle (V)	Viscid layer outside the vascular bundle

(L) Characters resembling with *Loranthaceae*.
(V) Characters resembling with *Viscaceae*.
(L, V) Characters common with both *Loranthaceae* and *Viscaceae*.

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Two New Species of Iris from Afghanistan

Studies in the Flora of Afghanistan 10

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ABSTRACT

Iris porphyrochrysa WENDELBO sp. nov. and *I. xanthochlora* WENDELBO sp. nov., both of subgen. *Scorpiris* (Syn. sect. *Juno*) are described from Afghanistan.

Iris porphyrochrysa WENDELBO, sp. nov. (Fig. 1 D—F).

Subgen. *Scorpiris* SPACH

Bulbus 1.5—2 cm diametro, tunicis brunnescentibus nervis prominentibus, basi radices carnosas diffusas emittens. *Caulis* florendi tempore 4—5 cm longus, subterraneus. *Folia* 4—6, florendi tempore complete evoluta, basi vaginam caulem involucrantem c. 1 cm longam formantia, usque ad 17 cm longa, 1.5 cm lata, coriacea, canaliculata, falcata, marginibus et costa mediana subtus albis corneis valde distinctis, inter nervos minute papilloso-puberula. *Flores* 1—3. *Spathae* valvae 5—8 cm longae, membranaceae, acuminatae, minute papilloso-puberulae. *Tubus perigonii* c. 4 cm longus. *Segmenta exteriora* c. 4.5 cm longa; unguis erectus, c. 3 cm longus, c. 0.7 cm latus, taeniatus, marginibus ± parallelis, basin versus leviter gradatim attenuatus, brunneo-purpureus; lamina patens, c. 1.5 cm longa, c. 1 cm lata, late ovata, flava, centrum versus saturatior maculis parvis purpurascentibus; crista c. 1.5 cm longa, c. 0.1 cm alta, tuberculato-laciniata, aurantiaco-flava. *Segmenta interiora* erecta, 0.6 cm longa, lineari-lanceolata, obtusa. *Styli* rami c. 4 cm longi, bilobi; lobi c. 1.3 cm longi, c. 0.25 cm lati, parte basali purpurascenti-brunnei, lobis flavis; stigma bilobum marginibus crenatis. *Antherae* 1.7—1.9 cm longae; pollen 6—7-peltatum; filamenta c. 1.4 cm longa. *Capsula* et semina ignota.

Afghanistan. Parvan: Shibar pass east side near summit, steep rocky slopes, 2600 m, 20.V.1962, HEDGE & WENDELBO 3321, holotypus BG, isotypus E. — Bamian: a Ajdaha, 24.V.1947, LINDBERG 127; Band-e-Amir, 2900 m, 29.VI.1962, HEDGE & WENDELBO 4795.

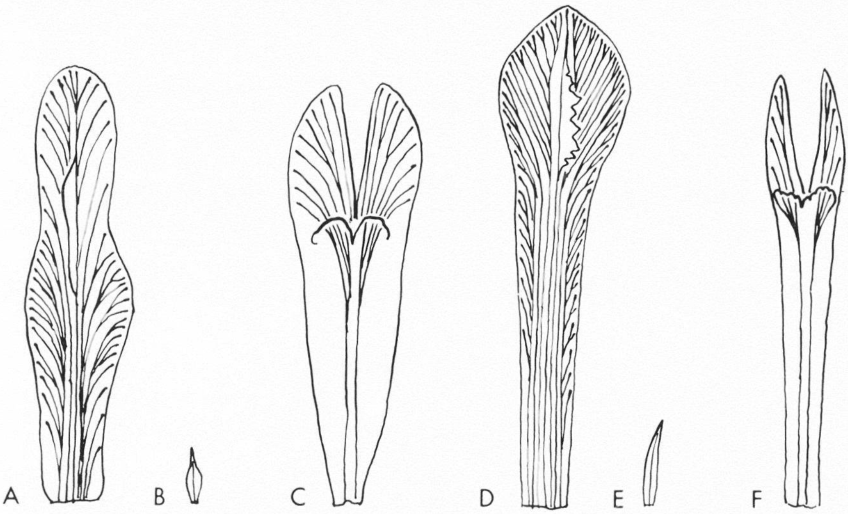

Fig. 1. A—C: *Iris xanthochlora* sp. nov. (typus). — D—F: *I. porphyrochrysa* sp. nov. (typus). — A, D: Outer perigon segments. — B, E: Inner perigon segments. — C, F: Stylar branches. — Nat. size.

The new species belongs to a group of species which have the base of the leaf formed as a closed sheath embracing the stem and which have a very small standard (inner perigon segment). Members of this group are *Iris parvula* VVED., *I. linifolia* O. FEDTSCH., *I. tadshikorum* VVED. and the new species *I. xanthochlora* WENDELBO described below.

I. porphyrochrysa differs from all these species in its flower-colour, and from the three former in not having a 3-lobed standard. *I. parvula* has a smaller flower and comparatively much shorter lobes of the stylar branches. *I. linifolia* has a somewhat smaller flower, a longer standard, twice as broad lobes of the stylar branches, narrower leaves and a more developed stem. *I. tadshikorum* differs in its much longer standard and in having twice as broad lobes of the stylar branches.

Iris xanthochlora WENDELBO, sp. nov. (Fig. 1 A—C).

Subgen. *Scorpiris* SPACH

Bulbus c. 1.5 cm diametro, ovoideo-oblongus, tunicis atro-brunneis tectus, basi radicis carnosis diffusis provisus. *Caulis* florendi tempore 5—8 cm longus. *Folia* 3—4, florendi tempore complete evoluta, basi vaginam caulem involucrantem usque ad 1 cm longam formantia; folium infimum 10—17 cm longum, 0.7—2 cm latum, apicem versus sensim attenuatum, falcatum, canaliculatum, atroviride, marginibus et nervo mediano subtus corneis albis, minute papilloso-puberulum, cetera similaria sed gradatim minora. *Flores* 1—3. *Spathae* valvae 5—7 cm longae, submembranaceae, minute papilloso-puberulae. *Perigonium* flavescenti-viride. *Tubus perigonii* 5.5—6 cm longus. *Segmenta exteriora* c. 4 cm longa; unguis erectus, c. 2.5 cm longus, basi 0.6 cm latus, marginibus subparallelis superne divergentibus, c. 1 cm latus; lamina patens, c. 1.5 cm longa, c. 0.8 cm lata, elliptica, apice rotundata; crista 1—1.2 cm longa, 0.1 cm alta, subintegra. *Segmenta interiora* erecta, c. 1 cm longa, oblanceolata, acuminato-caudata. *Styli* rami 4—4.3 cm longi, anguste elliptico-obovati, bilobi, lobis c. 1.5 cm longis, 0.5—0.6 cm latis; stigma bilobum. *Antherae* 1.4—1.6 cm longae; pollen c. 13-peltatum; filamenta c. 1 cm longa. *Capsula* et semina ignota.

Afghanistan. Kataghan: Salang pass, north side, 2850 m, 7.VI.1964, FURSE 6579, holotypus K; Oberstes Andarab-Tal, Westhänge des Khawak-Passes, 3100 m, 8.VI.1965, PODLECH 11227; Höhenweg auf der rechten Talseite, c. 15 km westlich des Khawak-Passes, 2800 m, 8.VI.1965, PODLECH 11215; Andarab-Tal, Kleines Seitental südlich von Darrah-i-Shu im Taganak-Tal, 2700 m, 4.VI.1965, PODLECH 11109.

The new species is most probably related to *Iris linifolia* O. FEDTSCH. and allied species (see discussion under *I. porphyrochrysa*). It differs in having the claw of the outer perigon segments widened in the upper part and broader than the lamina. In this respect it is transitional to those species which have a winged claw, e.g. *I. stocksii* BOISS., *I. cabulica* GILLI and *I. microglossa* WENDELBO. These latter species have, however, more or less bluish or bluish-violet flowers.

ACKNOWLEDGEMENTS

I am indebted to the Dr. D. PODLECH, Munich, and to the Director, Royal Botanic Gardens, Kew for sending me material for naming, and to Professor K. H. RECHINGER, Vienna, for translating my diagnoses into Latin.

A Study of the Family Geissolomataceae

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ABSTRACT

The family *Geissolomataceae* consists of the species *Geissoloma marginatum* (L.) A. JUSS., which is restricted to the Langeberg Mountains, Cape Prov., South Africa. This is studied from various aspects, and as all-round data as possible are collected and, where possible, checked up and complemented with additional investigations. The species has usually been treated in close proximity to the family *Penaeaceae* in previous literature. It is demonstrated here, however, that there are large differences in a great number of morphological and in most embryological, anatomical, and palynological and other details. The floral anatomy is different, and the pistil has a different orientation from that in *Penaeaceae*. The lack of internal phloem, the scalariform perforation of the xylem vessels, the lack of idioblast sclereids, the peculiar shape of the gynoecium, etc. even make the position of *Geissoloma* in the order *Myrtales* highly questionable. Comparison is also made with *Celastrales*. The most convincing similarities, however, which have not been suggested previously, are with the *Oleaceae* and *Salvadoraceae*. In a final discussion a comparison is made between these families and *Geissolomataceae*, in which the opinion is expressed that the families could be allied, in which case *Geissolomataceae* represents a more "primitive" level than *Oleaceae*.

INTRODUCTION, MATERIAL, METHODS

Geissolomataceae is a monotypic family, represented by *Geissoloma marginatum* (L.) A. JUSS., and restricted in its distribution to the Cape Province of South Africa, where it occurs only in a limited part of the Langeberg Mountains, in the Swellendam and Riversdale Divisions.

The species was originally described under *Penaea*, and has usually been placed in or next to *Penaeaceae*, the members of which it resembles in the decussate, entire leaves, the tetramerous perianth, the four carpels making up a squarish pistil, and the loculicidal capsule. Within *Penaeaceae*, especially *Endonema lateriflora* (L. FIL.) GILG (see DAHLGREN 1967) shows resemblance with *Geissoloma* in having three pairs of large bracts subtending each of the flowers (which are distributed along the branches in the leaf axils) and in the shape of the somewhat coriaceous, ± distinctly marginate leaves.

However, as shall be demonstrated below, there are numerous and far-reaching differences between the two families mentioned, and it may be questioned whether they are related at all.

The study has been performed on dried herbarium material. The following herbaria have been consulted, abbreviated according to LANJOUW and STAFLEU (1964): BM, BOL, LD, NBG, PRE, S, SAM and STE.

The floral details were studied on flowers quickly boiled in water. The anatomical slides were stained with safranine. Sections for the study of the vascular anatomy of the flower were made on the collection TAYLOR no. 143, using either haematoxylin or gentian violet and erythrosin.

An extensive literature on the species has accumulated because of the treatment of the species as a separate family. This accounts for the somewhat detailed historic outline.

PREVIOUS LITERATURE

The single species, *Geissoloma marginatum* (L.) A. JUSS. was originally described by LINNAEUS in Mantissa plantarum altera (1771 p. 199) under the name *Penaea marginata* (typified by a specimen named "*marginata*" in LINN). This name was used for the species also by, e.g., LAMARCK (1791 p. 316), POIRET (1804 p. 541), and THUNBERG (1807 p. 123 and 1823 p. 150).

VENTENAT (1804 plate 87) notified the great floral difference between *P. marginata* and other *Penaea* species, and KUNTH (1830 p. 678) described the genus *Geissoloma* from a herbarium name previously used by LINDLEY. The actual combination *Geissoloma marginatum* was not made by KUNTH, however, but appeared in JUSSIEU's rather detailed account of the genus in 1846 (p. 27 plate 4). JUSSIEU pointed out the differences from the other genera of *Penaeaceae,* and regarded *Geissoloma* as a "genus a genuinis Penaeaceis excludendum". He contributed a description and detailed figure.

ENDLICHER in Enchiridon botanicum (1841 p. 214) treated *Geissoloma* as a special taxon "*Geissolomeae*", but this was clearly subordered "Ordo CXII *Penaeaceae*" and therefore should not be regarded as of family (="ordo" sensu ENDLICHER) rank. It was not named "ordo" either. Moreover, in ENDLICHER 1847 (p. 74) it was treated as a genus anomalum under *Penaeaceae.* SONDER (1850 p. 105) and, somewhat later, DE CANDOLLE (1857 p. 491) are therefore apparently the first botanists to distinguish "*Geissolomaceae*" (=*Geissolomataceae*) properly as a family. By the same time *Geissoloma* was described and illustrated in SCHNITZLEIN's Iconographia (1858 plate 112), with a plate partly based on that of JUSSIEU (see above). In SCHNITZLEIN's floral diagram the pistil is wrongly directed, however, though in JUSSIEU's diagram the carpels have the correct, diagonal orientation. LINDLEY (1853

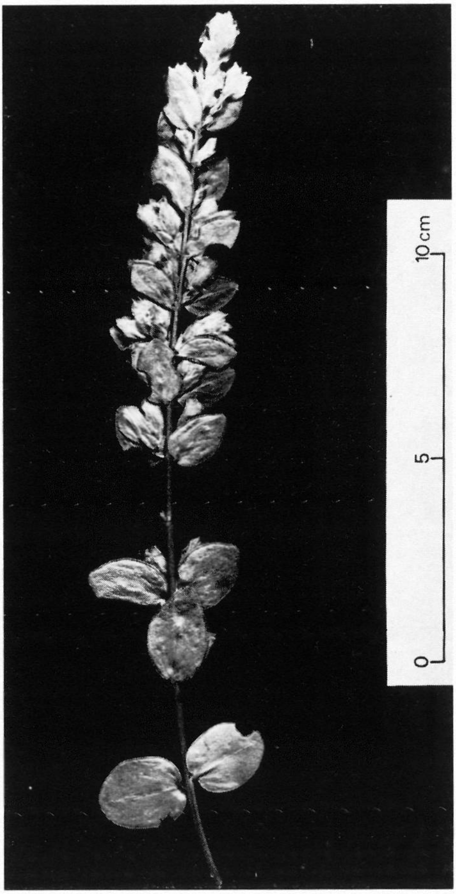

Fig. 1. *Geissoloma marginatum,* branch of TAYLOR no. 3870.

p. 577) and BENTHAM and HOOKER (1883 p. 203) treated *Geissoloma* under *Penaeaceae,* whereas BAILLON (1877 p. 49, Figs. 37—38) included the genus in *Celastraceae,* a position which has been seriously reconsidered later (cf. CRONQUIST 1968).

VAN TIEGHEM (1893 p. 286 ff) analyzed the anatomy of *Geissoloma,* and found that the genus should definitely be excluded from *Penaeaceae.* SUPPRIAN (1894 pp. 329—330) extended the anatomical account, illustrating the epidermis of the leaf margin and the phloem of the young stem. He noticed the scalariform perforation of the xylem vessels (with up to 21 bars) and pointed out that this represents a great difference from, e.g., *Penaeaceae.*

GILG (1894 pp. 525—526, and 1895 pp. 206—207) compared *Geissoloma* with the *Penaeaceae,* enumerating several of the main differences, which he regarded to be of relatively little importance, however. He completely disagreed to the relationship with *Celastraceae* previously pointed out by BAILLON.

An embryological account was given by STEPHENS (1910 pp. 345—347), who demonstrated that the development of the embryo sac follows the Normal (=Polygonum) Type, contrary to the *Penaeaceae*. She also wrote the account of the genus for Flora Capensis (1925 pp. 98—99), in which the geographical range was outlined.

PHILLIPS in 1951 (p. 523) placed *Geissolomataceae* next to *Penaeaceae,* and HUTCHINSON (1926 p. 150, 1959 p. 214 and 1967 p. 244) treated *Geissolomataceae* together with, e.g., *Penaeaceae* and *Thymelaeaceae* in the order *Thymelaeales*. CRONQUIST (1968 p. 254), on the other hand, placed *Geissolomataceae* in *Celastrales,* primarily because of the pollen shape and the lack of internal phloem.

Finally, the pollen grains of *Geissoloma* were described by ERDTMAN (1952 p. 183), and WEBERLING (1963 p. 119 ff) described and discussed the stipules in relation to those in *Penaeaceae* and *Oliniaceae*.

NOMENCLATURE

Family: *Geissolomataceae* ("*Geissolomaceae*") SONDER 1850 p. 105. — *Geissolomeae* ENDLICHER 1841 p. 214, with rank undefined, but clearly subordered "ordo *Penaeaceae*", not named 'ordo' (=family in ENDLICHER's terminology), nor numbered separately.

Genus: *Geissoloma* LINDLEY ex KUNTH 1830 p. 678.

Species: *Geissoloma marginatum* (LINNAEUS 1771 p. 199) A. JUSSIEU 1846 p. 27. — *Penaea marginata* LINNAEUS 1771 p. 199. — The combination "*Geissoloma marginatum* (L.) KUNTH" adopted in HUTCHINSON 1967 p. 244 was never made by KUNTH 1830, who merely, under *Geissoloma,* referred to *Penaea marginata* L.

MORPHOLOGY, DESCRIPTION

Shrub, ca. 50—100 cm tall, ascending, with dark-grey bark somewhat striated longitudinally, and with transverse, relatively inconspicuous leaf-scars. Branches subterete, sparingly branched; youngest branches somewhat 4-angled (or with 4 low ridges), closely and imbricatedly leafy, the ends closely covered with caducous, white indumentum of one-celled hairs (Fig. 5 A).

Lateral branches developing in the axils of the lowest pairs of bracts of the floriferous branchlets in the uppermost part of the floriferous zone. First leaves of lateral branches ± bracteose, later developed leaves larger and foliose.

Leaves opposite, decussate, entire, subsessile (or with an up to ca. 1 mm long, pubescent petiole), ovate, usually 12—24×6.5—18 mm

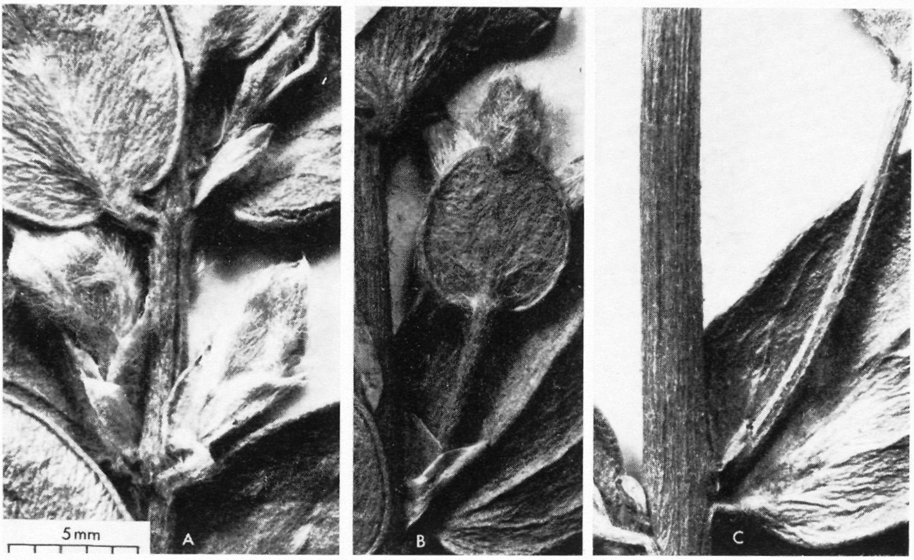

Fig. 2. *Geissoloma marginatum*, TAYLOR no. 3870. Three successive stages in the development of a vegetative branch from the axil of a bract of a floriferous branchlet. Scale indicated in A, common to A—C. See further in the text.

large, obtuse-subcordate at the base, bluntly acute—subobtuse at the apex, coriaceous, glabrescent (when grown out glabrous except for some pubescence on the base and midvein) but closely lanate in bud; with prominent midvein and indistinct lateral veins on the lower side, with rather indistinct veins on the upper side; margins thickened (see Fig. 5 C) especially on the lower side. Stipules present as small, subulate teeth, up to ca. 1 mm long, emerging near or up to 2 mm from the leaf base (Fig. 3 A).

Flowers (floriferous branchlets) in the axils of the foliaceous leaves, distributed for a distance of 3—10 cm or more of the branch ends. Each floriferous branchlet consisting of 3 pairs of bracts (bracteoles) and a terminal flower. At least the lower two pairs of bracts normally with axillary, vestigeal or subsequently developing buds.

Bracts whitish to ± rose or membraneous especially on the margins, entire or almost entire; lowest pair (Fig. 3 B) ca. 4.0—4.5 × ca. 2 mm large, oblong, weakly mucronate—mucronulate, distinctly keeled (± V-shaped in transversal section), with sparse hairs along the outer (lower) side; middle pair (Fig. 3 C) elliptic—ovate, ca. 5.5—6 × 4.0—4.5 mm large, weakly mucronulate or apiculate, glabrous, not keeled, with ± transparent—membraneous margins; uppermost pair (Fig. 3 D) largest, narrowly elliptic, ca. 8.5—9×4 mm large, acuminate, glabrous, generally partly rose in colour.

Petiole section above uppermost bract (bracteole) pair ca. 1.5—2 mm long, square, somewhat 4-ridged, bract pairs concentrated on a ca. 1.5 mm long section below this part.

Perianth (Fig. 3 E) rose in colour, submembraneous, consisting of two pairs of decussate, ovate, glabrous, apically acuminate-apiculate members, fused mutually and with stamens and pistil for ca. 1.2—1.5 mm at the base. Size of perianth segments ca. 12—13×8—8.5 mm.

Stamens 8 in number, 4 (the outer) alternating with the perianth segments, 4 (the inner) opposite these, all emerging at the base of the flower at about the same level and fused with the perianth for only ca. 1 mm at the base. Filaments linear, up to ca. 6.5 mm long in postfloral stage, during anthesis much shorter, ± obtusely 3-angled at the base, otherwise somewhat flattened. Anthers versatile, dorsifixed, broadly ovate, cordate (Fig. 3 G—H), 4-locular (4-microsporangiate) in the bud, dehiscing at an early stage with longitudinal splits, seemingly 2-locular during the floral—postfloral stages. A well-developed endothecium (Fig. 3 Q) developing gradually (not differentiated in the bud stage, Fig. 3 O). Anthers with a distinct, but obtuse connective tip (Fig. 3 G—H). Anthers of outer staminal whorl in the postfloral stage up to ca. 1.3×1.1 mm large, those of inner whorl larger, up to ca. 1.6×1.3 mm large.

Pistil 4-carpellary, syncarpous in the ovary region, with 4 styles free

Fig. 3. *Geissoloma marginatum.* — A: Leaf base with subulate stipules. — B: Lowest bract pair of floriferous branchlet, inner and outer sides. — C: Bract of middle pair. — D: Bract (bracteole) of uppermost pair, closest to the flower; C and D, outer side. — E: Flower. — F: Stamen. — G—H: Anther, inner and outer side. — I: Pistil. — J: Base of carpel opened along midvein and ventral suture. — K: Upper part of ovary, not opened, to show that the carpels are mutually free at the ovary top and style base. — L: Stigmas, somewhat separated by pressure on a slide (normally they are more closely connate). — M—N: Capsule in different views. — O: Seed. — P: Transversal section of anther in early bud stage (endothecium not yet differentiated). — Q: T.s. of anther at postfloral stage (endothecium indicated). — R: Epidermis, endothecium, and middle layer at postfloral stage (from Q). — S: Floral diagram based on the present investigation, the 3 pairs of bracts subtending the flower indicated, the foliose leaf below and the branch axis above. A, M, N and O: from PHILLIPS no. 305; B—L and Q—R from TAYLOR no. 3870; P from BARKER 5525. — A, G, H, J and K ×9; B—F, I and M—O ×4.5; L, P and Q ×ca. 50; R ×ca. 150.

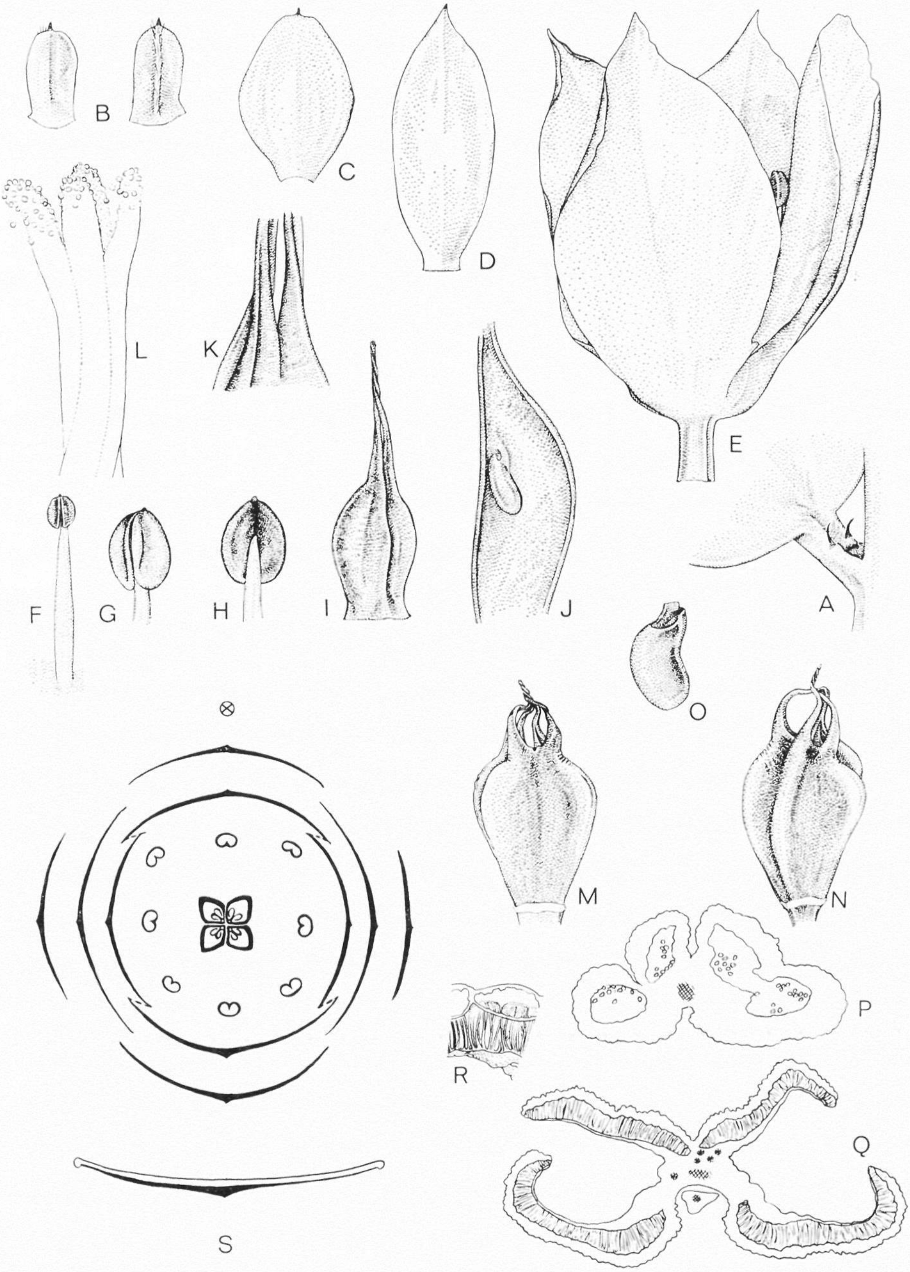

Fig. 3.

in the lower parts, twisted and connate in the upper part. Carpels alternating with the perianth segments (Fig. 3 R). Ovary sessile, squarish, with 4 relatively prominent ridges along the carpel midveins (dorsals), with relatively smooth walls. Locules 4, entirely separate (Fig. 4 F—K); each locule with 2 pendulous ovules, one on each side of the inner suture in the middle part of the ovary. Apex of ovary divided into 4 separate parts (Fig. 4 L) continuing into the free style bases (Fig. 3 K); the styles twisted for about one turn or more around each other. Stigmas extremely small, consisting of the 4 carpel apices which though coherent are ± free from each other (in Fig. 3 L somewhat dispersed through pressure in a slide). Ovule shape, see the embryological paragraph.

Capsule (Fig. 3 M—N), enclosed in the persistent perianth, hard, dark-brown, 5—6 mm long (excluding the style bases), loculicidal, dehiscing by 4 longitudinal splits along the carpellary dorsals. Seeds (Fig. 3 M) solitary in each cell, oblong, somewhat curved, compressed, rather smooth, ca. 3.5 mm long, with a short and stout, white funicle; embryo straight, central, almost as long as the fleshy albumen, with long, linear cotyledons, with superior, short, cylindrical, obtuse radicle, and with inconspicuous plumula (the latter information according to STEPHENS 1925 p. 99).

EMBRYOLOGY

Embryological information was given by STEPHENS (1910 pp. 345—347). Her studied material was collected in Garcia's Pass (see collection list below). A resumé on the knowledge is given in DAVIES 1966 p. 126.

The ovule is anatropous and bitegmic, and micropyle is formed by both integuments. STEPHENS never observed a row of megaspores, but according to her there is strong presumptive evidence that it is formed. She remarked that "the appearance of the first four nuclei formed in the embryo sac, suggests that they are the result of ordinary nuclear divisions, and not of meiosis". [The embryo sac in *Penaeaceae* is believed to be tetrasporic, and is of a very particular, 16-nucleate type (STEPHENS 1909)].

In *Geissoloma* the polar nuclei fuse at the chalazal end of the embryo sac before fertilization, and the three antipodals degenerate rapidly. In the egg apparatus the synergids take up stain deeply and are provided with distinct, weak-staining tips. The nucellus in its centre has a strand of elongated cells, surrounded by starch-filled parenchyma;

as the embryo sac elongates starch grains appear also in the periphery of the embryo sac, but disappear later as they are used up. Copious endosperm (much better developed than in *Penaeaceae*) is formed after fertilization, filling up the embryo sac, but is partly absorbed around the developing embryo, which lies in a sap-filled cavity. Suspensor is lacking. The proembryo becomes spherical, and the embryo has long and linear cotyledons, better developed than in *Penaeaceae*.

Conclusion. The embryology of *Geissoloma*, contrary to that of *Penaeaceae*, is of a monosporic, Normal Type. The endosperm is better developed, the cotyledons larger, and starch grains are temporarily present in the embryo sac. The embryology is of a very common type, and affords little positive — although some negative — evidence for judgement of relationship.

FLORAL ANATOMY

[Material studied: TAYLOR no. 143 from the Swellendam Div. (NBG).]

Above the vascular supply to the last pair of bracts, the gaps close up and a continuous vascular cylinder, somewhat square in transverse section, is formed. This splits up into a number of separate strands (Fig. 4 A—B). From the four angles of this "cylinder" arise four large perianth-marginal—stamen cords, and from its sides four smaller median traces of the perianth (Fig. 4 C). All these eight strands usually arise at the same level but sometimes the latter are borne at a slightly higher level. The origin of the marginal traces of a perianth member at a lower level than its median bundles is not very unusual and has been reported in a number of families. At the periphery of the thalamus the perianth-marginal—stamen cords divide to form an inner stamen trace for a stamen of the outer whorl, and outer traces which supply the margins of adjacent perianth members (Fig. 4 D—E). The perianth-median trace also may bear in the outer region of the thalamus, one or two lateral branches for the member that it supplies. Thus each perianth lobe receives a median bundle and a varying number of lateral bundles. Just above the origin of the median traces of the perianth and opposite them, four stamen traces are borne by the vascular cylinder. These supply the stamens of the inner whorl (Fig. 4 D). At the same level the dorsal bundles of the four carpels are also borne in positions alternating with them. Four septal bundles arise just above the origin of the traces of the inner whorl of stamens, and on the same radii (Fig. 4 E).

A very short perianth tube with the adnate bases of the four stamens that alternate with its lobes gets separated from the ovary, at first only in the regions opposite the carpels (Fig. 4 E—F). For a short distance the inner surfaces of the other four stamens are adnate at their base to the ovary wall opposite the septal radii, while their outer surfaces are adherent to the median region of the perianth member opposite (Fig. 4 F). These stamens get separated first from the ovary and then from the perianth and this detachment occurs at a slightly higher level than that of the alternating four stamens from the perianth margins. The adhesion of four of the stamens at the base to the ovary and to the perianth is just a growth phenomenon and has no special implications. It should be emphasized that the cohesion of the margins of the perianth members as well as the adnation of the stamens to them or to the ovary is only for a negligible distance.

Although described as imbricate in taxonomic literature, the perianth members are clearly decussate, with one pair outer and the other inner. The term decussate would give a better understanding of the situation in this case than the word imbricate. Out of the two pairs, the outer one is antero-posterior in position while the other one is lateral.

The septal traces branch and supply the ovary wall on either side. The ovary wall thus gets the dorsal bundles and a number of small lateral bundles. The latter fade away at the top of the ovary. The carpels of *Geissoloma* are not in the antero-posterior and lateral positions, but are diagonally placed. The carpellary dorsals thus are on radii that alternate with the perianth members (Fig. 4 L). The ovary is square in transverse section with the dorsal bundles running in the angles. The closure of the gaps caused by the outwardly going car-

Fig. 4. *Geissoloma marginatum*; from TAYLOR no. 3870. — A: Showing three pairs of bracteoles and the flower stalk. — B: Flower stalk at a slightly higher level. — C: Origin of four large perianth-marginal—stamen cords (Mg) and the perianth median traces (M). — D: Shows division of the 'Mg'-bundles into inner stamen trace of outer androecial whorl (SO) and outer perianth marginal traces, origin of the four staminal traces of the inner whorl (SI) and the dorsal bundles of the carpels (D). — E: Slightly higher level showing origin of the septal strands (L). — F: Separation of the short perianth tube from the ovary in position opposite to the carpels. — G: Ovary, stamens and the perianth members separated. — H: T.s. of ovary showing complete vascular cylinder in the axial zone. — I: Separation of the two ventral bundles of each carpel. — J: Ovule traces being borne by the ventral bundles. — K: T.s. through top or ovary. — L—N: Sections through style at successively higher levels. — O: Diagrammatic l.s. showing placentation.

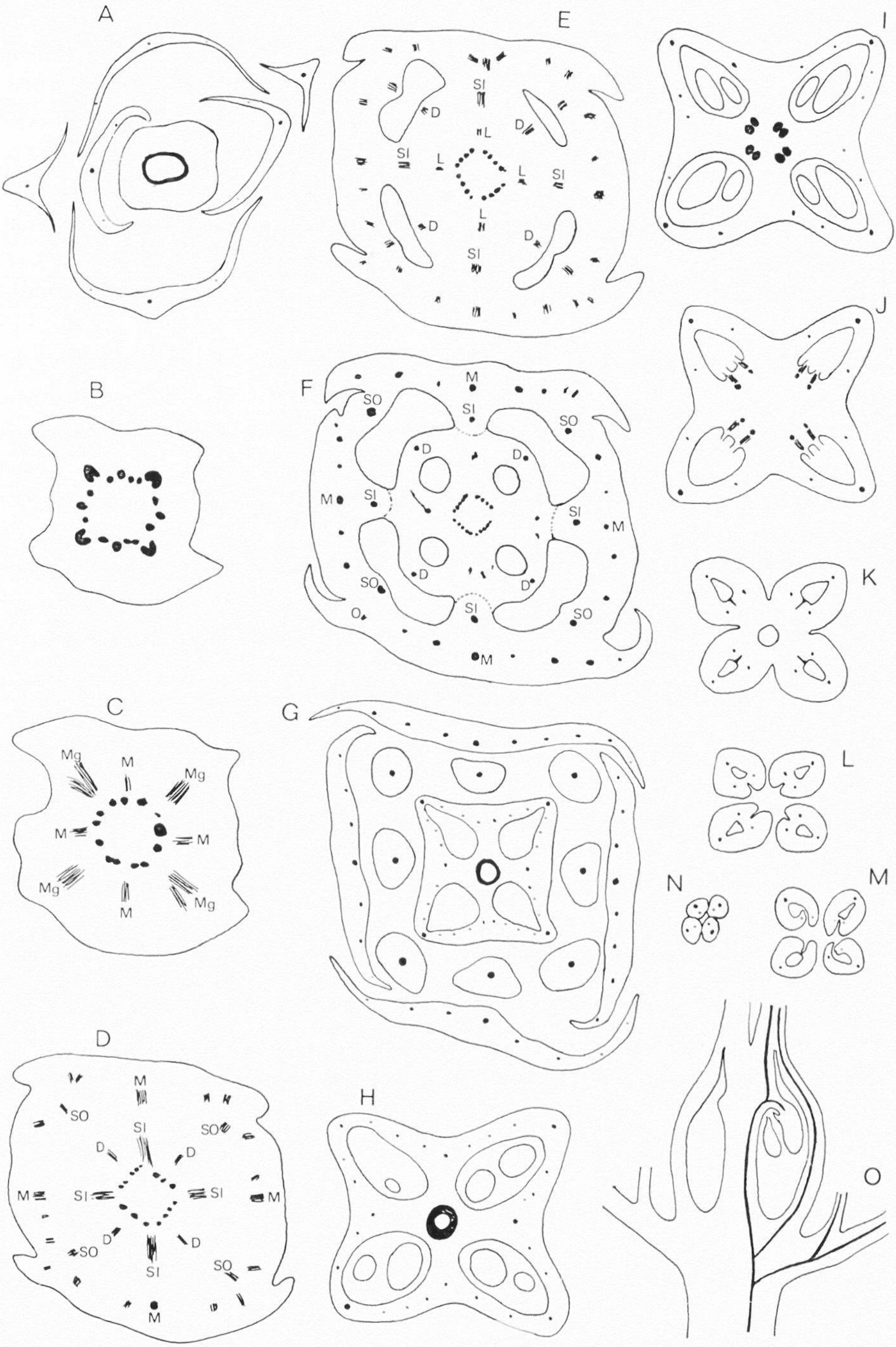
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Fig. 4.

pellary traces is followed by the formation of a complete cylinder of vascular tissue which runs upwards in the axile zone of the ovary for a considerable distance (Fig. 4 G, H). A little beneath the top of the ovarian loculi it splits into four flat strands placed opposite the loculi. Each of these divides into two ventral bundles (Fig. 4 I) which bear a prominent inward ovular branch that runs into a funicle (Fig. 4 J) and continue upwards into the style as ventral bundles of the carpels in a reduced state (Fig. 4 K—M). Each loculus has two ovules which are pendulous from the axile zone of the ovary near the apex of the loculi (Fig. 4 O). Longitudinal sections passing more or less in a tangential direction give a wrong impression that the ovules hang down from the roof of the ovary. They are actually pendulous from the axile zone in the upper part of the loculi. The ovules of a carpel are thus supplied by branches of the ventral bundles which belong to the same carpel. Above the ovuliferous zone the ovary becomes deeply four-lobed and a hollow canal appears in the centre (Fig. 4 K). The four lobes become separated from one another and are continued up as the free styles. The loculus of each carpel is also continued as a canal into the style (Fig. 4 L). For some distance the hollow styles show clearly the margins of each carpel which appear almost free from each other (Fig. 4 M). Each style has a dorsal bundle and two ventral bundles. It is quite close to their tips that the styles become solid and the two ventral bundles fuse together (Fig. 4 N). The dorsal and the fused ventral bundles run up to the base of the stigma and fade away.

Discussion. The distinction of *Geissoloma* in a family separate from *Penaeaceae* is justified. Except for some conspicuous similarities, such as the prominent bracts, the four perianth members, the squarish transverse section of the four-carpellary ovary, and the loculicidal capsule, there is little resemblance with *Glischrocolla* of *Penaeaceae,* the floral anatomy of which has recently been studied (RAO & DAHLGREN 1968).

A comparison between the two genera is given in Table 1.

Glischrocolla differs from *Geissoloma* especially in having only four stamens, inserted high up on the perianth tube and alternating with the perianth lobes, and in the carpels which alternate with the stamens and are oriented opposite the perianth members. In *Geissoloma* the carpels alternate with the perianth members. This difference may be responsible for part of the great anatomical differences expressed in the table below. In *Glischrocolla* four pairs of ventral bundles and four large septal bundles are organized within the ovary. The entire course and disposition of the vascular strands of the ovary in *Geissoloma* are widely different, and the prominent septal bundles have no correspondence here.

Table 1. Comparison between *Geissoloma* and *Glischrocolla* in some features of floral anatomy and morphology.

	Geissoloma	*Glischrocolla*
Aestivation	decussate (see the text)	(reduplicate-) valvate
Stamen(s)	eight, outer whorl alternating with perianth and with inner whorl, this alternating with the carpels	four, alternating with perianth and with carpels
Connective	inconspicuous	large, platelike
Carpellary dorsal traces	independent of perianth traces	fused at the base with four perianth median traces
Stamen traces	outer: conjoined only at the base with the perianth marginal traces inner: conjoined only at the base with the perianth median traces	conjoined high up with the perianth commissural traces for a considerable length
Orientation of carpels	alternating with the perianth members	opposite the perianth members
Stipe	extremely short and stout	long and thick
Ventral carpellary traces	continuing above the ovary into the style	exhausted in supplying the ovules
Style(s)	four, largely free	one, the members fused
Stigma	inconspicuous	larger, of commissural type

No vestigeal traces of any kind of an additional perianth whorl outside the outer staminal whorl, nor outside the existing perianth, have been discovered in *Geissoloma*.

PALYNOLOGY

The pollen grains (Fig. 5 F) of *Geissoloma*, according to ERDTMAN (1952 p. 183, Fig. 107), are "3-colporate, oblate spheroidal—subprolate (diameter about 20.5 µ)"; with "sexine about as thick as nexine, and finely and distinctly reticulate". The pollen grains differ from those of *Penaeaceae* in lacking the colpoid grooves alternating with the colpi, and in being more distinctly reticulate. On the other hand, they are closely similar to the pollen grains in *Celastraceae, Hippocrateaceae* and *Staphyleaceae,* and somewhat similar pollen grains are also found in, e.g., *Theaceae, Dilleniaceae, Crossosomataceae, Rhamnaceae, Vitaceae,* and *Oleaceae.*

ANATOMY

The Leaf

The leaves are flat and entire. The markedly swollen margins consist of large, high epidermal cells (SUPPRIAN 1894 Fig. X: 10; Fig. 5 Q). (It may be noted that the similarly pale, marked margins of the similar leaves in *Glischrocolla* of *Penaeaceae* are different in transverse section. Beside the pale, rather ordinarily large epidermal cells, also thick-walled mesenchymatous cells make up the "margins" in this species. Some of these cells are filled with crystal druses.)

The epidermis in *Geissoloma* has a thick cuticle, which is undulate especially below but also above the midvein, otherwise rather smooth. The secondary walls of the epidermis are rather thick. Some of the epidermal cells are mucilaginous, and mucilaginous subepidermal cells are frequent on the lower side of the leaf just below the midvein.

Stomata (Fig. 5 D—E) are restricted to the lower side of the leaf. They are of Ranunculaceous type (as in *Penaeaceae*). The cells adjacent to the guard cells being of the same shape as other epiderms cells, often rectangular or rhombic, and usually four in number bordering on each stoma.

The basal part of the trichomes are surrounded by the narrow, angled part of ca. 5—6 epidermis cells (Fig. 5 E).

Palisade parenchyma, consisting of elongate, vertical, cylindrical cells, is developed mainly on the upper side of the leaf. Contrary to the *Penaeaceae, Geissoloma* lacks sclereid cells of any kind. The inner mesenchymatous tissues consist of thin-walled irregular cells, often with some chloroplasts. Rather small crystal druses occur sparsely in the epidermis and mesophyll.

The midvein as well as the larger lateral veins are provided with sclerenchyma fibres on the upper as well as lower side. The upper strand, bordering on the xylem, is narrower than the lower, which borders on the phloem.

Fig. 5. *Geissoloma marginatum.* — A: Trichome from young leaf. — B: Transversal section of middle part of leaf with midvein. — C: T.s. of thickened leaf margin. — D: Epidermis with stomata seen from above, below to the right the base of a trichome surrounded by six epidermis cells. — E: Section of stoma from lower side of leaf. — F: Pollen grains according to ERDTMAN 1952 p. 183, Fig. 107. — G: Longitudinal section through ovule, the embryo sac in the centre (shaded). — H: Eight-nucleate embryo sac, notice the starch grains. — I: Longitudinal section of ovule at late stage, endosperm shaded, embryo on top still small. (G—I according to details in STEPHENS 1910 plate 6, redrawn.) — A, D and E ×ca. 170; B—C ×ca. 57; F ×ca. 1,600; G ×ca. 66; H ×ca. 430; I ×15.

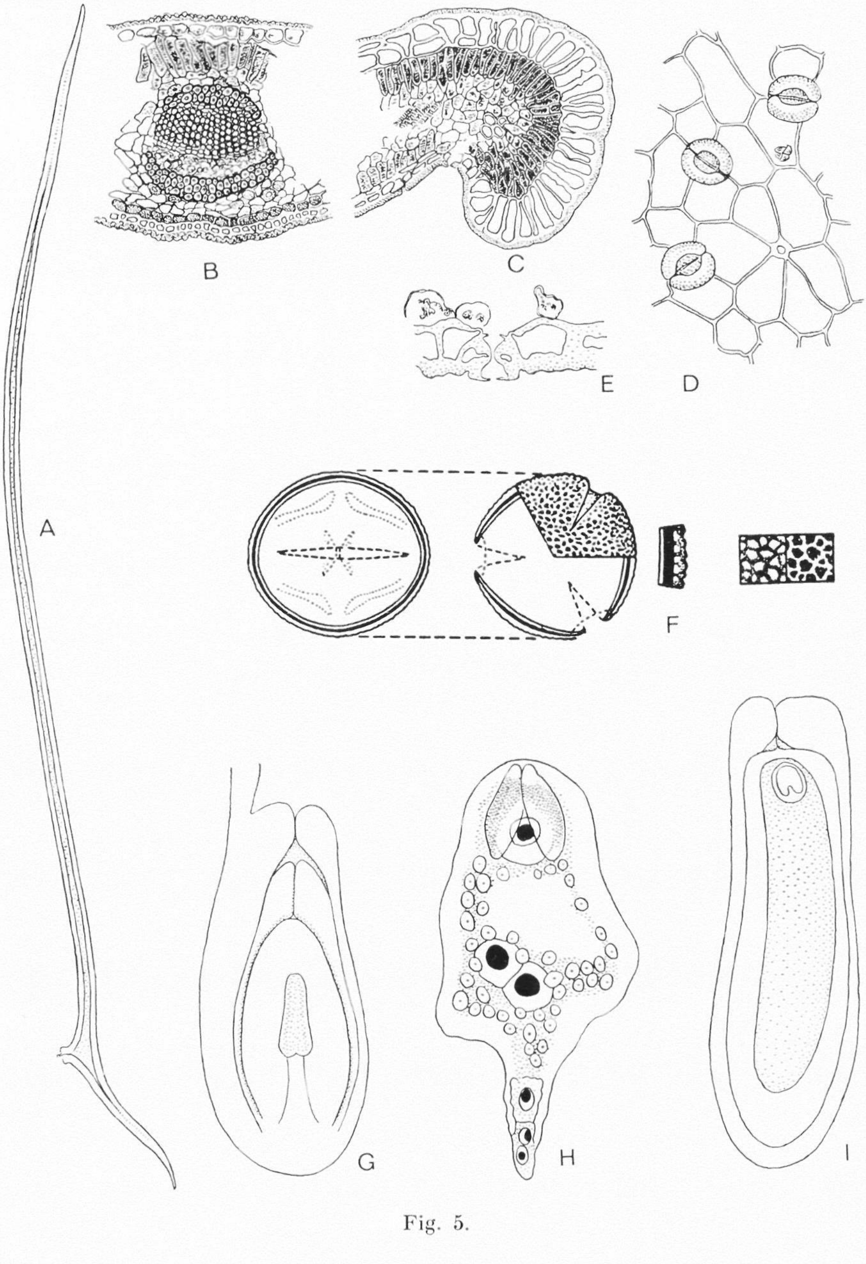

Fig. 5.

Pubescence

Trichomes occur on the branch ends and on the young leaves, from which they have largely been shed when the leaves attain their full size. In the young leaves they form a close shaggy felt on the lower side, but are sparsely scattered on the upper side. The trichomes (Fig. 5 A) are unicellular and T-shaped, with one arm shorter than the other and have a rather thick cell wall and a narrow lumen. The attachment point is narrow and apparently weak, causing early detachment. (Trichomes are lacking in *Penaeaceae*.)

The Axis

The young regions of the branches have an epidermis with thick cuticle and sparse—close hairs. The cork arises in the outer part of the primary cortex, and the phellem cells have fairly wide lumen. Stone cells occur in the cortex. A pericycle, consisting of a finally continuous ring of sclerenchyma fibres surrounds the vascular tissue. Intraxylary phloem is lacking. In the xylem there are scattered vessels with a mean diameter of 25 μ and with end walls having scalariform perforation plates with many bars. The vessel-ray pits are relatively large and simple. The fibres have bordered pits. The rays are 1—3 cells wide. Clustered and solitary crystals occur in the primary cortex.

Beside other minor differences between *Geissoloma* and *Penaeaceae*, the following may be mentioned: *1*. Intraxylary phloem is lacking in *Geissoloma*; *2*. there is a pericycle of fibres, forming a continuous ring, in *G.*; *3*. the xylem includes vessels with scalariform perforation in *G.*, but with simple perforation in *Penaeaceae*. (Information from VAN TIEGHEM 1893, SUPPRIAN 1894, and METCALFE & CHALK 1950.)

DISTRIBUTION

Geissoloma marginatum is restricted to the Langeberg Mountains, Cape Province, where it has been recorded in the Swellendam and Riversdale Divisions. It grows on mountain slopes at an altitude of 2000—4000 feet (=600—1200 m).

COLLECTIONS

Swellendam Div.: Swellendam Div. (without particulars). 1915, MARLOTH nos. 7191 and 7197 (PRE). — Swellendam Mts.; 7000 (sic!) ft. 1925, BARNARD, SAM no. 28970 (SAM). — Alpine, moist places nr Swellendam.

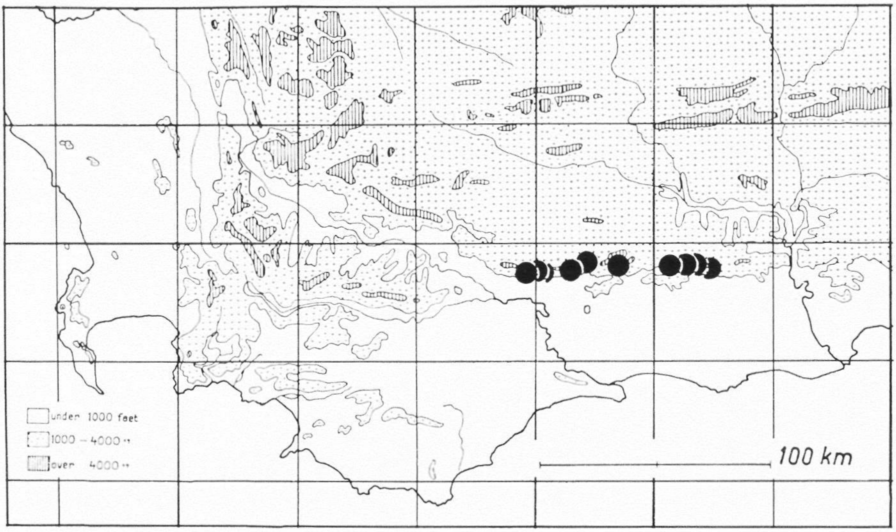

Fig. 6. Distribution of *Geissoloma marginatum*. The species is limited to the Langeberg Mountains, Swellendam and Riversdale Divisions of the Cape Province.

NIVEN (BM). — Swellendam Mt., S slopes above town of Swellendam. 1941, ESTERHUYSEN no. 4812 (BOL). — S slope of 11 O'Clock Peak above Swellendam; 2000 ft. 1962, BARKER no. 3870 (NBG); TAYLOR no. 3870 (PRE). — The Crown Mt.; 3800 ft. 1952, WURTS no. 62 (NBG). — Langeberg nr Swellendam, N slope of Sparrebosch Kloof; 2000 ft. 1950, TAYLOR no. 143 (BOL, NBG, PRE). — Mts. at Voormansbosch. ZEYHER no. 3729 (BOL, LD, PRE, S, SAM); ECKLON & ZEYHER (BOL). — Tradu Pass, rocky places nr. streamlets; 3000 ft. 1917, MARLOTH no. 7765 (PRE). — Tradu Pass. 1917, MARLOTH no. 8618 (PRE); 1947, OLIVIER (NBG). — Langeberg Mts. above Zuurbraak; 3500 ft. 1897, SCHLECHTER no. 5868 (BOL, PRE). — Wood, Grootwadersbosch. PAPPE, SAM no. 19966 (SAM).

Riversdale Div.: Langeberg Mts. above Corente River Farm; ca. 3000 ft. 1908, MUIR no. 170 (PRE). — Langeberg Mts. nr. Riversdale. 1892, SCHLECHTER no. 1783 (BOL). — S face of Kampscheberg nr. Garcia's Pass; 1200 ft. (=S face of Mozambique Kop nr. Garcia's Pass). 1897, GALPIN no. 4539 (BOL, PRE). — Kampscheberg; 2000—3000 ft. 1926, THORNE, SAM no. 41621 (SAM). — Garcia's Pass. 1908, PHILLIPS no. 305 (SAM); STEPHENS without no. (BOL, PRE); 1949, BARKER no. 5525 (NBG).

CONCLUSIONS

Geissolomataceae differs from the families *Penaeaceae*, *Lythraceae*, *Melastomataceae*, and *Combretaceae*, which are apparently mutually closely related and belong in the order *Myrtales*, in lacking intraxylary phloem, in lacking idioblast-sclereids, in having cork arising in the outer part of the primary cortex, in having scalariform (not simple) xylem perforations, and in having several styles. The connective is inconsiderable in *Geissolomataceae.* There are, accordingly, strong reasons for referring this family to a different order.

CRONQUIST (1968 p. 239) excluded *Geissolomataceae* from *Myrtales* primarily because of the lack of internal phloem, and placed it in *Celastrales,* where it has a somewhat aberrant position, through lacking disc and in having simple perianth and two whorls of stamens (the latter also found in some *Celastraceae,* however). *Geissoloma* previously was treated even in the family *Celastraceae,* viz. by BAILLON, who also included other presently distinguished families, like *Buxaceae* and *Hippocrateaceae,* in this family.

Geissolomataceae has several features in common with *Celastraceae,* like the shape of the pollen grains (often tricolporate and reticulate), the few ovules per ovary, hypogyny, the foliaceous cotyledons, the straight embryo, the absence of intraxylary phloem, the two integuments, the Polygonum type of embryo sac formation, the formation of cork in the outer layers of the cortex, the scalariform perforation of the xylem (in *Celastraceae* more often entire, however), the presence of simple 2-armed hairs, and the rudimentary or absent stipules. Some differences are important, however, among them the absence in *Geissolomataceae* of a disc (occasionally absent also in *Celastraceae,* however), the two staminal whorls (but occasionally also two in *Celastraceae*), and the simple perianth (always double in *Celastraceae*). The floral morphology and floral anatomy of *Celastraceae* (see BERKELEY 1953) show a number of differences from the condition in *Geissoloma.* Hence, even a relationship of this genus with *Celastraceae* appears remote.

Beside the *Myrtales* and *Celastrales,* with which *Geissolomataceae* apparently does not agree very well, a quite different group may be brought forward for comparison.

Such a group is, in fact, *Oleaceae* with the following notable similarities to *Geissolomataceae*: the opposite, usually entire (but exstipulate) leaves; the 4-merous perianth whorls, the prevailingly bisexual, hypogynous flowers; the quite similar stamen construction with linear filaments and versatile, 4-microsporangial, longitudinally dehiscing anthers with an apical connective tip; the 2-ovuled locules with central placentation; the anatropous ovules; the fruit which if a capsule is loculicidal; the fibrous thickenings of the endothecium; the Polygonum type of embryo sac with hooked synergids and ephemeral antipods; the at least temporarily Cellular endosperm; the straight embryo; the similar tricolpor(oid)ate pollen grains; the Ranunculaceous type of stomata usually confined to the lower surface of the leaves; the superficially arising cork, the sometimes continuous ring of sclerenchyma in the pericycle; and the lack of internal phloem.

Notable differences from *Geissolomataceae* are, e.g., the single integument; the presence of peltate trichomes (however, simple unicellular hairs also occur in *Oleaceae*); and the simple perforation of the vessels (scalariform perforation with few bars is reported in *Syringa* and *Forsythia*).

A transformation of the outer staminal whorl of *Geissoloma* into 4 "petals" — probably a common transformation among the angiosperms —, a reduction of the median stamens of the inner whorl (the stamens are even 4 in a couple of genera in *Oleaceae*), and a reduction of the carpels to two (in the median plane) give the exact floral diagram of the *Oleaceae.* Moreover, in the calyx we find, in some *Oleaceae,* the same decussate position as in the perianth of *Geissolomataceae.* (The two outer pairs of bracts in *Geissolomataceae* in this connection may be disregarded, as they may well be classed as belonging to a floriferous branch or an inflorescence rather than to the individual flower.)

Equally close similarity as with the *Oleaceae* is, perhaps, found with especially *Azima* of the *Salvadoraceae,* a family which is sometimes placed in *Oleales,* sometimes in *Celastrales.* In the mentioned genus we find the characters enumerated above as similarities between *Geissoloma* and *Oleaceae.* Rudimentary stipules are also often present, the inflorescences are axillary (but the flowers unisexual), the stamens are 4 in number like the petals alternating with them, the integuments are two in number, and the trichomes are simple. Intraxylary phloem is absent, but occurs in other members of *Salvadoraceae,* a fact which indicates, together with others, that there may very well be some connection between groups referred to *Oleales*, *Celastrales,* and *Myrtales* as well. The most suitable place of several families, like *Salvadoraceae* (and *Geissolomataceae*), is therefore not very easy to decide, and further investigations are desirable.

As a final estimation, put forward by one of us, namely R.D., an affinity of *Geissolomataceae* with *Oleaceae* and *Salvadoraceae* is more probable than any other suggestion. If this is true, *Geissolomataceae* would represent a level considerably more "primitive" than that of *Oleaceae* because of the scalariform perforation of the vessels, the outer staminal whorl (replaced in *Oleaceae* by "petals"), the four carpels (two in *Oleaceae*), and the two integuments (one in *Oleaceae*).

The establishment of a separate order, *Geissolomatales*, connecting *Oleales* (*Ligustrales*) with more "primitive" angiosperms might be justified.

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Observations on the Genus Monostroma in the Northern Baltic Sea Area (Seili Islands, SW Archipelago of Finland)

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ABSTRACT

Hitherto, *Monostroma balticum* (Aresch.) Wittr., which has been observed growing only in a detached condition, is the only species of the genus so far reported from the inner part of the Baltic Sea. Annual attention has been paid to the occurrence of *M. balticum*; but during the winter and spring of 1968, the first few plants attached to stones were observed. Their development in nature, and partly in culture, has been followed.

The thalli of the young saccate plants split and form irregularly lobed fronds that remain attached for some time to the substrate, but later they become detached and continue their growth as detached plants in a way similar to the plants that formerly have been referred to *M. balticum*.

Now that the existence of the attached stage in the development of *M. balticum* has been established, there are, in fact, no differences left for distinguishing it from *M. grevillei*. It is suggested, therefore, that *M. balticum* should be considered synonymous with *M. grevillei* as *M. balticum* seems to be merely a Baltic form of *M. grevillei*.

INTRODUCTION

M. balticum, which was named by Areschoug and described by Wittrock (1886 pp. 48—49, pl. III, fig. 103), has been observed in several localities of the Baltic since 1865 (Hauck 1885 p. 424; Levring 1940 p. 4; Häyrén 1930 p. 178; 1950 p. 14; Waern 1952 p. 31).

M. balticum has been reported to occur only in a detached condition, even though Wittrock already believed that it begins its development as an attached plant.

The purpose of this study has been to determine whether *M. balticum* occurs as an attached plant during its early stages of development and to study its relationship to other *Monostroma* species.

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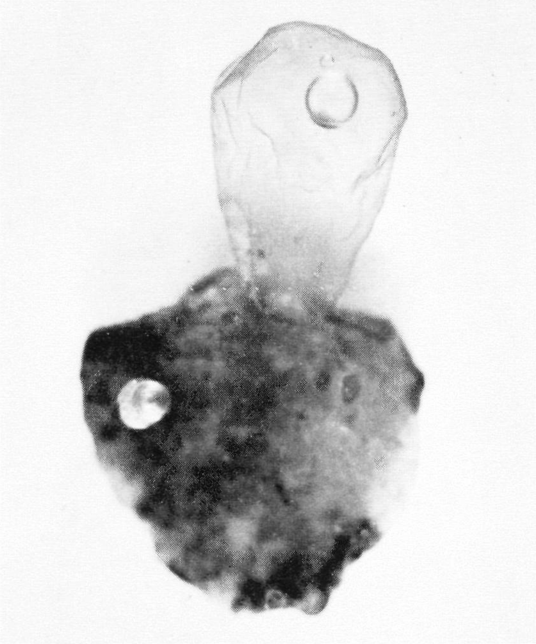

Fig. 1. A saccate *Monostroma* plant attached to a pebble. SW side of the Seili Islands (January 23, 1968). — ×4. — Photo K. ALHO.

METHODS AND MATERIALS

The present author has observed and studied *Monostroma* plants in the SW Archipelago of Finland over a total of seven summers (1961—1966 and 1968). Besides, collections and observations were made on January 23, February 26, May 5, and several times later in the spring of 1968.

Young plants that were collected on January 23, 1968, were transferred to Erdschreiber's culture solution and kept in a culture chamber at a temperature of 10°C. After about one month, the temperature of the growth chamber was raised to 13°C. The development of the plants in culture was followed.

Material of detached *Monostroma* plants is preserved in TUR (dried specimens: numbers 52—56; wet stack: box 5, jars 68—69, box 16, jars 211, 221, 304, 306). The same is valid for the attached plants (dried specimens: 57—59; wet stack: box 5, jar 67; box 16, jar 219).

OBSERVATIONS IN NATURE

In protected places, and especially in the spring, a great number of detached *Monostroma* plants can be seen on the shores. Skindivers have also brought copious amounts of it from depths of 2—3 m in sheltered bays.

My investigations were mostly made at the end of July and in August.

Fig. 2. Different stages in the development of *Monostroma grevillei* as seen in nature (SW side of the Seili Islands, January 23, 1968). All of the plants are attached to pebbles. Some of the small plants are still saccate; others have a hole in the upper part of the thallus; and some are partly split. Only one of them (lower line, at right) is split all the way, forming irregular lobes.

From 1961—1966 only detached plants were observed at that time of the year. These plants were all referred to *M. balticum* (RAVANKO 1968). During an excursion on January 23, 1968, *Monostroma* plants were observed for the first time attached to pebbles and stones in the Seili Islands (SW side of the main island of Seili). The saccate, 2—20 mm tall (Fig. 1) plants grew under the ice at depths of 30—70 cm.

More detailed studies showed that many of the collected plants had a hole in the upper part of the saccate thallus. Some of the plants were only split halfway, but the thallus of one of the plants was split so that irregular lobes were found (Fig. 2). A few small disk-like plants were also observed on the pebbles in company with the saccate plants.

In order to follow the development of *Monostroma* in nature, a trip was made to the Seili Islands on February 26, 1968. At that time, only a few, small, saccate *Monostroma* plants were observed among the few attached ones. Masses of large *Monostroma* plants were seen entangled with *Potamogeton pectinatus, Fucus vesiculosus,* and with byssus filaments of *Mytilus edulis* as during previous summers.

In the spring after the melting of the sea ice, and at least as late as in May (excursion was made May 5, 1968), a few *Monostroma* plants were seen attached to pebbles at a depth of c. 30 cm (plants number 57—59, in TUR). The development of a few plants from an attached stage to the detached condition was followed in nature.

OBSERVATIONS IN CULTURE

The young disk-like plants, which were collected on January 23, 1968, grew in culture (temp. 10°C). They expanded and swelled in the middle parts giving rise to small saccate thalli. The sacs grew larger and finally split forming irregularly shaped thalli.

When the temperature of the growth chamber was raised to 13°C, the cells of the upper part of the thalli had, after one week, started to divide and produce swarmers. The culture was, however, contaminated, and swarmers were not liberated.

DISCUSSION AND CONCLUSIONS

The detached plants that had been referred to *Monostroma balticum* at the end of previous summers are according to my investigations identical with those plants that were observed beginning their development as attached plants during the winter and early summer of 1968.

A comparison was carried out between *M. balticum* and *M. grevillei* (THUR.) WITTR. No notable morphological differences were observed. Also, the patterns of the life cycles are similar in both species. Outside the Baltic it is known that *M. grevillei* becomes detached during the later stages of its development. The detached stages, however, have been referred to other taxa, such as *M. latissimum* (KÜTZ.) WITTR., of which a part recently has been shown to belong to *M. grevillei* (BLIDING 1968).

It should be mentioned that HAUCK (1885 p. 424) has presented the opinion that *M. balticum* belongs to the forms of *M. latissimum*.

Monostroma balticum was observed to occur as an attached plant. A comparison between *M. balticum* and *M. grevillei* showed that no differences exist between these two species. *M. balticum* seems to be only a form of *M. grevillei*, which in the inner part of the Baltic occurs in the attached stage of growth only during the winter and spring, a time of the year when phycological studies have only seldom been made.

The widely distributed *M. grevillei* has not been reported before in its attached stage from the northern Baltic Sea area, though, on the other hand, this condition is well known from the southern part of the Baltic Sea (LEVRING 1940 p. 3; WAERN 1952 pp. 8, 31, and MARTINSSON 1955 p. 255).

ACKNOWLEDGEMENTS

For critically reading my manuscript, I am grateful to Professor ANTERO VAARAMA, Head of the Department of Botany, University of Turku.

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Taxonomy and Distribution of Veronica hederifolia s. lat. (Scrophulariaceae) in Scandinavia

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ABSTRACT

Veronica hederifolia L. (*Scrophulariaceae*) forms a polyploid complex with x=9. One tetraploid and one hexaploid cytotype are widely spread in Scandinavia. The correlation between morphological characters and ploidy level is not absolute, but the major part of the Scandinavian herbarium material can be sorted into two taxa, which are best treated as subspecies, viz. *V. hederifolia* L. ssp. *hederifolia* (2n=54) and ssp. *lucorum* KLETT & RICHTER (2n=36). The variability in most diagnostic characters is considerable and several probably autogamous populations combine characters of both subspecies. The existence of other deviating forms and indications of deviating chromosome numbers call for further investigations.

INTRODUCTION

The *Veronica hederifolia* complex has recently been subject to a cytotaxonomical analysis throughout its distribution range (FISCHER 1967). The picture that emerged is that of a widespread polyploid complex with a basic number of x=9. The ploidy levels known with certainty are 2x, 4x, and 6x. A few deviating chromosome numbers have been published but need verification (2n=c. 26—28, SORSA 1963; 2n=28, GADELLA & KLIPHUIS 1966; 2n=30 in *V. sibthorpioides*, HOFELICH 1935). FISCHER found correlations between chromosome numbers and morphological characters and recognized five taxa, which he assigned the rank of species, viz. *V. triloba* OPIZ (2n=18), *V. hederoides* M. FISCHER (2n=18), *V. sibthorpioides* DEB. & DEG. (2n=30), *V. sublobata* M. FISCHER (2n=36), and *V. hederifolia* L. s.str. (2n=54).

Only *V. sublobata* and *V. hederifolia* s.str. were recorded for Fennoscandia by FISCHER. The variation and distribution of the complex in Scandinavia were studied by us on the complete herbarium material from the following herbaria: C, GB, LD, O, S, UPS (the abbreviations follow Index Herbariorum, Ed. 5, 1964).

Our investigation also included population studies in the field, analyses of population samples, cultivation under uniform conditions in a greenhouse, and cytological studies.

MORPHOLOGICAL CHARACTERS AND VARIATION

Fischer (1967) stated that the tetraploid ("*sublobata*") and the hexaploid ("*hederifolia*") cytotypes could be distinguished on a large number of morphological characters, particularly in leaf shape and texture, pedicel length, pubescence of pedicels and sepals, and corolla size and colour. In addition he found statistical differences in the size of pollen grains, stomata, and cell nuclei. The most important macromorphological characters, which according to Fischer serve to distinguish the two cytotypes, are listed below.

4x ("*sublobata*")	6x ("*hederifolia*")
Leaves herbaceous, ± longer than broad; lamina usually 5(—7)-lobed with central lobe mostly somewhat longer than broad, blunt or often rounded at the apex; lateral lobes much narrower, short and often toothlike; interlobular sinus often ± obtuse; youngest leaves more elongate with longer central lobe and distinctly shorter lateral lobes.	*Leaves* subcarnose, slightly shorter to slightly longer than broad; lamina deeply 3—5-lobed with central lobe somewhat broader than long, blunt with a small tip or mucro; interlobular sinus ± acute; youngest leaves more deeply lobed with central lobe scarcely longer than the lateral lobes.
Pedicels (in fruit) 3.5—7 times longer than calyx, with an adaxial hair list of short hairs and ± patent hairs all around, esp. apically.	*Pedicels* (in fruit) 2—4 times longer than calyx, with an adaxial hair list only (and rarely scattered patent hairs all around).
Sepals hairy on the face or glabrous; marginal hairs 0.5—0.9 mm long, weak.	*Sepals* glabrous on the face; marginal hairs 0.9—1.2 mm long, stiff.
Corolla c. 4—6 mm in diam., pale purple to whitish, with c. 16—19 light purple veins.	*Corolla* c. 6—9 mm in diam., light blue with a purplish tinge and a white centre, with c. 20—22 deep blue veins.
Anthers 0.4—0.8 mm long 0.4—0.7 mm wide, faintly blue to pale.	*Anthers* 0.7—1.2 mm long, 0.6—1 mm wide, blue.
Style c. 0.3—0.5 mm long.	*Style* c. 0.7—1.1 mm long.
Seeds c. 2.5 mm long and 2.1 mm wide; margins of orifice distinctly curved inwards.	*Seeds* c. 2.8 mm long and 2.3 mm wide; margins of orifice only slightly curved inwards.

An examination of the characters listed reveals most of them to be of a purely quantitative nature. The herbarium worker as well as the field botanist will also find the overlapping in several characters much greater than is apparent from the above table. As also stressed by FISCHER, many diagnostic characters are subject to considerable modification in nature. The modifiability is so pronounced that "*hederifolia*" in shaded localities becomes in several respects rather similar to "*sublobata*", whereas the latter in exposed situations assumes much the habit of "*hederifolia*". This plasticity very much reduces the practical taxonomic value of the characters of leaf shape, leaf texture, and pedicel length.

In addition there is a pronounced genetic variability in some other diagnostic features, e.g., type and degree of pubescence on the pedicels and sepals, corolla size and colour, and style length. On the whole we have in the Scandinavian material observed greater variation and more overlapping in most morphological characters than reported by FISCHER. Population studies indicate that much of this variation has a genetic background. In some populations the normally most important diagnostic characters may be combined in almost any pattern. One finds individuals, strains, or entire local populations, which deviate from the typical "*hederifolia*" and "*sublobata*" sets of characters in one or several important respects. The transitional specimens are (at least normally) perfectly fertile and occur in often high proportions within the local populations. This situation could have arisen through introgressive hybridization or, more likely, may be the result of a strong variability in combination with autogamy. At any rate, the high proportion of transitional specimens or populations must be taken into account in a taxonomic treatment of the group. We estimated that about 85 % of the available Scandinavian material could be sorted without great difficulties into one of the two taxa. The remainder was too obviously transitional or deviating in one or usually several important characters to be referable with certainty to either taxon.

To illustrate the point a population from Uppsala (province of Uppland, Central Sweden) will be briefly described and discussed. The population, which in nature made a mixed impression, inhabited an ecologically rather uniform area of waste ground in the town. In May 1967 a total of 158 individuals were collected at random in the locality. In a morphological analysis the specimens could be sorted into four categories, two of which showed the character sets typical of "*sublobata*" (A) and "*hederifolia*" (D), respectively. Two other types with

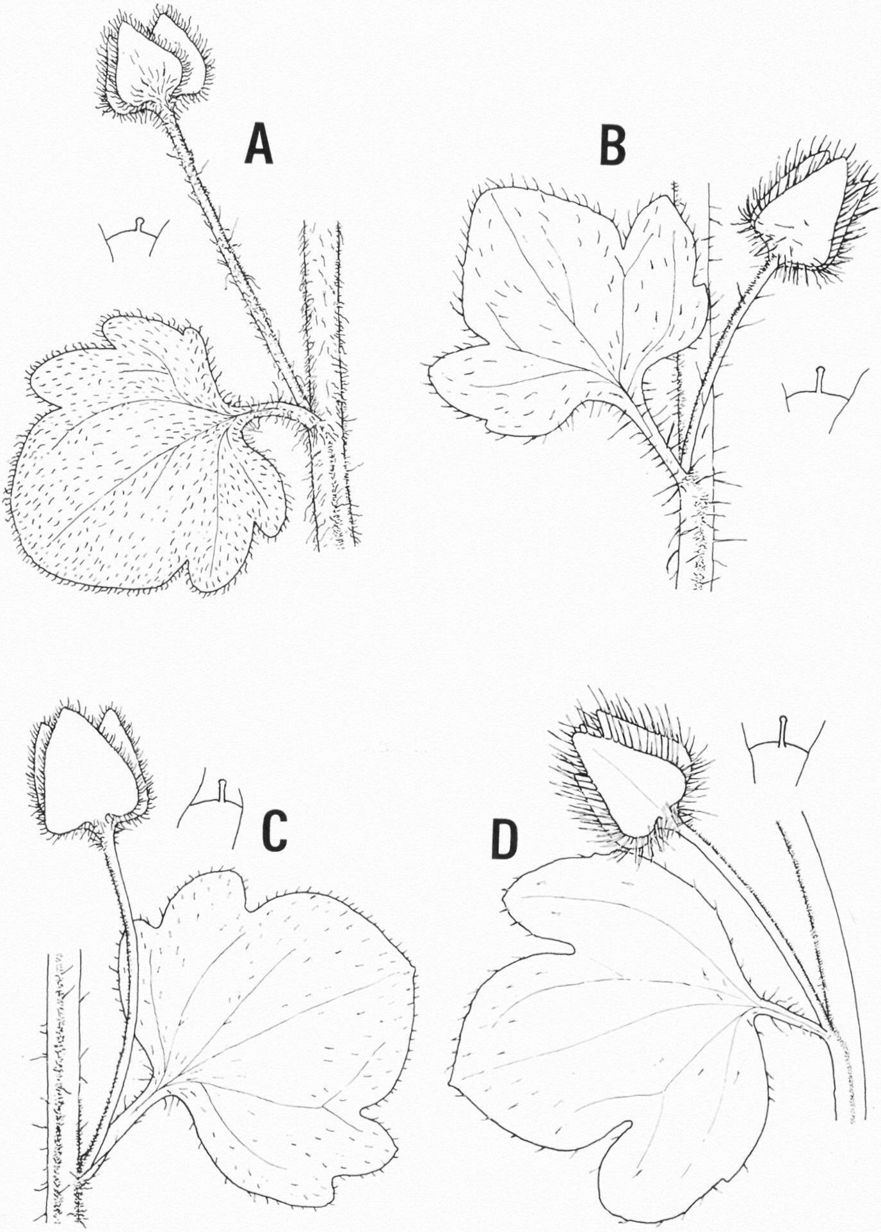


Fig. 1. Four morphological types (A—D) of *Veronica hederifolia* in a mixed population from Uppsala. Style length is illustrated in inserted small figures. — A: typical ssp. *lucorum*. — D: typical ssp. *hederifolia*. Further discussion in the text.

Table 1. Variation within a mixed population of *V. hederifolia* s. lat. from Uppsala (Uppland, Sweden). 5×50 pollen grains, 10 petals, and 40 styles were studied of each type.

	Type A "*sublobata*"	Type B	Type C	Type D "*hederifolia*"
Number of individuals	77	52	24	5
% of total sample	49 %	33 %	15 %	3 %
Pollen grain size (μ)	32(31–33)	36(36–38)	36(33–38)	37(36–40)
Pollen fertility	98 %	96 %	84 %	96 %
Petal length (mm)	2.0(1.8–2.1)	2.6(2.4–2.6)	2.8(2.4–3.0)	2.8(2.6–2.8)
Style length (mm)	0.4(0.3–0.7)	0.7(0.6–1.0)	0.6(0.6–0.8)	1.0(0.7–1.2)
Chromosome number in progeny, 2n (no. of individuals)	18(1) 36(1) 54(1)	54(3)	36(4)	54(1)

different character combinations occurred in considerable quantities (B and C). Typical specimens of the four types are illustrated in Fig. 1, and the variation in some further characters is shown in Table 1.

It is seen that almost half of the Uppsala population consisted of "*sublobata*" (A), whereas only a small fraction was classifiable as typical "*hederifolia*" (D). The remaining specimens, almost 50 % of the total sample, could easily be sorted into two groups (B and C), each with a characteristic combination of characters. Type B combines the leaf-shape and long marginal sepal hairs of "*hederifolia*" with the sepal surface hairs and pale to white flower colour of "*sublobata*", whereas pedicel pubescence, flower size and style length are intermediate or approaching the conditions in "*hederifolia*". Type C has a quite different character combination, viz., "*sublobata*"-like marginal sepal hairs, "*hederifolia*"-like pedicels with an adaxial hair list only and glabrous sepal surfaces, whereas some other characters are intermediate or, like leaf-shape and style length approach the conditions in "*sublobata*".

Progeny of all four types was raised from seeds and grown under uniform conditions in a greenhouse in the Botanical Garden, Lund. Chromosome counts were made on root tip mitoses (paraffin method, fixative a modified Navashin-Karpechenko, stain crystal violet with aniline). Types B and D turned out to be hexaploid (2n=54), types C and A tetraploid (2n=36) with the notable additions of an occasional diploid (2n=18) and a hexaploid (2n=54) in the progeny of type A. The cytologically investigated material is too scanty to allow any defi-

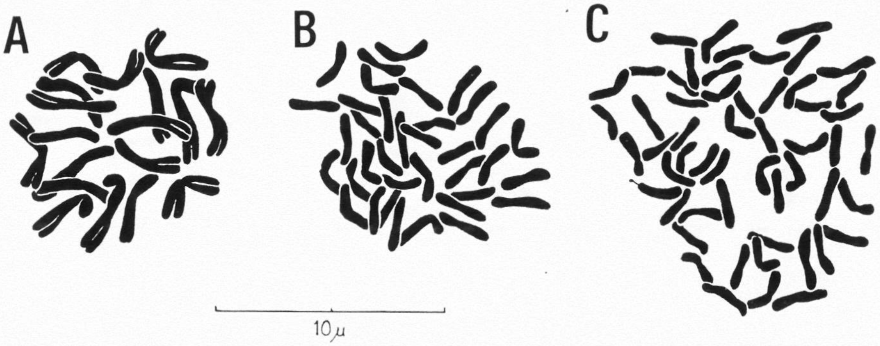


Fig. 2. Somatic metaphase plates illustrating three ploidy levels in the Uppsala population. — A: 2n=18 in a specimen from morphological type A (ssp. *lucorum*). — B: 2n=36, morphological type C. — C: 2n=54, morphological type D (ssp. *hederifolia*). Cf. Fig. 1 and the text.

nite conclusions. The existence of three levels of ploidy within a single morphological type is remarkable, however. This may seem to indicate the occurrence of three cytotypes in Scandinavian *V. hederifolia*. On the other hand, the diploid specimen could be dismissed as an occasional aberration, a single case of deploidization. Another possibility — in sharp contrast to FISCHER's phylogenetic scheme — would be that the tetraploid has originated (perhaps polytopically) recently from a diploid and a hexaploid ancestor and not yet achieved complete genetic stability, its progeny occasionally reverting to the parental ploidy levels.

At any rate, our results contradict the assumption that *V. hederifolia* in Scandinavia is represented by only two cytotypes, each with a constant and characteristic combination of characters. The correlation between morphological character sets and ploidy levels seems to be less close than assumed by FISCHER (1967).

In the field we have observed other examples of deviating character combinations. It seems likely that the deviating strains easily become established in nature through their evidently high fertility and, very likely, autogamy.

The greatest taxonomic difficulties are met with in eastern Sweden, from Kalmar northwards to northern Uppland, and on Öland and Gotland in the Baltic. A list of collections not immediately referable to any of the two taxa recognized is presented in the Appendix, with the hope that it may provide some information and inspiration for future workers in the field. As pointed out above, the possibility that more than two ploidy levels are represented in Scandinavia cannot be wholly excluded, and at any rate the degree of compatibility between the two known cytotypes and the population structure and mode of breeding need further investigation. Among the deviating forms we would especially like to draw attention to a "*sublobata*"-like type with, however, fairly thick and ovate and shallowly lobed leaves which dry black, dense pubescence, narrow sepals, and large blue corollas. This form, which flowers early and seems confined to arable land, has been found in several localities especially in eastern Sweden. It has often reduced seed setting and may be of hybrid origin, but its closer affinities remain obscure. This form has been marked with an asterisk in the Appendix.

CYTOLOGY

Apart from the Uppsala population we have obtained chromosome numbers of a few other Swedish populations. All counts were made on root tip mitoses (cf. above).

2n=18. — Uppland: Uppsala. (A single specimen in population discussed in the preceding paragraph.)

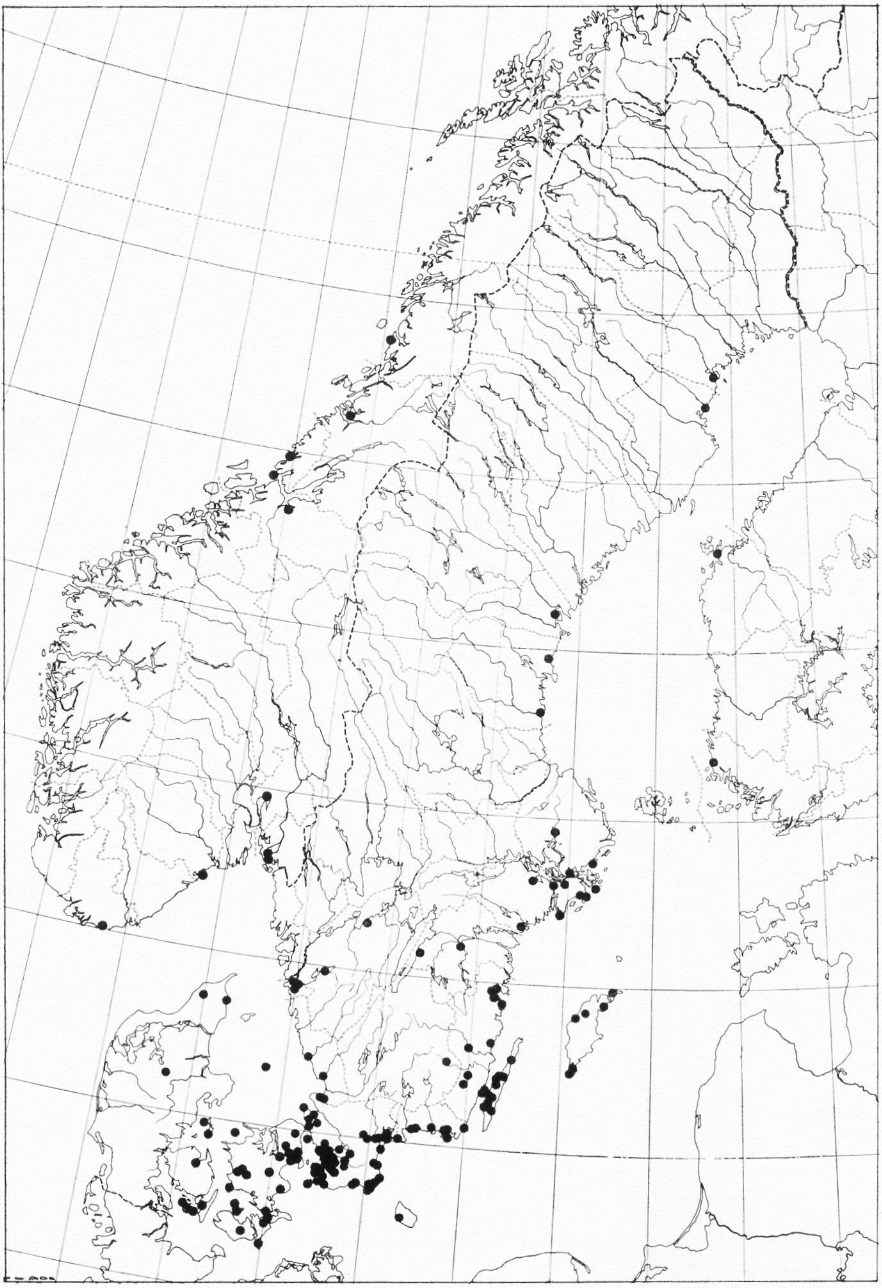
2n=36. — Scania: Botanical Garden, Lund (spont.); L. Sigridsgatan, Lund; Börringe. — Uppland: Uppsala.

2n=54. — Scania: Ö. Grevie. — Uppland: Uppsala.

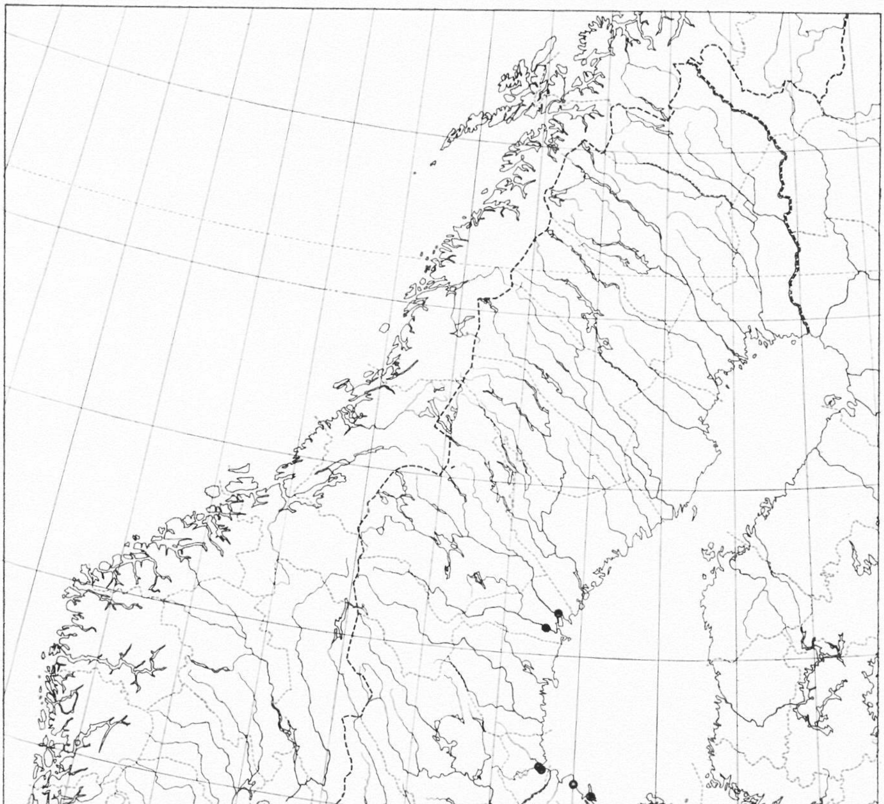
THE TAXONOMIC RANK OF THE SCANDINAVIAN CYTOTYPES

A taxon more or less corresponding to the tetraploid cytotype was distinguished on an infraspecific level by several earlier authors and assigned different ranks. For a selected synonymy, see Fischer (1967). In Scandinavian floras and herbaria the epithets f. *umbrosa* Lüb. ex Neuman (1901) and var. *umbrosa* H. Mort. ex Lange (1864) have been applied to typical forms from groves, woods and other shaded localities. It should be noted, however, that Mortensen's original material is heterogeneous, only one collection having the tetraploid's typical set of characters [Denmark, Jonstrup Vang, 1863, H. Mortensen, (C)].

Our study has led us to the belief that the Scandinavian races cannot be upheld as species. The considerable amount of material not readily classifiable as either of the two taxa and the random combination of the main diagnostic characters met with in many populations speak



Map 1. Scandinavian distribution of *Veronica hederifolia* ssp. *hederifolia*.



Map 2. Scandinavian distribution of *Veronica hederifolia* ssp. *lucorum*.

against a separation on the species level. In extreme cases a proper determination is impossible without knowledge of the chromosome number. The same difficulty has been expressed also by DE JONGH (1968). On the other hand, the readiness with which the majority of the material can be sorted in two groups and the likelihood of a (at least partial) genetic barrier between the two ploidal levels are points in favour of a taxonomic distinction. With the information available we find the rank of subspecies most appropriate. Subspecific rank is also adopted in the new edition of HEGI (HARTL 1968).

The earliest legitimate subspecific epithet is β *lucorum* KLETT & RICHTER (1830). The rank has later been interpreted as subspecies (FISCHER 1967 in syn., HARTL 1968), and this interpretation must be followed according to Article 35 of the International Code of Botanical Nomenclature. This leaves us with the following two taxa in Scandinavia:

V. hederifolia L. ssp. *hederifolia*
„ ssp. *lucorum* KLETT & RICHTER (syn. *V. sublobata* M. FISCHER)

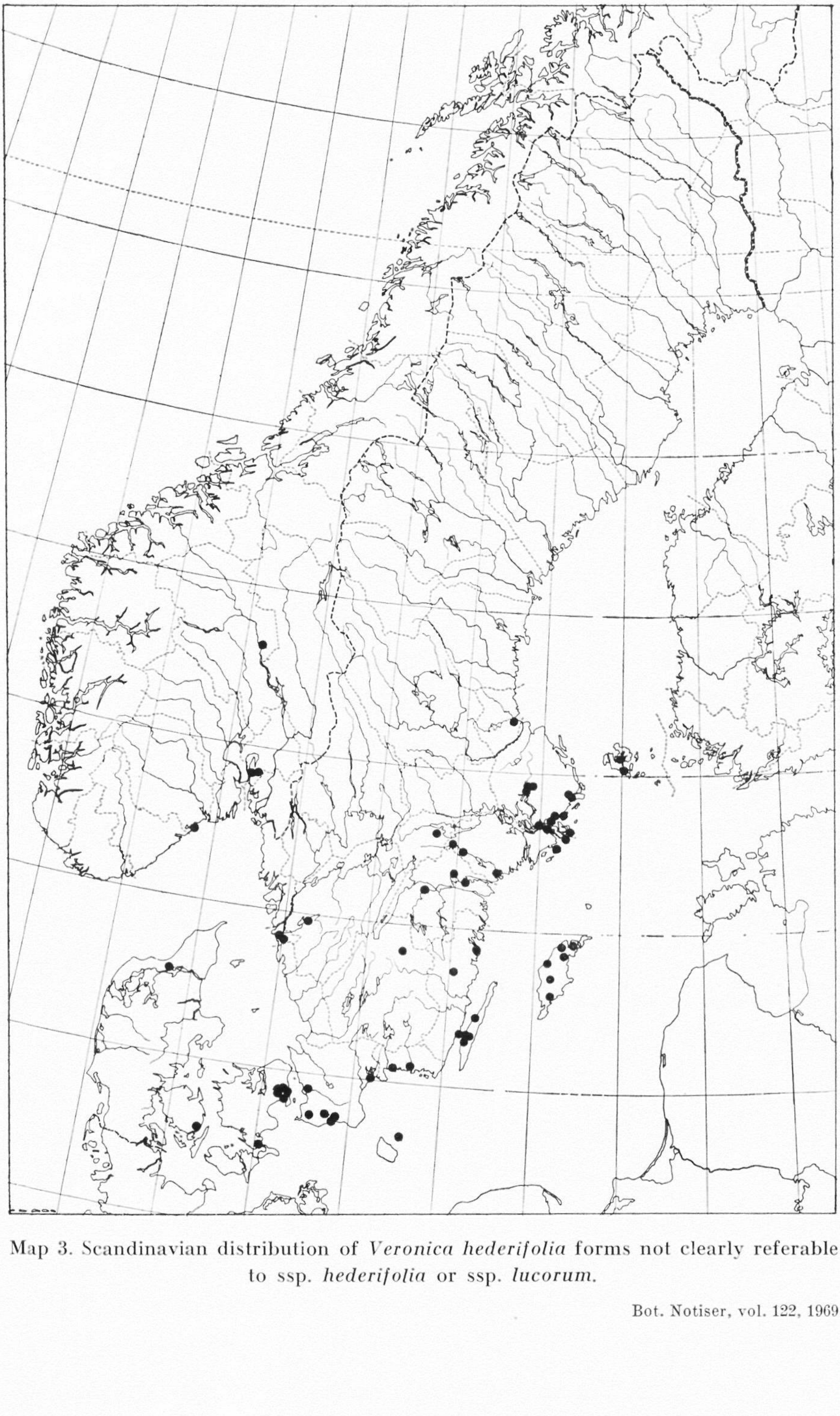
It has recently been suggested (BRUMMITT & CHATER 1967) that names published without a clear indication of rank should not be taken into account for purposes of priority. Should this amendment to Article 35 be adopted by a future International Congress, the first valid publication of the taxon concerned with a clear indication of subspecific rank ought to be adopted, dating from the same publication. Under the present Code, however, we feel obliged to back-date the publication of ssp. *lucorum* to KLETT & RICHTER 1830.

DISTRIBUTION AND ECOLOGY

Ssp. *hederifolia* (Map 1). This subspecies ranges in Sweden from Scania northwards to Uppland and with scattered localities further north to above the 65th latitude. The taxon is most common in Scania, Blekinge and on Öland but is generally less frequent than ssp. *lucorum*. In Central South Sweden the subspecies is rare, and on the whole it shows a preference for the coastal districts. On Gotland it is comparatively rare, however, considering the rich occurrences on Öland.

In Denmark the subspecies is rare in Jutland but widespread on the isles. In Norway and Finland there are only occasional and mostly ephemeral occurrences, mainly on ballast.

Ssp. *hederifolia* grows on cultivated fields, roadsides, in gardens,



Map 3. Scandinavian distribution of *Veronica hederifolia* forms not clearly referable to ssp. *hederifolia* or ssp. *lucorum*.

and other disturbed habitats. Especially on its outpost localities it is more or less adventitious and often ephemeral.

Ssp. *lucorum* (Map 2). This subspecies is on the whole somewhat more frequent in Scandinavia. The Swedish distribution ranges from Scania to Gästrikland, with two outpost localities (adventitious) in Medelpad. The subspecies is especially frequent in Scania, on Gotland, and in the lowland areas of Central Sweden, e.g. in Södermanland and Uppland. In Halland and the poor highlands of Central South Sweden it is rare.

In Denmark the subspecies is most frequent on Zealand and more scattered on the other isles and in Jutland. In Norway it is confined to the southernmost coastal districts. The taxon is not as yet recorded from the mainland of Finland but fairly frequent on the islands of Åland.

Ssp. *lucorum* has a wider ecological amplitude than ssp. *hederifolia*. The two subspecies grow in similar habitats and often together, but ssp. *lucorum* is in addition very common in deciduous woods, groves, thickets and hedges, and other shaded habitats with not too poor edaphic conditions. Especially in the more natural biotopes the taxon seems to be of a more pronounced indigenous character than ssp. *hederifolia*, or at least a more stable component in the vegetation.

The material not classifiable into subspecies (Map 3) is scattered over the total distribution area but mainly concentrated to southeastern Sweden. Especially on Gotland the conditions are complicated, and the more or less intermediate forms seem to be equally or even more frequent than typical ssp. *hederifolia*. Whereas some of the "intermediate" collections from other parts of the distribution area could perhaps be dismissed as extreme modifications or occasional hybrids, this is certainly not the case in southeastern Sweden, where the taxonomic pattern seems more complex (cf. p. 238).

SUMMARY AND CONCLUSIONS

FISCHER's (1967) study of the *Veronica hederifolia* group started with a cytological analysis revealing the existence of different ploidy levels (2x, 4x, 6x). He proceeded to search for morphological characters distinguishing the cytotypes. His findings led him to distinguish five taxa, which he gave the rank of species.

Our approach has been somewhat reverse. We tested the morphological diagnostic characters supposed to distinguish "*hederifolia*" and "*sublobata*" on a large herbarium material from Scandinavia. Most of the material could be referred to one of these taxa, but an embarrassingly large amount could not be classified with certainty on morphological criteria alone. In the field we experienced that most populations could be classified without difficulties, but some showed marked deviations from the typical character combinations. An extreme case is the Uppsala population, which could be sorted into four morphological groups, representing two or perhaps three levels of ploidy.

To sum up we may conclude that *Veronica hederifolia* in Scandinavia is represented by at least two widespread cytotypes (4x and 6x), which are in most but not all cases distinguishable on a combination of morphological characters. The most reliable characters are length of marginal sepal hairs, leaf-shape, and the ratio pedicel length/petiole length. Less reliable characters are type of pedicel pubescence, style length, and corolla size and colour. The diagnostic value of each single character is much reduced by high plasticity and/or genetic variability. Our findings speak strongly against a taxonomic distinction on the species level, and we favour a treatment of the two cytotypes as subspecies.

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APPENDIX

List of collections not referable to either of the subspecies (Map 3). The type marked by an asterisk is mentioned on p. 239.

Other symbols: h=mixed with ssp. *hederifolia*
l= „ „ ssp. *lucorum*
BN=leg. B. Nordenstam
ÖN=leg. Ö. Nilsson

Denmark. Jutland: Öster Hanherred, Oxholm, Öland, 1905, P. Petersen (C)*; Fyn: Skovmöllen v. Skårupsör, 1878, E. Rostrup (C); Sjælland: Viemose Skov, 1901, Warming (C); Furesöens nordside, 1896, H. Mortensen (C); Hops Old Skov, 1879, C. Jensen (C); Kalvebod, 1965, K. Andersen (C); Söndersöens nordskrænt, 1860, H. Mortensen (C); Charlottenlund, 1894, H. Mortensen (S, UPS); Bornholm: Christiansö, Kongens Have, 1962, A. Stork (S).

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Faroe Islands (outside the map). Strömø, Thorshavn, 1867, ROSTRUP (C); Strömø (C); Thorshavn (C).

Ecology of Heavy Metals – a Regional and Historical Study

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ABSTRACT

Samples of *Hypnum cupressiforme,* collected during 1968—69 in north-eastern Götaland, the low-land areas and the ridge areas of Skåne (southern Sweden) have been analysed for Pb, Zn, Cu, Ni, and Cr. The concentration of these metals were significantly lower in the north-eastern area than in the areas of Skåne, particularly in Pb, Ni, and Cr. Between the two areas in Skåne differences were only established for Pb and Cu, with the largest concentrations in the humid ridge areas. The differences in the concentrations of these heavy metals between north-eastern Götaland and Skåne will be explained by the geographical position with respect to the large industrial regions of Europe.

Samples of the same species, collected in Skåne 1870—1943 have also been analysed. Significant increases during the decades around 1900 were demonstrated for Cu and Zn. In the concentrations of Ni a rapid rise has occurred since about 1920, when this metal was introduced in the world production. The content of Ni in the samples from 1969 is more than twice as large as in the samples collected before 1920. The historical trends in the concentrations of Pb have earlier been demonstrated (RÜHLING & TYLER 1968 a). There is little doubt that the rise in the concentrations of these metals is an effect of a larger air-borne supply, originating from human activity.

INTRODUCTION

The present paper is a continuation of a previous study (RÜHLING & TYLER 1968 a, in the following abbreviated RT). In this study a distinct regional decrease towards the north-east in southern and central Sweden was established as to lead concentration of three different mosses. Particularly large concentrations were measured in the most humid parts of south-western Götaland, indicating that a considerable part of the lead which is brought down by the rain, at least in this area, originates from areas outside Sweden.

The aims of the present paper is to measure the local, regional and

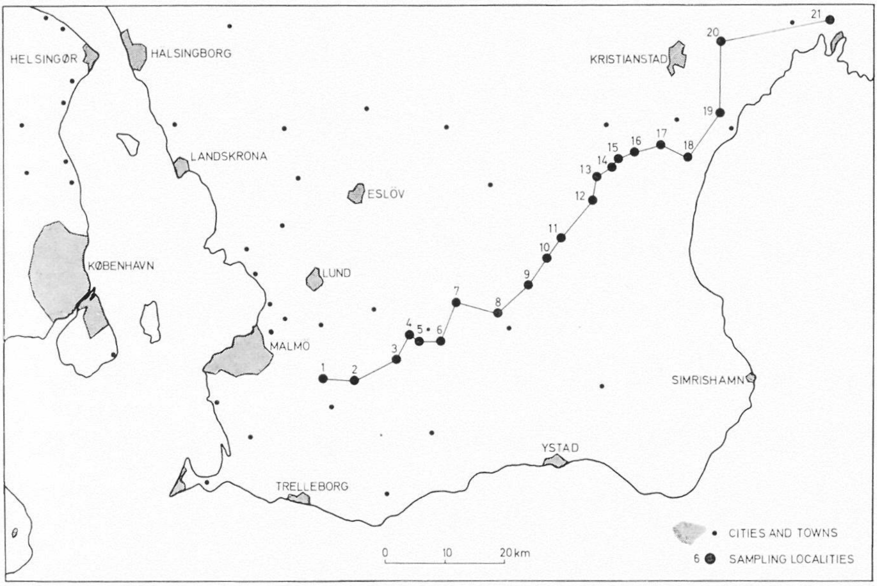

Fig. 1. Sampling localities in the transect across Skåne.

historical differences in the concentrations of certain heavy metals, as they are reflected in a common moss species.

MATERIALS AND METHODS

As the material of this study the moss *Hypnum cupressiforme* was chosen. In 21 localities, situated more than 300 m from roads along a SW—NE transect across Skåne (cf. Fig. 1), three separate samples were collected on each locality in February 1969 and analysed. For comparison samples from Östergötland and adjacent areas, as well as from Denmark (Sjælland) and the very humid south-western slopes of Sydsvenska Höglandet, collected in 1968 and previously analysed for lead (cf. RT) were analysed for other heavy metals (Zn, Cu, Ni, Cr, and Co). The same elements were also determined in a historical material from Skåne, collected in 1870—1943. The analyses were performed by atomic absorption spectrophotometry (cf. RT). The metal concentrations of the samples are always calculated as ppm dry matter. Statistical calculations have been performed according to Snedecor (1961).

THE TRANSECT ACROSS SKÅNE

The position of the 21 localities along the transect line is illustrated in Figs. 1 and 2, cf. also Table 1. The transect is drawn from the low-land plain

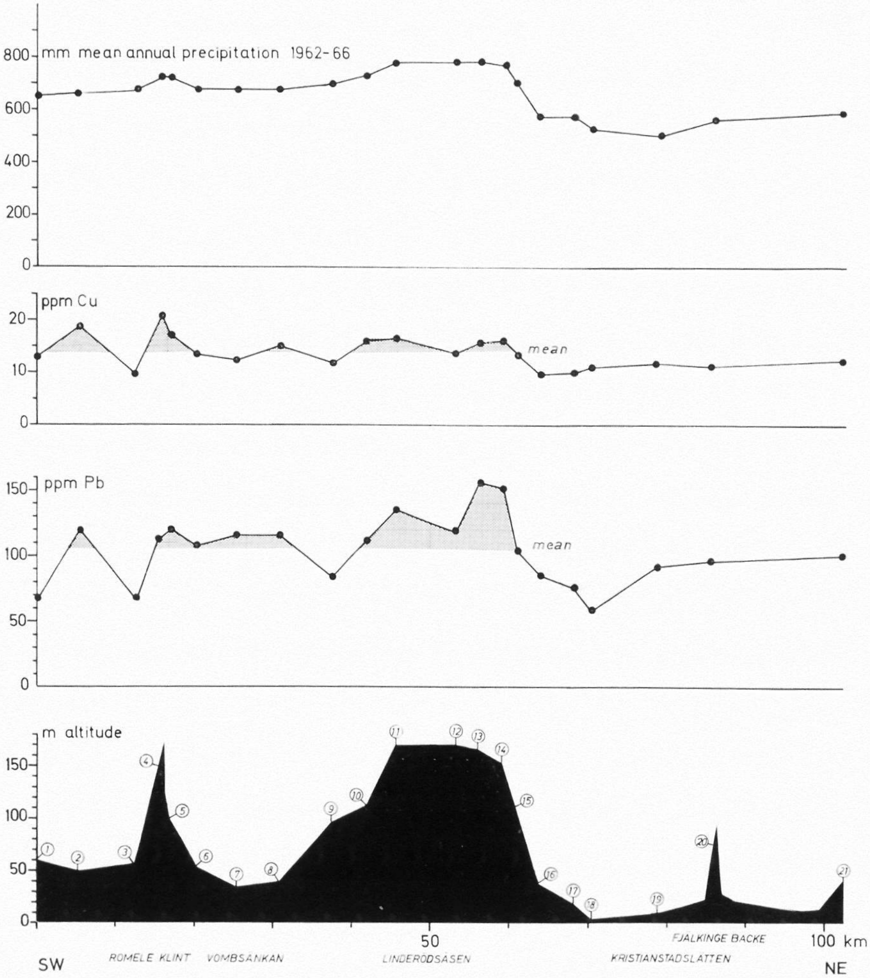

Fig. 2. The transect across Skåne. Mean annual precipitation, concentration of Cu and Pb in *Hypnum cupressiforme* and elevation above sea-level of the sampling points (1—21).

E Malmö (localities 1—3), across the ridge of Romeleåsen (4—5), the plain of Vombsänkan (6—9), the ridge of Linderödsåsen (10—15) and the plain of Kristianstadslätten (16—21). Consequently, widely different soils are represented, and the humidity is considerably higher on the ridges than in the low-land areas. The bedrock of the ridges (localities 4—5, 10—15), is predominantly igneous Archaean gneiss and the soils are more or less podzolised Archaean moraines poor in calcium. The mean annual precipitation is distinctly higher than on the adjacent plains. The plains are developed on

Table 1. The concentration of heavy metals in *Hypnum cupressiforme* from the southwest—northeastern transect across Skåne. Median values (n=3), calculated as ppm dry matter.

Locality / Element	Pb	Cu	Zn	Ni	Cr	Co
1. Torup, 4.5 km S Bara ch.	68	12.7	99	11.3	6.5	1.5
2. Ekholmssjön, 4.5 km SE Hyby ch.	120	19.2	126	13.3	9.5	1.3
3. Häckeberga, 2 km SSE Genarp	67	9.8	102	8.6	5.5	1.7
4. 300 m SW Romeleklint, 3.5 km SW Veberöd	112	21.2	149	12.5	9.7	1.2
5. 0.5 km SSW Husagård, 3 km SSW Veberöd	120	17.0	112	8.8	7.5	1.3
6. Skogmöllan, 3.5 km SE Veberöd	107	13.5	135	10.2	7.5	2.7
7. 1 km ESE Vomb ch.	116	12.5	93	7.8	5.8	1.3
8. 1.3 km NW S Åsum ch.	116	15.0	102	8.6	9.8	2.5
9. 0.5 km W Vollsjö ch.	83	11.8	115	9.2	14.0	3.0
10. 1.5 km N Fränninge ch.	112	16.3	107	7.6	6.5	1.6
11. 2.5 km SSE Långaröd ch.	136	16.6	148	7.7	5.6	1.5
12. 3.0 km SW Huaröd ch.	117	13.9	98	9.8	8.0	2.8
13. 2.5 km NW Huaröd ch.	156	15.8	101	9.4	7.7	1.9
14. 2.2 km SW Ö. Sönnarslöv ch.	151	16.4	100	11.8	6.2	1.4
15. 1.1 km SW Ö. Sönnarslöv ch.	103	13.7	100	8.3	8.2	1.6
16. 2 km SW Everöd ch.	85	9.8	93	8.6	8.6	1.2
17. 2.5 km E Everöd ch.	76	10.1	88	6.5	5.5	1.0
18. 4 km NNE Vittskövle ch.	57	11.2	90	9.9	8.9	2.4
19. Horna, 3 km NNW Åhus	92	11.7	99	7.4	7.5	1.3
20. Fjälkinge backe, 2 km N Fjälkinge ch.	95	11.4	108	6.8	8.1	1.0
21. 2.5 km NNE Valje	100	12.5	119	6.7	5.3	1.3

Cretaceous rocks, chiefly limestone (localities 1—3, 6—8, 16—19), Silurian slate (9) or Archaean rocks (20—21). The low-land soils are variable, in the south-west (localities 1—3) rather clayey moraines but otherwise mostly glacio-fluvial sands, on Kristianstadslätten partly very calcareous.

The mean annual precipitation for the period 1962—66, calculated from SMHI (1964—1968) is between 700—800 mm on the ridges, 600—700 mm on the south-western plain and in Vombsänkan, and 500—550 mm on Kristianstadslätten (cf. Fig. 2, where the altitude of the localities is also given).

The results of the analyses are compiled in Table 1 as the medians from each locality. Any significant differences between the ridges and the low-land areas have only been established with Pb and Cu. The lead concentration ranges between 103—156 ppm (mean 124) on the ridges, and 57—100 ppm (mean 87) on Kristianstadslätten, corresponding to the precipitation of 725—775 mm and 500—590 mm, respectively. The values for the south-western plain and Vombsänkan are intermediate both in lead and in mean annual precipitation. A quite similar trend may be demonstrated for Cu (cf. Fig. 2). The copper concentration on the ridges averages 16.3 ppm, on the plains 12.4 ppm.

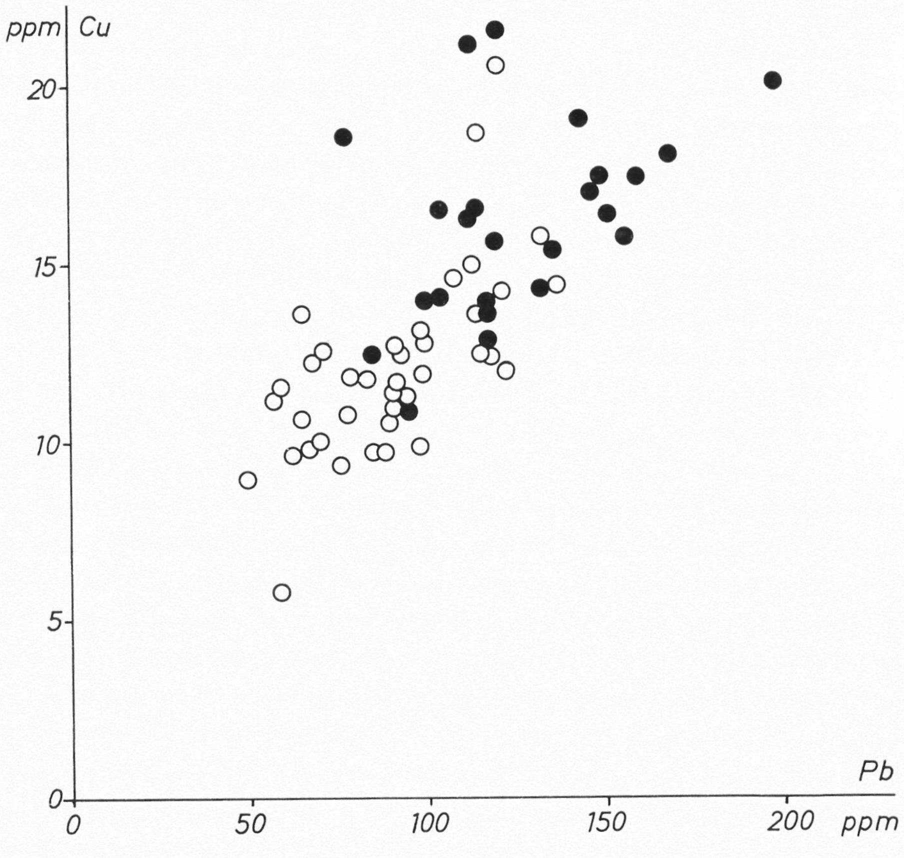

Fig. 3. Correlation between Pb and Cu in the samples of the transect across Skåne. Open circles = low-land areas, filled circles = ridge areas.

The correlation between Pb and Cu is evident from Fig. 2 and illustrated in Fig. 3. The coefficients of correlation between the concentrations of the metals have been compiled in the following table.

	Pb	Zn	Cu	Ni
Zn	0.29	—	—	—
Cu	0.49	0.56	—	—
Ni	0.29	0.33	0.61	—
Cr	0.29	0.16	0.24	0.45

Rather good positive correlations were obtained between Cu and Ni, Cu and Zn, as well as between Cu and Pb.

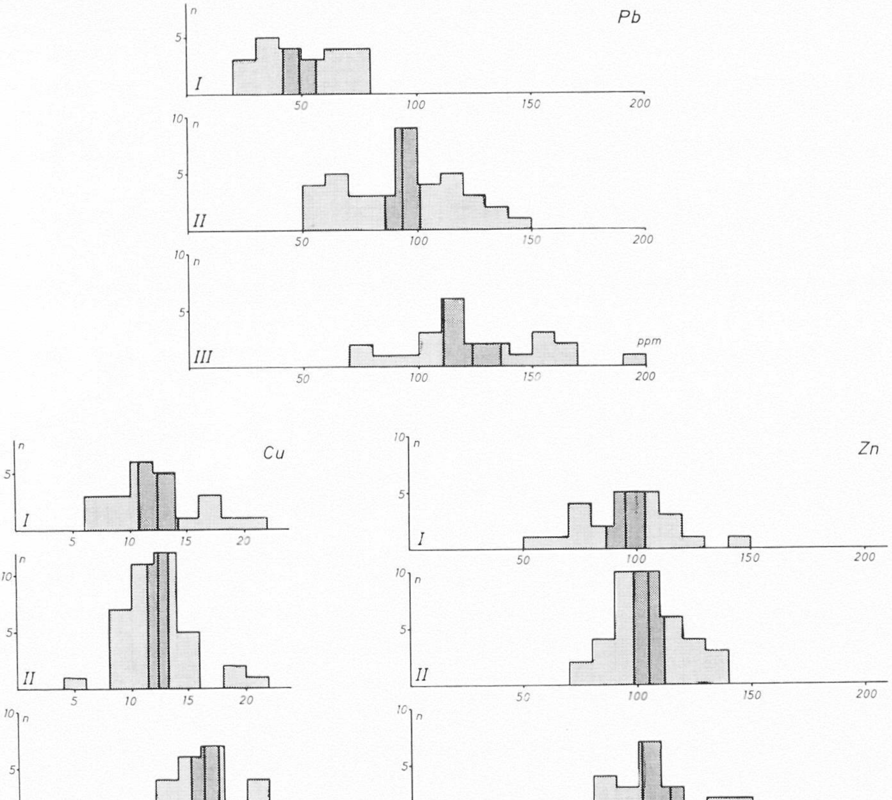

Fig. 4. The distribution of metal concentrations (ppm dry matter) in samples from 1968—69. I=Östergötland and adjacent areas, II=Skåne, low-land areas, III=Skåne, ridge areas. Means and limits of means, probability 95 %, are indicated.

Table 2. Statistical calculations on the regional differences in 1968—69. Means (ppm) and significance of the differences between the means. Area I=Östergötland and adjacent areas, II=Skåne, low-land areas, III=Skåne, ridge areas. Level of significance: *=$p < 0.05$, **=$p < 0.01$, ***=$p < 0.001$.

Area	Means, ppm			t-values and levels of significance		
	I	II	III	I—II	I—III	II—III
Pb ……	49	93	124	*** 8.49	*** 10.4	*** 4.10
Cu ……	12.4	12.4	16.3	0.00	*** 3.94	*** 5.36
Zn ……	95	105	114	* 2.21	* 2.64	1.38
Ni ……	6.1	8.8	9.6	*** 4.33	*** 5.40	0.17
Cr ……	4.5	7.9	7.9	*** 4.74	*** 5.30	0.00

REGIONAL COMPARISONS

23 samples of *Hypnum cupressiforme* from different parts of Östergötland and adjacent areas have also been analysed for heavy metals. This group is designated I in Fig. 4. For comparison the samples from the transect across Skåne have been divided into two groups, one group (II) comprising the low-land plains (localities 1—3, 6—9, 16—21) and one group (III) comprising the ridge areas (localities 4—5, 10—15). Statistical calculations have been compiled in Table 2.

Significant differences (***) between the means of lead were recorded for all areas, with the lowest mean (49 ppm) from the north-eastern area, the highest mean from the humid ridge areas in Skåne (124 ppm) and with the mean of the low-land areas of Skåne in an intermediate position (93 ppm). Also for Ni and Cr the means of the north-eastern area are significantly lower than the corresponding means of the two areas in Skåne but no differences exist between the latter. The copper means of the north-eastern area and the low-land area are identical (12.4 ppm), whereas the mean of the ridge area is significantly higher (16.3 ppm). The observed differences in the means of Zn are not fully secured.

In general the concentrations of these metals are highest on the ridges in Skåne, lowest in the north-eastern area. In this area Zn takes the largest share of the metals analysed, but on the humid ridges Zn is surpassed by Pb. As a comparison, a few samples from Denmark (Sjælland) and Halland have also been analysed. The samples from Sjælland are higher in Pb and Cu than the samples from the corre-

Table 3. Statistical calculations on the historical changes. Means (ppm) and significance of the differences between the means (cf. Table 2).

	Means, ppm				t-values and levels of significance			
	1870/99	1900/19	1920/43	1969	1870/99—1900/19	1900/19—1920/43	1920/43—1969	1870/99—1969
Cu	10.2	13.0	13.5	13.9	1.73	0.30	0.30	* 2.74
Zn	66	94	103	109	* 2.23	0.70	0.71	*** 5.49
Ni	4.0	3.7	5.5	9.1	0.55	** 4.12	*** 10.2	*** 10.7
Cr	5.8	5.5	6.5	7.7	0.27	1.15	1.36	1.74

sponding low-land areas in Skåne, but no differences were measured in Zn, Ni and Cr. The four samples from the very humid Halland area are very high in Pb (mean 164 ppm), rather high in Cu (15.7 ppm), but the concentrations of Zn, Ni and Cr are similar to the north-eastern area.

MEASUREMENTS OF HISTORICAL CHANGES

In previous papers (RÜHLING & TYLER 1968 a, 1968 b, 1969) changes in the lead concentrations of mosses during the last 100 years have been recorded and discussed. In order to establish if any changes in other heavy metals have occurred during this period, we have also analysed samples of *Hypnum cupressiforme,* collected in Skåne 1870—1943. This historical material has arbitrarily been divided into three groups: 1870—99 (n=15), 1900—19 (n=15) and 1920—43 (n=13). As a fourth group the figures in Table 1 from the transect across Skåne in 1969 (n=21) have been used. The means and the significance of the differences between the means of the periods have been compiled in Table 3.

The copper concentrations increase between the periods 1870—99 and 1900—19, whereas no changes have been measured in the 20th century (Fig. 5). A large increase in the concentrations of Zn has occurred since the 19th century, chiefly confined to the decades around 1900. For Ni and Cr any corresponding change between the first and the second period has not been measured. Between 1900—19 and 1920—43 there is a rise in the concentrations of Ni and the figures from 1969 indicate that this rise has continued and accelerated. In the case of Cr the apparent increase of the means and the medians is not statistically significant, partly owing to two aberrant values in period 1870—99

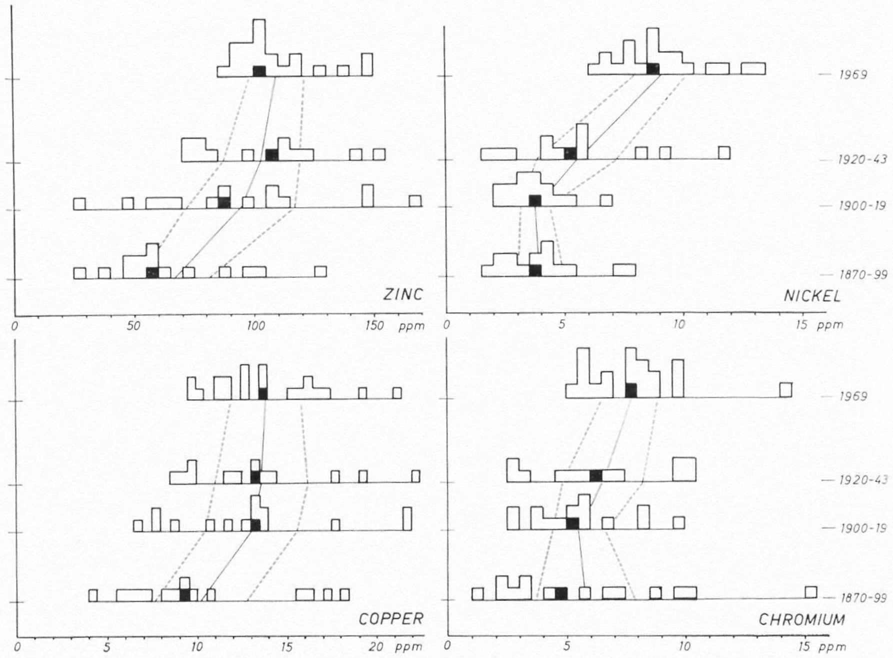

Fig. 5. Changes in the concentrations of Zn, Cu, Ni, and Cr in samples from Skåne during the last century. The entire curve connects the means and the broken curve the limits of the means, probability 95 %. The position of the medians are indicated by the black symbols, the number of samples in each class by the height of the columns.

and 1969, respectively. But half of the values from 1870—99 are below the lowest value from 1969 (cf. Fig. 5).

DISCUSSION

As distinguished from vascular plants, mosses have little or no possibilities to utilize minerals directly from the ground. The minerals must be collected either through a concentration of the minerals in the precipitation or supplied as dust (cf., e.g., Tamm 1953, Svensson & Lidén 1965). Through the action of mineral or organic acids the elementary constituents of the dust particles may be released and absorbed by the moss carpet. The share of metals supplied as dust or as dry deposition will be larger in the vicinity of the source. The indirect influence of the substrate cannot be neglected, because the main part of the dust originates from the close vicinity. However, the local mineral substrate seems to be less important as a source of the metals included in this study than the supply from the atmosphere. The deposition of dust particles, originating from eolic erosion, must be larger in the low-land areas than on the ridges in Skåne. If this deposition were of any importance to the supply and accumulation of these minor metals by the mosses, the low-land areas would exhibit the largest concentrations, but this is not the case with any of the metals.

The recent acidification of the precipitation (cf. ERIKSSON & ODÉN in Miljövårdsforskning 1967, ODÉN 1968) could theoretically have increased the weathering and the release of minerals from the dust particles, deposited in the moss carpets. But as no change in the concentrations of Cu and Zn has been demonstrated during the 20th century, the large recent increases in Pb and Ni cannot be due to increased weathering. A substantial increment in the supply of Ni and Pb from the atmosphere, originating from human activities must be the obvious reason.

The soils of north-eastern Götaland and the ridge areas of Skåne are both predominantly Archaean moraines. Nevertheless, the concentrations of all minor metals are considerably lower in the north-eastern area (cf. Fig. 4). The single probable reason for these differences must be a corresponding difference in the atmospheric supply of these metals.

The very considerable rise in the lead concentrations, recorded since about 1950, can be connected to a very special source of pollution — the lead petrol — which does not apply to other metals. But a recent increase has been established for Ni, first recognized as the difference in the means of the periods 1900—19 and 1920—43, and the increase has accelerated between 1920—43 and 1969. This trend is correlated with the world production of Ni, which was negligible before 1920 — less than 0.01 million tons a year, corresponding to 0.36 million tons in 1966 (Statistisk Årsbok för Sverige 1920—1968).

The rise observed in the nickel concentration of mosses will be the effect of industrial losses. The differences in the contents of Ni between north-eastern Götaland and the low-land areas of Skåne (cf. Fig. 4) will be explained by the geographical position with respect to the large industrial regions of Europe. But unlike lead, no difference in Ni between the low-land and the ridge areas of Skåne has been observed. Evidently, a larger precipitation will not achieve any increase in the case of Ni. Will this indicate that a large share of this metal, transported as atmospheric pollution, is supplied as dry deposition and therefore more uniformly distributed between the ridge and the low-land areas?

For Zn and Cu an increase has been established between the periods 1870—99 and 1900—19, but not later. However, it is very probable that this rise may have started already before the first period (as previously demonstrated for Pb; cf. Fig. 8 in RT), but sufficient material from earlier days was not available. The rise in zinc concentration is considerable, amounting to about 30 ppm between the first two periods, whereas the corresponding figures for Cu is only about 3 ppm. The production of these metals did not differ substantially, but the probable reason for this much larger supply of Zn will be the greater volatility of this metal. Metallurgic processes as well as the increased combustion of coal may both have been of importance as sources of pollution. During the 20th century more refined processes may have reduced the relative emission, balancing the increases in the production of the metals and keeping the total emission on a more constant level.

CONCLUSIONS

Significant differences in the recent concentrations of Pb, Cu, Zn, Ni, and Cr in *Hypnum cupressiforme* have been established between north-eastern Götaland and the ridge areas as well as the low-land areas of Skåne, the only exception being Cu between the north-eastern area and the low-land areas. Between the two areas in Skåne significant differences exist in Pb and Cu, but not in the other metals. Where differences have been demonstrated, the highest means occur in the ridge areas of Skåne, the lowest means in north-eastern Götaland.

Significant increases during the last century have been established for Cu, Zn and Ni, as previously for Pb. The rise in the concentrations of Ni has been very marked during the last decades and corresponds to the introduction of this metal in the world production. For Zn and Cu there has also been an increase in the concentrations, considerable in the case of Zn, but chiefly confined to the decades around 1900. There is little doubt that the rise in the concentrations of these metals is an effect of a larger air-borne supply, originating from industrial activity.

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Dinkel und Hirse aus der Bronzezeit Südschwedens nebst einigen Bemerkungen über ihre spätere Geschichte in Schweden

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ABSTRACT

Several impressions of spelt (*Triticum spelta* L.) and millet (*Panicum miliaceum* L.) were found in pot sherds and other clay material from the younger Bronze Age of Scania. The former species is previously not at all, the latter only incompletely known from the Bronze Age of Sweden. An impression of barnyard millet, *Echinochloa crus-galli* (L.) Beauv., was further observed in pottery from the Roman Iron Age of Scania, and numerous grains of *Panicum miliaceum* were found in contexts of early Mediaeval time in Lund. Thus it is unquestionable that spelt and millet were cultivated in Sweden in the younger Bronze Age, and it is not impossible that a cultivation of the one or the other millet species took place in Sweden during the mentioned later periods — which both had a more favourable climate than the present one.

Bei neuerdings angestellten Ausgrabungen einer Siedlung aus der jüngeren Bronzezeit bei Bromölla in Schonen, von R. Petré, Historisches Museum der Universität Lund, vorgenommen, wurde ein reiches Material von Keramikscherben und Tonstücken angetroffen, die hinsichtlich des Vorkommens von Getreideabdrücken untersucht wurden. Es stellte sich dann heraus, dass hier verschiedene Abdrücke der beiden Getreidearten Dinkel und Hirse vorkamen, die früher gar nicht oder sehr fragmentarisch aus der Bronzezeit Schwedens bekannt sind.

Die Abdrücke von Dinkel, *Triticum spelta* L., kamen hauptsächlich in Tonstücken vor; besonders reichlich waren sie in Tonstücken, die von einer Wand stammten (als Å 82 bezeichnet) und die auch im übrigen reich an Getreideabdrücken waren; offenbar war Stroh mit damit folgenden Ährenfragmenten in den Ton hineingemischt worden. Die Abdrücke waren im allgemeinen von den Basalpartien der Ährchen oder der Hüllspelzen (Fig. 1 A—E) gebildet worden. Die darunter sitzenden Ährenglieder traten niemals in den Abdrücken hervor, aber ganz vereinzelt wurde ein Abdruck eines neben dem Ährchen sitzenden

Gliedes beobachtet (Fig. 1 A), das zu dem nächsthöheren Ährchen gehörte, also die für Dinkel typische Artikulation. Im übrigen waren die Abdrücke an der breiten und queren Basis kenntlich, an den längs verlaufenden Streifen der Hüllspelzen und dem ebenen, abgerundeten Umriss, ohne die scharfen Ecken, die für Emmer und Einkorn kennzeichnend sind; die Hüllspelzen hatten eine stumpfe Kante mit ca. 90° Winkel zwischen den Oberflächen beiderseits davon, und ihre Breite war grösser als bei Emmer und Einkorn. Im Vergleich mit jetzigem, in guter Erde angebautem Dinkel waren die Ährchen klein und erinnerten am meisten an die kleinen Ährchen, die im Gipfel der Ähren vorzukommen pflegen. In einem Falle kam auch ein Abdruck vor, der wahrscheinlich von einem Dinkelkorn gebildet worden war. Der Abdruck zeigte die Dorsalseite eines Korns, 6 mm lang und ca. 2.3 mm breit, mit dicker Spitze versehen. Die Form konnte sowohl auf Dinkel als auf Emmer deuten; da der Keim aber sehr deutlich hervortrat und die Dorsalseite offenbar nicht so hochgewölbt wie bei Emmer war, handelt es sich wahrscheinlich um einen Dinkelabdruck.

Wenn von dem letzterwähnten, etwas fraglichen Abdruck abgesehen wird, waren die Dinkel-Abdrücke, die im Ton aus Bromölla angetroffen wurden, 32 an der Zahl, was 17 % der ganzen Anzahl von Getreideabdrücken entspricht. Die Gerste, Spelz- und Nacktgerste, war wie gewöhnlich in dieser Periode die dominierende Getreideart. Die übrigen speltoiden Weizen, Einkorn und Emmer, waren spärlich vertreten, wie auch Weizen und Hafer, und der Dinkel hatte nach der Gerste die zweithöchste Frequenz.

Der Dinkel ist nicht früher für die Bronzezeit Schwedens belegt. Aus der älteren Eisenzeit und dem Beginn der jüngeren liegen indessen mehrere Funde vor, teils von Abdrücken, teils von verkohlten Körnern. Besonders gute Abdrücke gibt es aus Bohuslän, Völkerwanderungszeit, welche u. a. die charakteristischen, grossen, an der einen Seite konkaven Ährenglieder zeigen (HJELMQVIST 1955 S. 99—100, Fig. 16 G—H). Einzelne Abdrücke liegen auch aus Schonen, Östergötland und Uppland vor, alle aus römischer Eisenzeit (a.a.O.). Verkohlte Körner und Ährenfragmente sind in Östergötland angetroffen worden, aus der Völkerwanderungszeit (HJELMQVIST 1960) und verkohlte Körner auf Gotland bei Vallhagar, aus einem frühen Teil derselben Periode (HELBÆK 1955).

Auch aus mittel-neolithischer Zeit liegt ein Abdruck aus Östergötland, Fagervik vor, der nicht anders als ein Dinkelabdruck gedeutet werden konnte (HJELMQVIST 1955). Wegen des isolierten Vorkommens ist dieser Fund zuweilen als unsicher betrachtet worden; durch die neuen bronzezeitlichen Funde wird diese Isoliertheit etwas vermindert.

Während der Dinkel früher für die Bronzezeit Schwedens unbekannt war, gibt es verschiedene Funde aus dieser Periode in anderen europäischen Ländern. Unfern von dem Fundort in Schonen ist ein bronzezeitlicher Fund in Dänemark, Voldtofte auf Fyn, gemacht (HELBÆK 1952 a), während ein zweites Vorkommen, bei Birknæs in Jütland, von mehr unsicherem Alter ist (es scheint nicht ganz unmöglich, dass es zur jüngeren Steinzeit gehört). Weitere bronzezeitliche Funde sind nach der Zusammenstellung von SCHULTZE-MOTEL und KRUSE (1965) 2 Funde aus Norditalien (der eine vielleicht eisenzeitlich), 5 aus der Schweiz, 1 aus Südwest-Deutschland, 1 aus England. Auch für neolithische Zeit ist der Dinkel festgestellt worden; die erwähnten Verfasser geben 2 Funde in Südwest-Deutschland und wenigstens 2 in Polen an, und viele Funde von eisenzeitlichem Alter sind gemacht worden, in Deutschland, Polen, Dänemark und England.

Die prähistorischen schwedischen Funde schliessen sich also gut an das Auftreten des Dinkels im übrigen Europa in früheren Epochen an.

Die Geschichte des Dinkels in späterer Zeit in Schweden ist teilweise in Dunkel gehüllt. Es gibt zwar einige zerstreute Angaben über „Spelt, Spialt“ usw.; man hat aber nicht immer Emmer, Einkorn und Dinkel von einander unterschieden, und es ist oft schwierig zu sagen, ob die Angaben den Dinkel betreffen oder sich auf die anderen Getreidearten beziehen. Bei einigen Verfassern, MENTZER (1727), LINNÉ (1764) und RETZIUS (1809) wird jedoch, nach der Beschreibung oder den Namen zu urteilen, wirklich der Dinkel — oder wenigstens teilweise diese Getreideart — gemeint. Er wird auch als türkischer oder ägyptischer Hafer bezeichnet, und gemeinsam für alle Verfasser ist, dass sie ihn als ein seltenes Getreide betrachten. Indessen ist noch in spätester Zeit eine offenbar nicht so beschränkte Kultur auf Gotland vorgekommen. Anbau von Dinkel in Reinkultur soll dort angeblich so spät als am Anfang des 20. Jahrhunderts vorgekommen sein, und noch immer tritt er in Weizenäckern als Einmischung auf, als ein Überbleibsel früherer Kultur (HJELMQVIST 1966).

Aus der Bromölla-Siedlung stammen auch einige Abdrücke von Rispenhirse, *Panicum miliaceum* L. Sie kamen alle in Topfscherben vor, während in den Tonstücken keine solche Abdrücke zu finden waren. Die meisten der Abdrücke waren von der charakteristischen Ventralseite gebildet und waren ausser an Grösse und allgemeiner Form besonders kenntlich an der typischen, längs der Kante laufenden Linie,

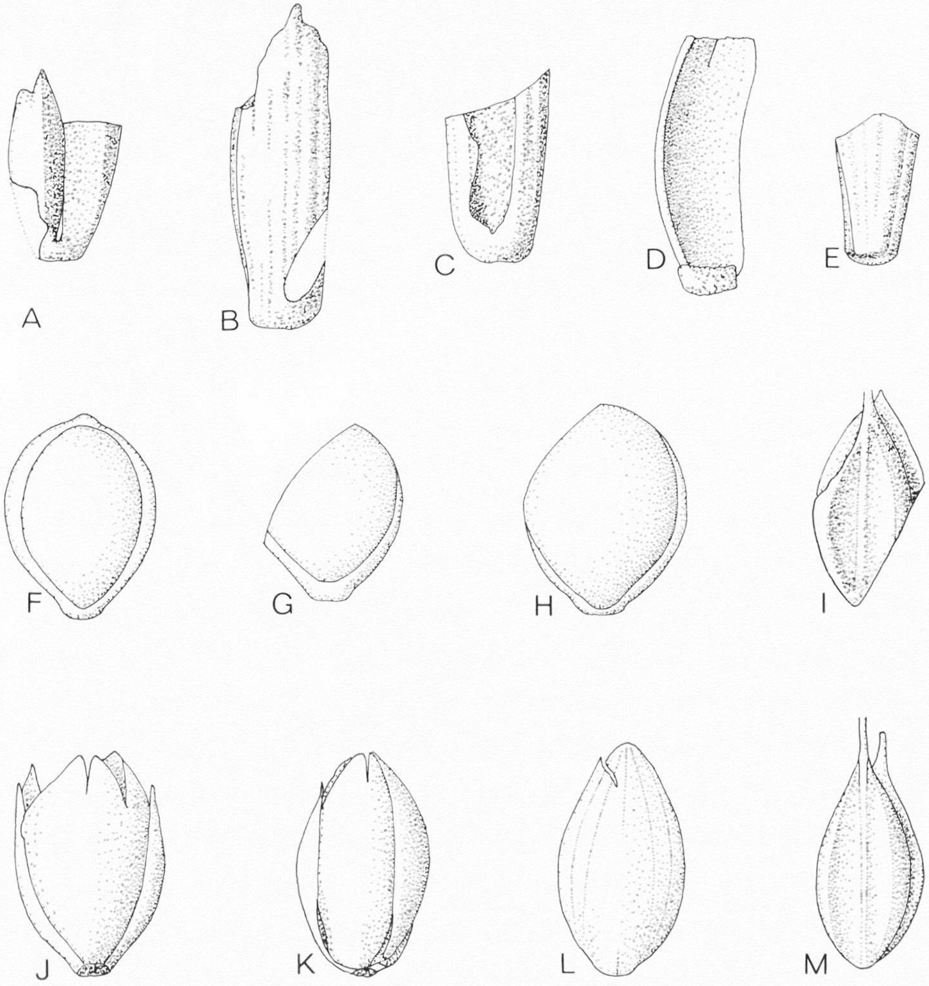

Fig. 1. A—J Abdrücke von einigen Getreidearten. — A—E. Dinkel, *Triticum spelta*, in Tonstücken aus der Bronzezeit, Bromölla, Schonen. — A. Ährchenbasis mit Ährenglied daneben. — B, C, E. Basalpartien von Ährchen. — D. Unterer Teil einer Hüllspelze von der Innenseite. — F—H. Rispenhirse, *Panicum miliaceum*, in bronzezeitlichen Keramikscherben von Bromölla. — I. Hühnerhirse, *Echinochloa crus-galli*, aus römischer Eisenzeit, Valleberga: Tygapil. — J—L. Rispenhirse, Ährchen aus dem älteren Mittelalter von Lund. — M. *Echinochloa crus-galli*, rezentes Ährchen, zum Vergleich mit Fig. 1 I. — Die Abdrücke sind nach Plastilina-Abklatschen gezeichnet. Vergrösserung A—E ×5, F—M ×10.

die den Rand der Deckspelze bezeichnet, welche die Vorspelze darunder umschliesst (Fig. 1 F—H). 6 solche Abdrücke wurden festgestellt, während zwei andere von den Dorsalseiten gebildet waren, die keine derartigen speziellen Merkmale haben, aber an der breit eirunden Form und der ebenen Oberfläche erkannt wurden; wenigstens in dem einen Falle trat auch im Abdrucke ein wenig von der Bauchseite hervor mit den erwähnten Spelzrändern. Die Grösse der Abdrücke war dieselbe wie bei kleinen rezenten Hirsekörnern; wenn die Abdrücke vollständig waren, war die Länge 2.5—2.8 mm, die Breite 1.8—2.2 mm.

Ein Abdruck war ferner von zwei von einander getrennten Spelzen gebildet, von ähnlicher Grösse wie die erwähnten Körner; möglicherweise repräsentierte er ein leeres Ährchen von Hirse, aber dies ist etwas unsicher.

Es war also ein relativ unerhebliches Prozent der Bromölla-Abdrücke, das von Hirse gebildet worden war; die 8 sicheren Abdrücke machen etwas über 4 % der ganzen Zahl von Getreideabdrücken aus. Der Fund überflügelt indessen beträchtlich die früheren prähistorischen Hirsefunde in Schweden. Früher sind in der Tat nur 2 als Hirse bestimmte Abdrücke bekannt, der eine aus Schonen: Barsebäck, der andere aus Uppland, beide aus der jüngeren Bronzezeit (Hjelmqvist 1955). In beiden Fällen ist die charakteristische Ventralseite nicht sichtbar, sondern die Bestimmung gründet sich auf die allgemeine Form und Grösse, in dem einen Falle auch auf Abdrücke von Rispenzweigen oder Grannen neben dem Kornabdruck. Dies macht, dass die beiden früheren Angaben nicht so sicher wie die neu hinzugekommenen sind.

Nebenbei sei bemerkt, dass Sarauw in seiner kleinen präliminaren Schrift (1899) Hirse für die jüngere Steinzeit Schwedens angab. In einer brieflichen Mitteilung (Sernander 1908 S. 217) hat Sarauw jedoch selbst diese Bestimmung als unsicher zurückgenommen. Eine unsichere Vermutung von Hirseabdrücken aus Ö. Vrå in Södermanland, frühneolithischer Zeit, liegt auch bei Schiemann (1958) vor; sie konnte jedoch nicht bestätigt werden.

Aus späterer Zeit sind indessen ein paar Funde von Hirse in Schweden gemacht worden, die auch eine andere Art als die gewöhnliche Rispenhirse umfassen.

Der eine von diesen Funden stammt aus Schonen, Valleberga: Tygapil und wird zur römischen Eisenzeit gezählt (Ausgrabung von M. Strömberg, Hist. Museum der Universität Lund, 1968). In einer kleinen Topfscherbe kam hier ein scharfer und deutlicher Abdruck eines

Grasährchens vor, wenn auch etwas unvollständig in den Kanten (Fig. 1 I). In Grösse stimmte er mit den Hirsen überein, aber durch die aufwärts sich verengenden und spitzen Spelzen wich er von der Rispenhirse ab und stimmt auch nicht mit den *Setaria*-Arten überein. Hingegen ist die Übereinstimmung gut mit der Hühnerhirse, *Echinochloa crus-galli* BEAUV. (=*Panicum crus-galli* L.), wie durch einen Vergleich mit einem kleinen rezenten Ährchen dieser Art gezeigt wird (Fig. 1 M). Die vorn sichtbare Spelze entspricht ganz der Deckspelze der unteren (sterilen) Blüte (auch als die dritte Hüllspelze bezeichnet) und endigt wie diese in einer kräftigen Granne. Die zweite, dahinter sichtbare Spelze ist die obere der beiden eigentlichen Hüllspelzen — die untere, ganz kleine tritt nicht hervor — und hat eine kurze Spitze, wie bei dieser gewöhnlich ist. Die erstere Spelze ist flach oder etwas konkav, hat eine Längsrippe in der Mitte und zwei abgerundete, ziemlich breite Kanten, stimmt also wohl mit *Echinochloa* überein. Dicht neben dem Ährchenabdruck kam auch ein Abdruck einer dünnen, langen Granne oder eines Rispenzweiges vor und in derselben Scherbe ein ebener, kurz eirunder Abdruck, ca. 2 mm lang, mit stark gewölbter Oberfläche und einer schwach hervortretenden Kante, der von einer *Echinochloa*-Frucht gebildet sein kann, obwohl bindende Beweise in diesem Fall — wie betreffs der Grannen- oder Zweigabdrücke — fehlen.

Wenigstens ein Abdruck ist indessen mit Sicherheit von der Hühnerhirse gebildet worden, und dann stellt sich die Frage auf, ob dies bedeutet, dass die Art angebaut worden ist. In späterer Zeit ist die Hühnerhirse in Europa nur als Unkraut vorgekommen, und es ist ja möglich, dass dies in der römischen Eisenzeit von Skåne auch der Fall gewesen ist. Indessen zeigen ein paar Funde aus Dänemark, Jütland, dass die Art dort in einer Zeit benutzt wurde, die wahrscheinlich zu derselben Periode als der Abdruck von Valleberga gehört (HELBÆK 1954). Es ist darum wohl anzunehmen, dass wenn die Hühnerhirse zusammen mit der Rispenhirse oder anderen Getreidearten vorgekommen ist, sie zusammen mit diesen benutzt wurde. Es ist also nicht unmöglich, dass die Art in der römischen Eisenzeit in Skåne eine — absichtlich oder unabsichtlich — angebaute Kulturpflanze war.

Bei neuerdings (1964) in Lund angestellten Ausgrabungen wurden ferner mehrere Hirsefrüchte in Lagern aus dem 11. bis 13. Jahrhundert (nach schwedischer Zeitrechnung zum älteren Mittelalter gehörend) angetroffen. Sie waren leer oder hatten einen eingeschrumpften Kernrest, und die Spelzen waren mehr oder weniger beschädigt, oft aufgeritzt oder zerfallen (Fig. 1 J—L). Die charakteristischen glatten, rundlichen Spelzen, von denen die eine mit den Rändern die andere umschliesst, machten jedoch, dass sie leicht als *Panicum miliaceum* bestimmt werden konnten. Sie gehörten zu drei verschiedenen Funden eines grösseren Bauplatzes (Stadtviertel St. Botulf, Kulturhist. Mus. Nr. 57135), und die Anzahl war in einer Probe, vom 11.—12. Jahrhundert, 153 grössere Körner und 207 kleinere Fragmente, in einer anderen, vom 12.—13. Jahrhundert, 10 grössere Körner und 6 Fragmente, in der dritten, vom 12. Jahrhundert, nur 2 kleine Fragmente.

In diesem Fall ist es natürlich nicht sicher, dass die Hirse tatsächlich am Orte angebaut gewesen ist; es ist möglich, dass sie von auswärts eingeführt ist. Offenbar hat jedoch die Hirse im Mittelalter eine nicht geringe Bedeutung in Schweden gehabt (vgl. z.B. das Erwähnen im Calendarium Oeconomicum vom Bischof HANS BRASK am Ende der Periode), und es ist darum wohl nicht unmöglich, dass wenigstens ein begrenzter Anbau stattgefunden ist, wenn die Möglichkeit dazu vorhanden war. Ein Name im Grundbuch von Skåne aus dem 16. Jahrhundert (LJUNGGREN & EJDER 1950 S. 367): *hirritze backenn* (ungefähr=der Hirsehügel) deutet wohl darauf, dass ein Anbau im Mittelalter vorgekommen ist.

Die bis jetzt vorliegenden Funde von Hirse in Schweden aus älterer Zeit sind also von geringer Anzahl und gehören zu voneinander getrennten Perioden. *Panicum miliaceum* ist aus der jüngeren Bronzezeit und aus dem älteren Mittelalter, *Echinochloa crus-galli* aus der römischen Eisenzeit bekannt. Wenn man mit den Angaben aus anderen Gebieten vergleicht, findet man dort ein weit reichlicheres Fundmaterial.

Die vorgeschichtliche Verbreitung der Rispenhirse in Europa und Vorderasien ist von mehreren Verfassern geschildert worden (besonders sei auf die Darstellungen von NETOLITZKY 1914 und BERTSCH und BERTSCH 1947 verwiesen). Aus neolithischer Zeit liegen Funde vor aus Vorderasien, Thera in Persien (NEUWEILER 1905) und Jemdt Nasr in Mesopotamien (HELBÆK 1959 a), und ferner nach NETOLITZKY aus der Ukraine, den Donau-Ländern, der Schweiz, Deutschland und Frankreich. Dazu kommen Funde aus der Steinzeit Polens (KLICHOWSKA 1967). In Deutschland tritt die Hirse schon in der bandkeramischen Kultur auf (ROTHMALER und NATHO 1957), ist aber hier ungewöhnlicher; allgemeiner scheint sie erst in der Bronzezeit zu werden. In mehreren Fällen bestehen die Funde aus mehr oder weniger ungemischter Hirse, was auf einen Anbau als Monokultur deutet. Nach

HELBÆK (1959 b) gibt es viele Funde aus Holland aus der Bronzezeit, und die Anzahl nimmt in der Eisenzeit zu; in Nord- und Nordwest-Deutschland sind die Funde jedoch spärlich aus älterer Zeit und können teilweise auf Einfuhr zurückzuführen sein (KÖRBER-GROHNE 1967). Auf den Britischen Inseln fehlen ältere Funde von Hirse ganz. In Dänemark ist die Hirse wie in Schweden seit der Bronzezeit bekannt. Der früheste Nachweis in Dänemark von prähistorischem Getreide (ROSTRUP 1877) war in der Tat ein Fund von Hirse und Weizen auf Lolland, aus der Bronzezeit. Dazu schliessen sich spätere Funde von Abdrücken an, zusammen 8 aus der jüngeren Bronzezeit (=2 % der sämtlichen Getreideabdrücke) und 2 aus der keltischen Eisenzeit, 6 % der Gesamtzahl entsprechend (JESSEN 1951). Ein später gemachter Fund, aus Bornholm, stammt wahrscheinlich aus der älteren Bronzezeit (HELBÆK 1952 b), einige weitere Funde gehören zu den ersten Jahrhunderten unserer Zeitrechnung (HELBÆK 1959 b). Auch aus dem Mittelalter gibt es Funde von Hirse in Dänemark; in älteren Schichten innerhalb Kopenhagens wurde Hirse an vier Orten angetroffen (ROSTRUP in ROSENKJÆR 1906), und drei von diesen Funden gehören nach JESSEN und LIND (1922—23 S. 22) mit Sicherheit zum Mittelalter und zwar zu seinem älteren Teil.

In früherer historischer Zeit hat die Hirse eine grosse Bedeutung in Mitteleuropa gehabt und ist besonders eine wichtige Nahrungspflanze für die ärmere Bevölkerung gewesen; es wird angegeben (NEUWEILER 1905), dass sie erst im 16. und 17. Jahrhundert zurückgedrängt wurde, wobei die Einführung der Kartoffel in Kultur mitgespielt hat. Später ist sie noch mehr, teilweise durch den allgemeineren Reisgebrauch, zurückgegangen (TEMPÍR 1961).

Während die Rispenhirse, *Panicum miliaceum*, also in den prähistorischen und frühgeschichtlichen Funden reich vertreten ist, kommt die Hühnerhirse, *Echinochloa crus-galli*, dort seltener vor. NETOLITZKY (1914) war sogar der Ansicht, dass sie erst in später historischer Zeit in Europa eingedrungen war. Es gibt jedoch eine ältere Angabe über prähistorisches Vorkommen der Art, bei Lengyel in Ungarn (DEININGER 1890), wo einige hundert Körner angetroffen wurden; dieser Fund ist nach moderner Auffassung bronzezeitlich-eisenzeitlich (HARTYÁNYI, NOVÁKI & PATAY 1968). Einige weitere Funde sind in späterer Zeit hinzugekommen, und zwar zwei Funde im Rheinlande, zur linienbandkeramischen Kultur gehörend, und ein Fund daselbst aus römischer Zeit (KNÖRZER 1967, 1968), ferner, wie oben erwähnt, zwei Funde in Dänemark, beide in sog. Moorenleichen angetroffen und wahrscheinlich aus älterer römischer Zeit (Helbæk 1954) und ein Fund aus dem Mittelalter Polens, 11.—12. Jahrhundert (Wieserowa 1967). Die beiden bandkeramischen Funde im Rheinlande sind unter Umständen angetroffen, die nach dem Bearbeiter darauf hindeuten, dass die Körner zu Nahrungszwecken bestimmt waren; in dem polnischen Funde war die Art in geringer Menge, zusammen mit der etwas gewöhnlicheren Rispenhirse, als Einmischung in Weizen und Roggen vorhanden.

Die Hirsen sind nahrungs- und wärmefordernde Getreidearten, und es heisst von der Rispenhirse, dass sie nur im Gebiet der Weinrebe einen reichen Ertrag ergibt. Es ist darum erklärlich, dass die Hirsearten in Schweden nie von grosser Bedeutung als Ackerpflanzen gewesen sind und nur im Anbau vorgekommen sind, wenn das Klima günstig gewesen ist. Mit voller Sicherheit ist die Rispenhirse in der jüngeren Bronzezeit angebaut gewesen, die ja zur subborealen Wärmezeit gehörte und durch ein erheblich wärmeres Klima als die Jetztzeit gekennzeichnet war. Es ist möglich, aber nicht ganz sicher, dass die Hühnerhirse in der römischen Eisenzeit angebaut wurde, und dass das Vorkommen der Rispenhirse im älteren Mittelalter auch mit einer Kultur im Zusammenhang steht. Mit Sicherheit kann wohl nichts darüber gesagt werden, aber es ist ein eigentümliches Zusammentreffen, dass eben diese beiden Perioden auch von einer höheren Sommertemperatur als die der Jetztzeit ausgezeichnet waren (Berglund 1968 SS. 34, 49), und mit Rücksicht auf die Klimaverhältnisse dürfte es also nicht undenkbar sein, dass ein Anbau — von der einen oder anderen Hirseart — in diesen Perioden wie in der Bronzezeit vorgekommen ist.

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Chromosome Numbers in Iberian Angiosperms

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ABSTRACT

Somatic chromosome numbers of 65 taxa of vascular plants mainly from southern Spain are reported. 17 of these have not been cytologically investigated previously. The chromosome numbers of five taxa deviate from those reported by earlier authors.

New records for the Spanish flora are *Cerastium brachypetalum* ssp. *roeseri* and *Spergularia echinosperma*.

MATERIAL AND METHODS

The material studied was collected in southern Spain, partly by the authors during a botanical tour in May 1967, and partly by Mr. JOHN KRAFT in Dec. 1967. Mr. KRAFT's collections originate from the Malaga District, and one collection from North Africa (Tanger) is also included in the present study.

Plants were raised from seeds in greenhouses in the Botanical Garden, Lund. The chromosome counts were made on sectioned root tips, treated according to the paraffin method (fixative: the Svalöv modification of Navashin-Karpechenko; stain: crystal violet). The drawings were made with the aid of a camera lucida.

RESULTS

The somatic chromosome numbers obtained are presented in the table below. New counts are marked with an asterisk. Voucher specimens are preserved in the Botanical Museum, Lund (LD). The designation "Sp" refers to material collected by the authors and "JK" to collections by Mr. KRAFT.

In the right column of the table are cited all previously published chromosome numbers of the different species.

Taxon	Voucher	Origin	2n	Previous counts and references
POLYGONACEAE				
Polygonum maritimum L.	Sp 6	Malaga: Torróx, c. 50 m s.m.	20	20 D & W 1955; Styles 1962
CARYOPHYLLACEAE				
Cerastium brachypetalum Pers. ssp. *roeseri* (Boiss. & Heldr.) Nyman	Sp 59	Granada: Western part of Sierra Nevada, c. 2500 m s.m.	52	52, 90 D & W 1955
Petrorhagia nanteuilii (Burnat) P. W. Ball & Heywood	Sp 79	Granada: Láchar, c. 500 m s.m.	60	60 Ball 1964
Silene gallica L.	Sp 47	Cadiz: 9 km NE of Tarifa, c. 300 m s.m.	24	24 Blackburn & Morton 1957
**Silene laeta* (Ait.) Godron	Sp 100	Same locality	24 (Fig. 1 A)	
**Spergularia echinosperma* Čelak.	Sp 62	Cadiz: Puerto Real	36	
**Spergularia echinosperma* Čelak.	Sp 74	Same locality	36	
**Spergularia marina* (L.) Griseb. s. lat.	Sp 65	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	18	36 D & W 1955; Löve & Löve 1956; Blackburn & Morton 1957; Skalińska et al. 1961; Ratter 1964
Spergularia media (L.) C. Presl	Sp 64	Cadiz: Puerto Real	18	18 D & W 1955; Blackburn & Morton 1957; Monnier 1962; Hair 1963; Ratter 1964 36 D & W 1955; Blackburn & Morton 1957
CHENOPODIACEAE				
Chenopodium ambrosioides L.	JK 6	Malaga: Fuengirola	32	16 D & W 1955; Mehra & Malik 1963 32 Woroschilov 1942; D & W 1955; Raghavan & Arora 1958 36, 48, 64 D & W 1955
AMARANTHACEAE				
**Amaranthus blitoides* S. Wats.	JK 4	Malaga: Fuengirola	32 (Fig. 1 B)	
RANUNCULACEAE				
Nigella damascena L.	Sp 8	Malaga: Torróx, c. 50 m s.m.	12	12 D & W 1955; Kurita 1956, 1959;

					BHATTACHARYYA 1958; KAPOOR 1966; MOUTSCHEN-DAHMEN et al. 1966
**Ranunculus trilobus* DESF.	Sp	77	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	32	42, 48 D & W 1955
PAPAVERACEAE					
**Fumaria agraria* LAG.	Sp	13	Cadiz: Vejer de la Frontera, c. 100 m s.m.	c. 80	56 D & W 1955
CRUCIFERAE					
**Alyssum minutum* SCHLECHT. ex DC.	Sp	52	Granada: Western part of Sierra Nevada, c. 2500 m s.m.	16 (Fig. 1 C)	
**Alyssum minutum* SCHLECHT. ex DC.	Sp	86	Same locality	16	
Capsella bursa-pastoris L.	JK	15	Malaga: Fuengirola	32	16 EASTERLY 1963 32 D & W 1955; LÖVE & LÖVE 1956; MULLIGAN 1957; BÖCHER & LARSEN 1958; EASTERLY 1963; RAJ 1967
Diplotaxis catholica (L.) DC.	JK	12	Africa, Tanger: Tanger	18	18 D & W 1955
Lobularia maritima (L.) DESV.	Sp	12	Cadiz: Vejer de la Frontera, c. 100 m s.m.	24	24 D & W 1955; LARSEN 1955; BONNET 1963; CATARINO 1965; GADELLA et al. 1966
Malcolmia littorea (L.) R. BR.	JK	10	Malaga: Marbella	20	20 D & W 1955
” ”	Sp	31	Cadiz: 6 km S of Cadiz	20	
Nasturtium officinale R. BR.	Sp	49	Cadiz: 9 km NE of Tarifa, c. 300 m s.m.	32	32 D & W 1955; RAJ 1965 14 EASTERLY 1963
LEGUMINOSAE					
**Lotus preslii* TEN.	Sp	60	Cadiz: Puerto Real	12 (Fig. 1 D)	
Medicago littoralis RHODE ex LOISEL.	Sp	73	Granada: Western part of Sierra Nevada, c. 1130 m s.m.	16	16 D & W 1955; HEYN 1956; SIMON & SIMON 1965
**Ononis natrix* L. ssp. *natrix*	JK	8	Malaga: Marbella	64	32 D & W 1955
**Ononis pendula* DESF.	Sp	94	Cadiz: 6 km S of Cadiz	32 (Fig. 1 E)	
EUPHORBIACEAE					
Euphorbia paralias L.	Sp	5	Same locality	16	16 D & W 1955
Euphorbia peplus L.	JK	2	Malaga: Fuengirola	16	16 D & W 1955; GADELLA & KLIPHUIS 1963

Taxon	Voucher	Origin	2n	Previous counts and references
Euphorbia pubescens VAHL	JK 3	Malaga: Fuengirola	14	14, 16 D & W 1955
POLYGALACEAE				
**Polygala rupestris* POURRET	Sp 72	Granada: Western part of Sierra Nevada, c. 1300 m s.m.	28	
THYMELAEACEAE				
**Daphne gnidium* L.	JK 29	Malaga: Fuengirola	18 (Fig. 1 F)	
VIOLACEAE				
Viola parvula TINEO	Sp 85	Granada: Western part of Sierra Nevada, c. 2500 m s.m.	10	10 SCHMIDT 1962
CISTACEAE				
Helianthemum ledifolium (L.) MILLER	Sp 93	Malaga: Antequera	20	20 D & W 1955; LÖVE & KJELLQUIST 1964; GADELLA et al. 1966
UMBELLIFERAE				
**Oenanthe globulosa* L. ssp. *kunzei* (WILLK.) NYMAN	Sp 70	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	22 (Fig. 1 G)	
Pseudorlaya pumila (L.) GRANDE [syn. *Daucus pumilus* (L.) HOFFMANNS. & LINK]	Sp 32	Cadiz: 6 km S of Cadiz	16	16 GARDÉ & MALHEIRO-GARDÉ 1954; D & W 1955; LARSEN 1956
ASCLEPIADACEAE				
Gomphocarpus fruticosus (L.) R. BR.	JK 40	Malaga: Fuengirola	22	22 D & W 1955; RILEY & HOFF 1961
VERBENACEAE				
Verbena officinalis L.	JK 31	Malaga: Marbella	14	14 D & W 1955
,, ,,	JK 39	Malaga: Fuengirola	14	
LABIATAE				
**Calamintha nepeta* (L.) SAVI	JK 44	Malaga: Marbella	24	

**Micromeria graeca* Benth.	Sp	24	Cadiz: Vejer de la Frontera, c. 100 m s.m.	20	
Salvia verbenacea L.	Sp	95	Cadiz: Las Guadiaro	c. 58	42 Reese 1957
,, ,,	Sp	43	Cadiz: Vigia, c. 75 m s.m.	c. 58	54 D & W 1955 59 Gadella et al. 1966
**Sideritis romana* L.	Sp	68	Granada: Western part of Sierra Nevada, c. 1130 m s.m.	28 (Fig. 1 H)	64 D & W 1955; Gadella et al. 1966
Stachys hirta L.	Sp	11	Cadiz: 9 km NE of Tarifa	18	18 Larsen 1960
,, ,,	Sp	28	Sevilla: 3 km S of Dos Hermanas	18	
SCROPHULARIACEAE					
Antirrhinum majus L. emend. Rothm. ssp. *linkianum* (Boiss. & Reut.) Rothm.	Sp	14	Cadiz: Vejer de la Frontera, c. 100 m s.m.	16	A. *majus* L.: 16 D & W 1955; Rieger 1957, 1958; Ortiz 1961; Verma & Dhillon 1967 32 D & W 1955; Morrison & Rajhathy 1960
Veronica anagallis-aquatica L.	Sp	21	Cadiz: 9 km NE of Tarifa	36	36 D & W 1955; Löve & Löve 1956; Khoshoo et al. 1961; Khoshoo & Khushu 1966 54 Khoshoo et al. 1961; Khoshoo & Khushu 1966; Verma & Dhillon 1967
Veronica anagalloides Gussone	Sp	65 b	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	18	18 D & W 1955
,, ,,	Sp	66	Same locality	18+2 B	
CAMPANULACEAE					
**Jasione blepharodon* Boiss. & Reut.	Sp	58	Cadiz: Puerto Real	12 (Fig. 1 I)	
COMPOSITAE					
Andryala integrifolia L.	Sp	27	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	18	18 D & W 1955
**Asteriscus maritimus* (L.) Less.	Sp	96	Cadiz: Tarifa	12 (Fig. 1 J)	
Bidens pilosa L.	JK	35	Malaga: Fuengirola	72	24 Turner, Ellison & King 1961; Powell & Turner 1963; Powell & King 1969

Taxon	Voucher	Origin	2n	Previous counts and references
Bidens pilosa L.	JK 34	Malaga: Fuengirola	c. 72	28 Powell & Turner 1963 48 Turner, Ellison & King 1961; Arano & Nakamura 1964; Smith 1965 72 D & W 1955; Powell & Turner 1963; Diers 1961; Turner & King 1964; Mehra et al. 1965; Harvey 1966 76 Turner & King 1964 n=38+2 Turner & Lewis 1965
Centaurea eriophora L.	Sp 90	Granada: Láchar, c. 500 m s.m.	24	24 Guinochet & Foissac 1962
Centaurea melitensis L.	Sp 78	Malaga: Torremolinos	24	22 D & W 1955 24 Guinochet 1957; Guinochet & Foissac 1962 36 Chiappini 1955
Centaurea sempervirens L.	Sp 36	Cadiz: Las Guadiaro	30	30 Guinochet & Foissac 1962
Cotula coronopifolia L.	Sp 44	Sevilla: Los Palacios y Villafranca	20	20 D & W 1955; Hair 1962; Powell & King 1969 40 Nordenstam 1967
Filago pyramidata L. (syn. *F. spathulata* Presl)	Sp 10	Granada: Armilla	28	28 D & W 1955
Gnaphalium luteo-album L.	JK 33	Malaga: Fuengirola	14	14 D & W 1955; Larsen 1960; Mehra et al. 1965; Raj 1965; Turner & Lewis 1965; Turner in King 1965; Gadella & Kliphuis 1966; Shetty 1967 14+1 Larsen 1960 n=7+1 Mehra et al. 1965 28 Raj 1965
Hyoseris radiata L.	Sp 92	Cadiz: Vejer de la Frontera, c. 100 m s.m.	16	16 D & W 1955
**Inula graveolens* Desf.	JK 36	Malaga: Fuengirola	20 (Fig. 1 K)	
Inula viscosa (L.) Aiton	JK 37	Malaga: Marbella	18	18 D & W 1955 34 Gadella et al. 1966
Phagnalon saxatile (L.) Cass.	Sp 91	Gibraltar	18	18 Reese 1957
,, ,,	Sp 97	Cadiz: Vejer de la Frontera, c. 100 m s.m.	18	

Phagnalon saxatile (L.) CASS.	Sp	98	Gibraltar, c. 300 m s.m.	18	
**Pulicaria odora* (L.) RCHB.	Sp	42	Cadiz: Vigia, c. 75 m s.m.	18 (Fig. 1 L)	
Silybum marianum (L.) GAERTNER	Sp	22	Same locality	34	34 D & W 1955; LARSEN 1956; SKALINSKA et al. 1959; MOORE & FRANKTON 1962; GADELLA et al. 1966
,, ,,	Sp	41	Same locality	34	
Sonchus tenerrimus L.	Sp	34	Cadiz: Vejer de la Frontera, c. 100 m s.m.	14	14 D & W 1955; LARSEN 1956
**Taraxacum obovatum* DC.	Sp	4	Granada: Western part of Sierra Nevada, c. 1200 m s.m.	32 (Fig. 1 M)	
ALISMATACEAE					
Alisma lanceolatum WITH.	Sp	105	Sevilla: 3 km S of Dos Hermanas, c. 50 m s.m.	26	26 D & W 1955; BJÖRKQVIST 1968; POGAN 1968 28 D & W 1955; BJÖRKQVIST 1968; POGAN 1968
Baldellia ranunculoides (L.) PARL.	Sp	106	Cadiz: 9 km NE of Tarifa	16	16 BJÖRKQVIST 1968 14, 16, 18, 22 D & W 1955
LILIACEAE					
**Asphodelus fistulosus* L.	Sp	17	Granada: Western part of Sierra Nevada, c. 1300 m s.m.	56	28 D & W 1955; LARSEN 1956; GADELLA et al. 1966
GRAMINEAE					
Bromus rubens L.	JK	18	Malaga: Mijas	28	28 D & W 1955; REESE 1957
Setaria glauca (L.) PB.	JK	20	Malaga: Fuengirola	72	36 D & W 1955; SHARMA & DE 1956; CHANDOLA 1959; SINGH & GOODWARD 1960; PLATZER 1962; GUPTA 1962; GUPTA 1963 72 D & W 1955; PRITCHARD & GOULD 1964

DISCUSSION

65 taxa of vascular plants from southern Spain and from Tanger (1 sp.) have been studied as to their chromosome numbers. To our knowledge 17 of these taxa have not been cytologically investigated before, and five additional counts represent new numbers.

Previously published counts for *Ranunculus trilobus* (DARLINGTON & WYLIE 1955) were not cited in 'Flora Europaea' (TUTIN 1964), possibly because of misidentification by the earlier authors. Thus our count of this species may also be a first record.

Our count ($2n=22$) on *Oenanthe globulosa* ssp. *kunzei* appears to be the first report for this subspecies but agrees with the number known for ssp. *globulosa* (COOK 1968).

Cerastium brachypetalum ssp. *roeseri* and *Spergularia echinosperma* do not seem to have been recorded from Spain previously. The latter species is in 'Flora Europaea' (MONNIER & RATTER 1964) recorded from central and western Europe and stated to be insufficiently known as to its distribution. Recently MONNIER (1968) reported the species from Morocco, and our records from Spain fall within the south-western European disjunction area which is most likely due to insufficient collecting.

The chromosome number of *Spergularia marina* was previously known to be $2n=36$. Our count of $2n=18$ is new to the species but agrees with the diploid number found in several other species of the genus. Our specimens deviate somewhat from the typical *S. marina*, e.g. in the number of stamens which appears to be 10 instead of the normal number 5.

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Fig. 1. Somatic metaphases in sections of root tips of Iberian Angiosperms. — A. *Silene laeta*, 2n 24. Plant no. Sp 100: 2. — B. *Amaranthus blitoides*, 2n 32. Plant no. JK 4: 1. — C. *Alyssum minutum*, 2n 16. Plant no. Sp 52: 1. — D. *Lotus preslii*, 2n 12. Plant no. Sp 60: 3. — E. *Ononis pendula*, 2n 32. Plant no. Sp 94: 2. — F. *Daphne gnidium*, 2n 18. Plant no. JK 29: 4. — G. *Oenanthe globulosa*, 2n 22. Plant no. Sp 70: 1. — H. *Sideritis romana*, 2n 28. Plant no. Sp 68: 1. — I. *Jasione blepharodon*, 2n 12. Plant no. Sp 58: 2. — J. *Asteriscus maritimus*, 2n 12. Plant no. Sp 96: 1. — K. *Inula graveolens*, 2n 20. Plant no. JK 36: 2. — L. *Pulicaria odora*, 2n 18. Plant no. JK 42: 2. — M. *Taraxacum obovatum*, 2n 32. Plant no. Sp 4: 2.

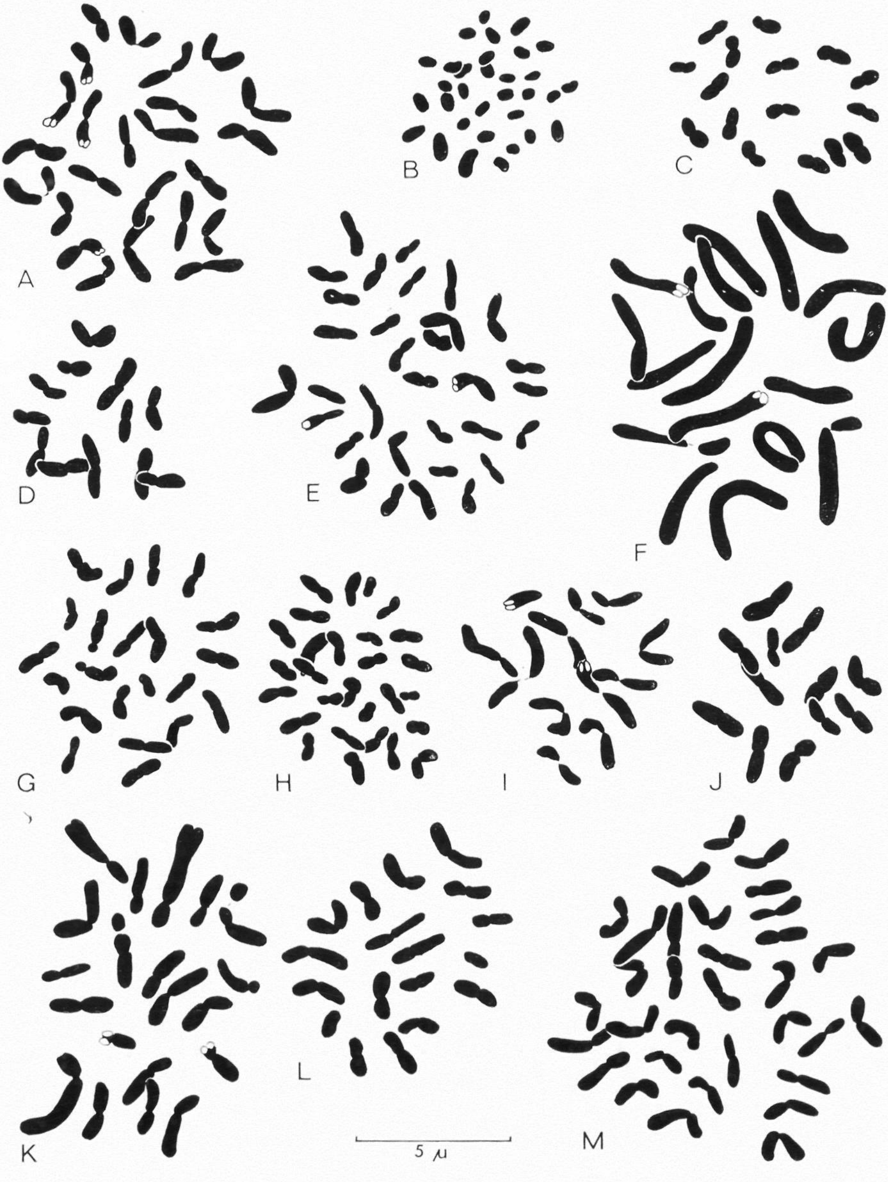

Fig. 1.

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Beitrag zur Kenntnis der Flora des Njuonjevare-Gebietes (Torne Lappmark, Nordschweden)

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ABSTRACT

In 1963 and 1965 the authors have investigated the vascular plant flora of an area NW of Lake Torneträsk, Swedish Lappland, including Mt. Njuonjevare (1140 m) and its surroundings. A short survey of the vegetation in the subalpine and alpine parts is given together with a locality list of some species found during the investigation. At a pool near Pålnoviken (the westernmost bay of Lake Torneträsk) *Calluna vulgaris* has its only known occurrence in mire vegetation in the Torneträsk area.

EINLEITUNG

Das Torneträsk-Gebiet, d. h. die Umgebung von dem grössten See Nordschwedens, ist vom floristischen Gesichtspunkt aus verhältnismässig vohlbekannt. Kein Teil davon ist aber so genau untersucht worden wie z. B. die Gemeinden in Schonen (Südschweden). In den Jahren 1963 und 1965 haben die Verfasser jedoch einen Versuch gemacht, die schonischen Untersuchungsmethoden (siehe z.B. WEIMARCK 1958) auf ein ca. 32 qkm grosses Gebiet nordwestlich vom Torneträsk anzuwenden. Dessen Gefässpflanzenflora wurde vom 16. Juli bis zum 4. August bzw. vom 10. bis zum 26. Juli untersucht. Das Gebiet, das u.a. den Berg Njuonjevare und die Halbinsel Pieske-njarka umfasst, wird folgendermassen begrenzt: im Osten von dem Torneträsk und dem Ablauf der Seen südlich vom Grenzmal (rr) 272, im Nordosten von der norwegischen Grenze, im Westen von dem Nationalpark Vadvetjåkko und im Südwesten von dem Fluss Njuoraätno (Abb. 1 A).

Die Bearbeitung des eingesammelten Materials wurde hauptsächlich im Institut für Systematische Botanik, Lund, durchgeführt und wir möchten an dieser Stelle dem Direktor, Herrn Professor H. WEIMARCK, unseren Dank für sein geneigtes Interesse sagen. Für wertvolle Hilfe sind wir auch Herrn Professor S. RUDBERG, Göteborg, und den Herren JAN BORG, Skellefteå, ÖRJAN NILSSON, Lund, OLLE SIGSTEDT, Jönköping, und MATS SONESSON, Lund, sehr dankbar. Einen ganz besonderen Dank schulden wir aber vor allem Herrn Laborator G. Sandberg, dem Vorsteher der Naturwissenschaftlichen Station in Abisko, und seiner Frau Dagmar, für freundliche Hilfe und stetes Entgegenkommen.

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TOPOGRAPHIE UND GEOLOGIE

Im Norden dominiert das in nordwest—südöstlicher Richtung ausgedehnte Njuonjevare-Massiv, das mit Ausnahme von dem unteren Teile des Nordostabhanges zu dem Gebiet gehört. Von seinen Gipfeln (1140 bzw. 1120 m) (Abb. 1 A) erstreckt sich ein Bergrücken südostwärts auf den Torneträsk und bildet in der Nähe der Bucht Pålnoviken den etwa 600 m hohen Berg Pålnovaras. Im Süden erheben sich einige isolierte Kleinberge (z. B. die Punkte 585, 520 und 413) über das kleinhügelige, see- und moorreiche Gelände, das langsam nach dem Torneträsk und dem Njuoraätno abfällt.

Geologisch kann man drei Zonen unterscheiden (Kulling 1961). (*1*) Der Südwestteil gehört zu dem sog. Vassijaure-Fenster, wo der Felsboden aus Granit/Syenit besteht (Abb. 1 B). Im übrigen sind die archäischen Sockelgesteine von kambrosilurischen Überschiebungsmassen bedeckt. (*2*) Längs der Nordostgrenze des Urgebirgsteiles folgt eine Zone, die aus schwerverwittertem Hartschiefer besteht. (*3*) Der Hauptteil des Gebietes wird von hochmetamorphen Gebirgsarten gekennzeichnet, vor allem Marmor und Glimmerschiefer (meist Granatglimmerschiefer). Stellenweise kommt aber auch Graphitschiefer vor. In den zwei letzten Zonen sind weiter Dolomit und Eruptivgesteine beobachtet worden.

Eine zusammenhängende Erdschicht kommt vor allem in einer bis zu 1 km breiten Zone am Torneträsk vor. Sonst ist das Gebiet an losen Ablagerungen sehr arm, und kahle Felsen sind u. a. bei Punkt 413 angetroffen worden, weiter zwischen Punkt 520 und dem Cañon 2,2—2,6 km NW von der Brücke über den Njuoraätno und in grossen Arealen der alpinen Zone (hier besonders auf den Windseiten). Zwischen der Hütte Pålnoviksstugan und Grenzmal (rr) 272 bildet das lose Material — wie es scheint — ein Kames-Gelände, dessen Hügel von einem lichten, parkähnlichen Birkenwald bedeckt sind. West- und nordwestlich von dem Grenzmal wird der Südostabhang des Njuonjevares von dem kalkreichen Untergrund geprägt: Karstspalten, dolinähnliche Niederungen, unterirdische Bäche und leichtverwitterte Kleinabhänge mit „Mikrosteilwänden“ sind sehr häufig. Fossile Steinströme mit *Silene rupestris, Sedum annuum* und mit mehr oder weniger kriechendem *Prunus padus* kommen auf der Südwestseite des Pålnovaras vor. WSW—SSW von Punkt 520 ist das Gelände sehr hügelig, steinreich (grosse Blöcke) und ohne sichtbaren Feinboden.

Talusbildungen sind verhältnismässig häufig. Wohlentwickelter, rezenter Talus kommt u. a. ca. 400 m S von Punkt 1120 vor, weiter 2,2—2,6 km W—WNW von Grenzmal (rr) 272 und auf den steilen Süd- und Westabhängen bei Punkt 585. Erwähnt sei noch, dass die Nordostseite des Pålnovaras von einem mächtigen fossilen Talus mit grossen Birken und Ebereschen (*Sorbus aucuparia*) bedeckt ist.

KLIMA

Das Klima ist von der Nähe des Atlantischen Ozeans deutlich beeinflusst. Einige Niederschlags- oder Temperaturmessungen liegen aber nicht vor, und die Werte, die man den veröffentlichten Karten (z. B. in BENUM 1959 SS. 16—18) entnehmen kann, sind wegen unzureichenden Quellenmaterials sehr unsicher. Nach BENUM (l.c.) könnte man das Mittel der jährlichen Niederschlagsmenge auf 550—600 mm und die Mitteltemperatur für Januar und Juli auf –4 bis –5 bzw. 12 bis 13°C schätzen. Diese Werte gelten aber jedenfalls nur für die niedrigsten Stufen. Hier mag auch erwähnt sein, dass SANDBERG (1963 S. 942) in der Nähe vom Lappenlager Njuoraluspe (440—460 m ü. d. M.) — ca. 2,5 km W von unserem Gebiete — vom 5. Juli 1962 bis zum 5. Juli 1963 einen Jahresniederschlag von 916 mm gemessen hat. PERSSON (1958 S. 13), der ein Gebiet unmittelbar östlich von unserem untersucht hat, liefert eine Reihe indirekte Beweise dafür, dass die Humidität dort verhältnismässig hoch ist. Sein Schluss dürfte wahrscheinlich auch für unser Gebiet gelten.

METHODIK

Bei der Untersuchung wurde das Gebiet in 1 qkm grosse Sektionen eingeteilt (Abb. 1). An den Grenzen sind sie jedoch kleiner und dort sind auch einige sehr kleine Sektionen mit angrenzenden zusammengelegt worden. Die Benennung geht aus Abb. 1 hervor.

Im allgemeinen wurden die Fundorte aller Arten notiert, die häufigsten jedoch nur einmal in jeder Sektion. Belege, besonders von schwerbestimmten Sippen, sind eingesammelt worden; Material von kritischen Gattungen (*Hieracium, Taraxacum* und gewissermassen auch *Salix*) jedoch nur vereinzelt.

Im Jahre 1965 hatte die Schneeschmelze sehr verspätet eingesetzt. Infolgedessen war es uns nicht möglich, gewisse Teile (besonders die nordwestlichen Sektionen) in wünschenswertem Ausmass zu untersuchen.

DIE BIRKENWALDREGION (REGIO SUBALPINA)

Das Gebiet ist, wo die natürlichen Verhältnisse es gestatten, bis auf ca. 600 m (im Nordosten ca. 650 m) ü. d. M. von Birkenwald bedeckt. Von Bäumen und grösseren Sträuchern kommen ausser der Bergform von *Betula pubescens* (*B. tortuosa*) auch Einzelexemplare oder Kleinbestände von *Sorbus aucuparia* und *Populus tremula* (meist strauchartig) vor. In feuchteren Partien sind auch *Salix borealis* (*S. myrsinifolia* ssp. *borealis*) und *Alnus incana* angetroffen worden, die letztere besonders auf Moorrändern, wo sie oft bestandbildend ist. Im Wiesenbirkenwald treten schliesslich Einzelexemplare von *Prunus padus* auf.

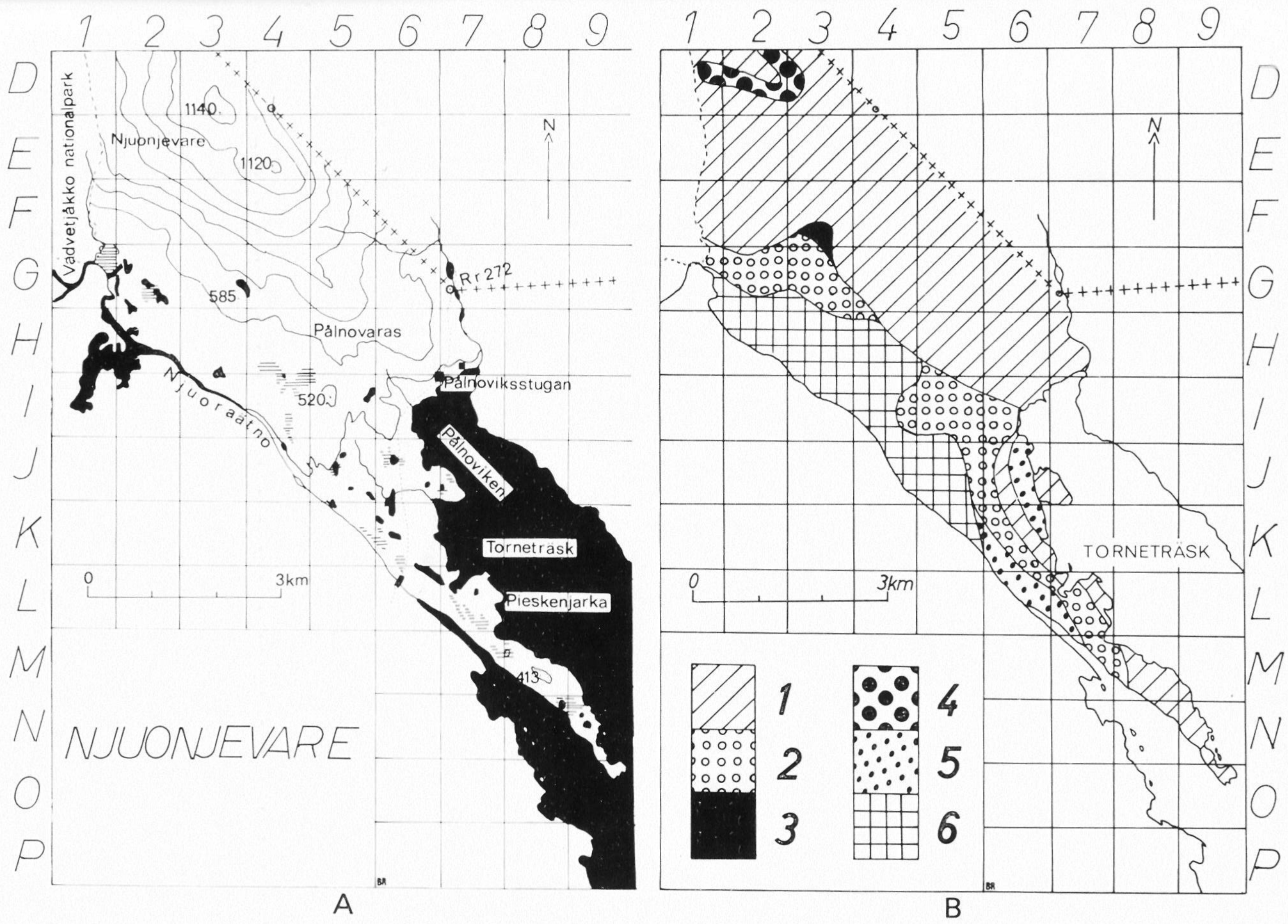

Abb. 1. — A. Das Untersuchungsgebiet. — B. Der Felsboden. Nach der Karte von KULLING (1965) aber in vereinfachter Darstellung. — 1—5. Allochtonischer Felsboden: 1. Marmor, Glimmerschiefer, Graphitschiefer; 2. Hartschiefer; 3. Dolomit; 4. Eruptivgesteine (Amphibolit, Diabas); 5. Eruptivgesteine (Granit, Syenit). — 6. Autoktonischer Felsboden: (Granit, Syenit). — Abb. 1 B mit am [redacted]. Juni 1969 datierter Genehmigung der „Sveriges Geologiska Undersökning“ veröffentlicht.

Die Birken sind oft bemerkenswert wohlentwickelt, besonders auf den Abhängen des Pålnovaras, wo geradegewachsene Bäume mit 2—3 dm dicken Stämmen vorkommen, z. B. 1 km südlich von Grenzmal 272. Hier sind auch die Einzelbirken, die früher die äussersten Vorposten gegen die alpine Zone bildeten, von zahlreichen Bäumchen umgeben.

Im Juli 1965 wurde der Wald ca. 500 m NNE von der Hütte Pålnoviksstugan von dem Spanner *Oporinia autumnata* Bkh. angegriffen, dessen Larven in etwa einer Woche die Bäume völlig entblätterten. Ähnliche Verheerungen sind früher im Gebiet vorgekommen. Die betroffenen Teile sind von einer auffälligen Anzahl toter Birken gekennzeichnet, die aber durch zahlreiche Stumpfsprosse weiterleben. Die Schäden scheinen deshalb relativ begrenzt zu sein.

WALDTYPEN. Die Urgebirgszone (Abb. 1 B) wird von Heidenbirkenwald dominiert, dessen Feldschicht vor allem von *Empetrum hermaphroditum* und *Vaccinium myrtillus* gekennzeichnet wird. Dieser Waldtypus ist sowohl im Hartschiefergebiet als auch in dem schmalen Streifen zwischen diesem und dem Torneträsk vorherrschend, aber der Einschlag von Wiesenwald ist grösser und weiter scheinen *Geranium silvaticum,* andere Kräuter und *Lastrea dryopteris* dort häufiger zu sein. Auf der Halbinsel Pieske-njarka nimmt der Wiesenbirkenwald noch mehr zu und die übrigen Teile des Waldgebietes werden von diesem Waldtypus völlig dominiert. Seine Feldschicht wird in der Regel durch grossgewachsene Kräuter ausgezeichnet, vor allen durch *Geranium silvaticum, Lactuca alpina* und *Trollius europaeus.* Diese Hochstaudenvegetation ist stellenweise sehr üppig, z.B. auf den Abhängen des Pålnovaras, wo der Wiesenbirkenwald besonders wohl ausgebildet ist. Die Bodenschicht ist im ganzen Gebiet grösstenteils moosreich.

WIESEN. Grössere, kräuterreiche Feuchtwiesen kommen vor allem einige hundert Meter WSW—SW von der Hütte Pålnoviksstugan vor. Vielleicht handelt es sich um kleinere Naturwiesen, die durch Abholzungen in den umgebenden Wiesenbirkenwald vergrössert worden sind. Die Einwohner des benachbarten, nun verlassenen Lappenlagers besassen nämlich während einer Reihe von Jahren Kühe (Sandberg 1960 S. I: 7).

MOORE. Die meisten und grössten Moore, darunter alle diejenigen, in denen die trockensten Teile von Hochmoorcharakter sind, befinden sich in den Urgebirgs- und Hartschiefergebieten, in dem schmalen Streifen zwischen dem letzteren und dem Torneträsk und auf der Halbinsel

Abb. 2. Der einzige bekannte Fundort von *Calluna vulgaris* in Moorvegetation im Torneträsk-Gebiet. Siehe S. 290.

Pieske-njarka. Hochmoorartige Teile sind verhältnismässig selten und kommen u. a. in zwei Mooren (Sekt. K 5—6, I 4) vor, die ca. 200 m NE vom Njuoraätno gelegen sind. In dem nördlichen sind die hochmoorartigen Buckel in Streifen quer über das Moor geordnet. Die More auf Pieske-njarka sind auch teilweise von Hochmoorcharakter.

Niedermoore, die als Reichniedermoore ausgebildet sind, kommen auch in den Urgebirgs- und Hartschiefergebieten vor, besonders im Anschluss an deutlich strömendes Wasser.

UFER. An den ca. 15 bzw. 9 km langen Ufern vom Torneträsk und dem Njuoraätno kommt, wo die natürlichen Verhältnisse es gestatten, ein meterbreiter Streifen mit kalkgebundenen oder kalkbegünstigten Arten dicht am Wasser vor. Das Ufer vom Torneträsk hat eine sehr veränderliche Ausgestaltung mit mehreren interessanten Arten, z.B. *Barbarea stricta, Primula stricta* und *Galium uliginosum.* An steilen Uferhängen mit spärlicher Vegetation sind auch *Dryas octopetala* und (in der Nähe von der Hütte Pålnoviksstugan) *Silene rupestris* beobachtet worden.

Die meisten Seen und kleineren Wasseransammlungen befinden sich in demselben Teilgebiet wie die Moore (siehe oben). Im allgemeinen sind die Ufer von Mooren bedeckt, aber stellenweise erreicht die Heide- oder Wiesenvegetation das Wasser. Von höheren Wasserpflanzen sind *Nuphar pumilum, Ranunculus trichophyllus* var. *eradicatus* (*R. confervoides*) und *Utricularia vulgaris* angetroffen worden; ausserdem haben wir *Potamogeton gramineus* in einem Bach in der Nähe vom Torneträsk gefunden. — Die Limnologie einiger Seen in dem Untersuchungsgebiet ist von EKMAN (1957 SS. 96—99) behandelt worden.

An einem See 600 m E von Punkt 520 kommt *Calluna vulgaris* in einem *Sphagnum*-Rasen vor (Abb. 2). Nach SONESSON (1967 S. 279) ist dies das einzige bisher bekannte Vorkommen in Moosvegetation im Torneträsk-Gebiet. Nur zwei Kleinbuckel wurden angetroffen, die 1965 in ziemlich schlechtem Zustand waren; voriges Jahr hatten sie doch geblüht. Folgende Begleitarten wurden beobachtet: *Trichophorum caespitosum* ssp. *austriacum, Carex rostrata, Rubus chamaemorus, Andromeda polifolia* und *Empetrum hermaphroditum.*

STEILABHÄNGE. Dem Süden zugewandte Steilabhänge kommen im Gebiet vor. Sie sind doch nicht so wohlentwickelt und so artenreich wie die von BRINGER (1962) beschriebenen Südabhänge auf der Nordseite des Torneträsks. Auf einem talusversehenen Abhang 300—400 m SSE von Punkt 585 sind u. a. folgende Arten gefunden worden: *Cystopteris fragilis, Polystichum lonchites, Silene rupestris, Sedum rosea, Ribes spicatum, Anthriscus silvestris, Veronica fruticans* und *Campanula rotundifolia.*

DIE ALPINE REGION (REGIO ALPINA)

Der oberhalb der Waldgrenze gelegene Teil des Untersuchungsgebietes fällt grösstenteils in die niederalpine Stufe. (Für die Stufeneinteilung siehe z. B. DU RIETZ 1950.) Nur die zwei höchsten Gipfel und ihre nächste Umgebung gehören zu der mittelalpinen Stufe.

Im unteren Teil der niederalpinen Stufe treten stellenweise Grauweiden- oder Wacholdersträucher auf, die ersteren auf feuchtem Boden, die letzteren auf dürren Abhängen. Wie auf der Nordseite vom Torneträsk (PERSSON 1961 S. 15) ist aber die Strauchvegetation sehr spärlich.

HEIDEN. Auf dem Njuonjevare, wo der Felsboden grösstenteils aus Marmor und Glimmerschiefer besteht, ist die Vegetation durch kalkgebundene oder kalkbegünstigte Arten gekennzeichnet. Die Gesellschaften der Heideserie sind vorherrschend und im allgemeinen von einer

Dryas-Heide mit *Rhododendron lapponicum* und *Cassiope tetragona* vertreten. Stellenweise kommen aber auch *Empetrum - Betula nana*-Heide und *Vaccinium myrtillus*- Heide vor.

Die Gipfel der Punkte 520 und 585 sind auch von Heide bedeckt. Auf dem ersteren, der im Hartschiefergebiet liegt, herrscht eine *Diapensia - Loiseleuria*-Heide vor, auf dem letzteren eine schwachentwickelte *Dryas*-Heide.

WIESEN. Im Hinblick auf den reichen Niederschlag ist das Areal der Wiesengesellschaften unerwartet klein.

MOORE. Die Moore sind klein, verhältnismässig selten und ausschliesslich von Niedermoorcharakter.

UFER. Oberhalb der Waldgrenze sind nur wenige Wasseransammlungen zu finden. Die grösste (ca. 100×60 m), die zwischen den Gipfeln des Njuonjevaares in einer Höhe von ca. 1030 m liegt, war am 22. Juli 1965 mit Eis bedeckt. Die Ufervegetation ist arm und ohne bemerkenswerte Arten.

STEILABHÄNGE. In der alpinen Region kommen zahlreiche Steilabhänge vor. Sie sind oft mit Talus versehen und hegen oft eine interessante Flora. Auf einem Abhang. 2,2—2,6 km W—WNW von Grenzmal (rr) 272 (ca. 720 m ü. d. M.) haben wir z. B. folgende Arten gefunden: *Botrychium lunaria, Carex glacialis, Arenaria norvegica, Saxifraga oppositifolia, Oxytropis lapponica, Viola rupestris* und *Arctostaphylos uva-ursi.*

FUNDORTE EINIGER ARTEN

Angaben über die Flora des Gebietes sind früher von u. a. SONDÉN (1907), SYLVÉN (1908), SMITH (1924), ALM & FRIES (1925) und ASPLUND (1950) veröffentlicht worden.

Ein vollständiges Verzeichnis über die Fundorte der von uns beobachteten Arten ist in der Naturwissenschaftlichen Station, Abisko, zugänglich. Belege der meisten Arten sind dem Botanischen Museum in Lund (LD) übergeben worden.

Die Fundortsangaben beziehen sich auf die Karte „Fjällen kring Abisko, Björkliden, Riksgränsen. Sommarkartan. Skala 1 : 100 000. Stockholm 1957“. Die Nomenklatur stimmt mit HYLANDER (1955) überein.

Abkürzungen: P = Punkt, P-n = Pålnoviksstugan, Rr = Riksröse (Grenzmal), T-k = Torneträsk.

Matteuccia struthiopteris. 1,3 km S von P-n, nahe am T-k, 350 m. — *Woodsia ilvensis.* 350 m N von P. 520, Steilabhang, 460 m; 1,2 km NNW von P. 585, Steilabhang. — *W. alpina×ilvensis.* 1,2 km NNW von P. 585, Steilabhang;

1,6 km NW von P. 585, Steilabhang, 550 m. — *W. glabella.* 400 m S von P. 1120, Steilabhang, 1000 m. — *Dryopteris filix-mas.* 200 m N von P-n, 400 m; 300 m NE von der Brücke über den Njuoraätno, 360 m; 350 m N von P. 520, 460 m; 1,7 km NW von P. 585, 520 m. — *Triglochin palustre.* 2,1 km SE von P. 520, 350 m; ca. 900 m WNW von P-n, nahe an einem See, 400 m. — *Potamogeton gramineus.* 2,1 km SE von P. 520, im Bach, 350 m. Det. Ö. Nilsson. — *Polygonatum verticillatum.* 200 m N von P-n, 400 m. — *Luzula parviflora.* 1,3 km S—SSW von P-n, am T-k, 345 m. — *Roegneria mutabilis.* 1,2 km NW von P. 585, an der Waldgrenze, 550 m. — *Kobresia myosuroides.* Ca. 2 km NW von P. 585, Steilabhang, 550 m. — *Carex brunnescens×loliacea.* 900 m NNW von P-n, 600 m. Det. Ö. Nilsson. — *C. caespitosa.* 1,1 km S von Rr 272, im Bach, 350 m; 900 m WNW von P-n, 400 m. Det. Ö. Nilsson. — *C. bigelowii×nigra.* 1,1 km S von Rr 272, 350 m. Det. Ö. Nilsson. — *C. adelostoma.* 2,0 km S—SSE von P. 585, am Njuoraätno, 400 m. Det. Ö. Nilsson. — *C. rariflora.* Pieske-njarka, am Weiher 1,0 km SE von P. 413, 350 m. Det. Ö. Nilsson. — *C. glacialis.* 2,2—2,6 km W—WNW von Rr 272, 720 m. — *Urtica dioeca* ssp. *sondenii.* 200 m NE von P-n, an Hütte, 370 m; 1,0 km ENE von P. 520, verlassenes Lappenlager, 400 m. — *Minuartia rubella.* 400 m S von P. 1120, 1000 m. — *Sagina intermedia.* 700 m SSE von P. 1120, 900 m; P. 1120, auf dem Gipfel, 1120 m. — *Arenaria norvegica.* 2,2—2,6 km W—WNW von Rr 272, 720 m. — *Silene rupestris.* Uferfundort: Unmittelbar NE von P-n, am T-k, 342 m. — *Nuphar pumilum.* Pieske-njarka, 1,0 km SE von P. 413, im See, 350 m. — *Ranunculus trichophyllus* var. *eradicatus* (*R. confervoides*) 500 m S von Rr 272, im Tümpel am Fussweg, 370 m; Unmittelbar NE von P-n, im T-k, 432 m. — *R. glacialis.* Zwischen den Punkten 1120 und 1140, 1130 m. — *Draba incana.* 14 Fundorte. Det. J. Borg. — *D. norvegica.* 12 Fundorte. Det. J. Borg. — *D. hirta.* 400—800 m W—WNW von P. 585, 500—530 m; Pieske-njarka, 300 m W von P. 413, 350 m; 1 km SSW von P. 1120, 800 m; 600 m NW von Rr 272, 460 m. Det. J. Borg. — *D. lactea.* 1,6 km W von Rr 272, 640 m; 1 km N von P. 585, 730 m; 2 km N von P. 585, 550 m; 450 m S von P. 1120, 1050 m. Det. J. Borg. — *D. fladnizensis.* 600 m S von P. 1120, 920 m. Det. J. Borg. — *D. nivalis.* P. 1120, auf dem Gipfel, 1120 m; 450 m S von P. 1120, 1050 m. Det. J. Borg. — *D. alpina.* 600 m S von P. 1120, 920 m; 200 m S von P. 1120, 1100 m; 300 m N von P. 1120, 1050 m. Det. J. Borg. — *Barbarea stricta.* 600 m SSE von P. 1120, 920 m; 200 m S von P. 1120, 1100 m; Pieske-njarka, am T-k N von P. 413, 342 m; 300 m N von P. 1120, 1050 m. — *Arabis hirsuta.* 900 m NNW von P-n, 600 m; 1 km ENE—NE von P. 585, 720 m. — *Erysimum hieraciifolium.* 350 m N von P. 520, Steilabhang, 460 m; 2,2 km NW von P. 585, Steilabhang, 580 m. — *Potentilla erecta.* 10 Fundorte. Vgl. Persson (1961 S. 157). — *Drosera rotundifolia.* 700 m NW—NNW von der Brücke über den Njuoraätno 370 m; Pieske-njarka, 800 m NW von P. 413; Pieske-njarka, 1,0 km SE von P. 413, 350 m. — *Viola montana.* 400—800 m W—WNW von P. 585, 520 m; 350 m N von P. 520. — *Epilobium davuricum.* 900 m WNW von P-n, 400 m. — *Calluna vulgaris.* 2,1 km NW von der Brücke über den Njuoraätno, Heide, 380 m; 600 m E von P. 520, am See, 400 m. — *Primula stricta.* Unmittelbar NE von P-n, am T-k, 342 m; 1,3 km S—SSW von P-n, am T-k, 342 m; 2,3—2,6 km NW von P. 413, am Njuoraätno, 342 m; Pieske-njarka, 1 km NW von P. 413, 360 m. — *Gen-*

tianella tenella. 400 m S von P. 1120, Steilabhang, 1000 m. — *Veronica officinalis.* 200 m N—NW von P-n, 400 m. — *Pedicularis hirsuta.* 200 m S von P. 1120, 1100 m; 200 m SE von P. 1140, 1100 m. — *Pinguicula villosa.* 8 Fundorte. — *Utricularia vulgaris.* 900 m WNW von P-n, am See, 400 m. — *Campanula uniflora.* 1,2 km S von Rr 272, 380 m; 400 m S von P. 1120, 1000 m; P. 1120, auf dem Gipfel, 1120 m. — *Antennaria carpathica.* 800 m ESE von P. 1120, 880 m; 700 m SSE von P. 1120, 900 m. — *A. porsildii.* P. 585, nahe dem Gipfel, 580 m; 700 m N von P. 585, 650 m.

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Brief Articles and Reports

Cleome spinosa Jacq. new to Africa

ABSTRACT. — *Cleome spinosa* JACQ. is reported from the Cameroons where it was found cultivated and naturalized. This seems to be the first record from Africa of this neotropical species. Some specimens of the "Spider Flower" from natural environments in Natal, have tentatively been determined as *Cleome Hassleriana* CHOD. They differ very slightly from *Cleome afrospina* ILTIS.

When visiting the Cameroons in 1968, I found *Cleome spinosa* JACQ. in Edea and Douala. In Douala I saw it in the garden of a native, where it was apparently cultivated, while in Edea it occurred on waste ground near some natives' huts and at roadside. The species has white flowers and cordate bracts and bears much the appearance of *Cleome gynandra* L., but it has stipular spines and much shorter androgynophore, only 2 mm long.

The occurrence of *Cleome spinosa* JACQ. in West Tropical Africa is of some interest for the following reason. ILTIS has shown in a recent paper (1967), that the African material of "*Cleome spinosa*" almost exclusively represents a new species, and he named it *Cleome afrospina*. This species is confined to Nigeria, Congo, the Cameroons and Equateur (ILTIS 1967). On the other hand, the widely cultivated, spiny and showy "Spider Flower", commonly known as *Cleome spinosa,* shall be named *Cleome Hassleriana* CHOD. if one follows the proposal of ILTIS (1967). The true *Cleome spinosa* JACQ., however, seems not to have been reported from Africa before.

According to ILTIS (1967), *Cleome afrospina* is an Old World vicariad to *Cleome trachycarpa* KL. ex EICHLER. As regards *Cleome spinosa* JACQ., however, I have not found any significant difference between the African and American material examined (Herb. S). All specimens which I observed in the Cameroons had comparatively small flowers (petals 16 mm long and 4 mm broad) which contributed to give the specimens a superficial resemblance to *Cleome gynandra* L. The American specimens generally have larger flowers with petals reaching 26 mm in length. But in the specimens grown in Stockholm from seeds of my Cameroon collection, the flowers are much larger than in the parent plant since the petals are 22—28 mm long. As the flower-size obviously varies due to environmental factors, there is no difference in the American and the African material with respect to petal size.

Whether *Cleome spinosa* Jacq. has recently arrived in tropical Africa, or has long existed there, though overlooked by the botanists, is not known. I consider it unlikely that this species has been consciously introduced as an ornamental plant in the Cameroons because the flowers were not particularly showy and because the indigenious people there seems not to grow plants for ornamental purpose. Probably it is grown for some other use e.g. medical herb, fish poison or vegetable (cf. the use of *Cleome gynandra*).

Further observations on the distribution and use of this species in West Tropical Africa would be of interest.

I also found *Cleome afrospina* Iltis in the Cameroons, namely in Edea, along the River Sanaga [Kers no. 1907 (S)].

Iltis (1967 p. 954) mentions only one African collection of *Cleome Hassleriana* Chod. The "Spider Flower" is rather commonly grown in South Africa, and I have seen some herbarium specimens from there which may represent occasional garden escapes (Herb. BOL, NBG, NH, PRE). It is not always easy to distinguish these from *Cleome afrospina* Iltis. The examples of *Cleome Hassleriana,* listed below, have tentatively been determined as belonging to this species. I have found it difficult to see a clear difference between them and *Cleome afrospina* Iltis, unless their leaflets tend to have fewer nerves (10—12).

COLLECTIONS. — *Cleome spinosa* Jacq.: Kers no. 1906, 9.I.1968, Cameroons, Edea. Roadside near the bridge (Sanaga River). Annual, erect and much branched, up to 9 dm tall. Stipular spines, mostly on older stems. Flowers pure white (S); Kers no. 3687, 1968, Spec. cult. in Stockholm from seeds of Kers no. 1906 (S). — ? *Cleome Hassleriana* Chod.: Cliver no. 196, 1925, Natal. Bed of River Umgeni, near the bridge (NH); Ogilvie no. 13, 1937, Natal. At edge of the road along the bank of the Umgeni River (NH, PRE); Wilman BOL 25536, 1954, Cape Province. Grown in a garden at George. Seeds collected in the Rhodesias? (BOL).

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Lars E. Kers

Studier av två flyggberg i övre Vindeldalen

(Studies of two mountains near the Vindel river, Swedish Lapland.)

ABSTRACT. — This paper describes two mountains, Bjettarpakte and Hemfjället near the Vindel river in Lycksele Lappmark of Swedish Lapland. The author has studied the terrain south of Bjettarpakte and has stated that this area is slowly rising. A small sea plateau is situated there at some distance from the perpendicular steep of the mountain. The author has investigated the site of a forest fire in the mountain and has found that leaf trees have

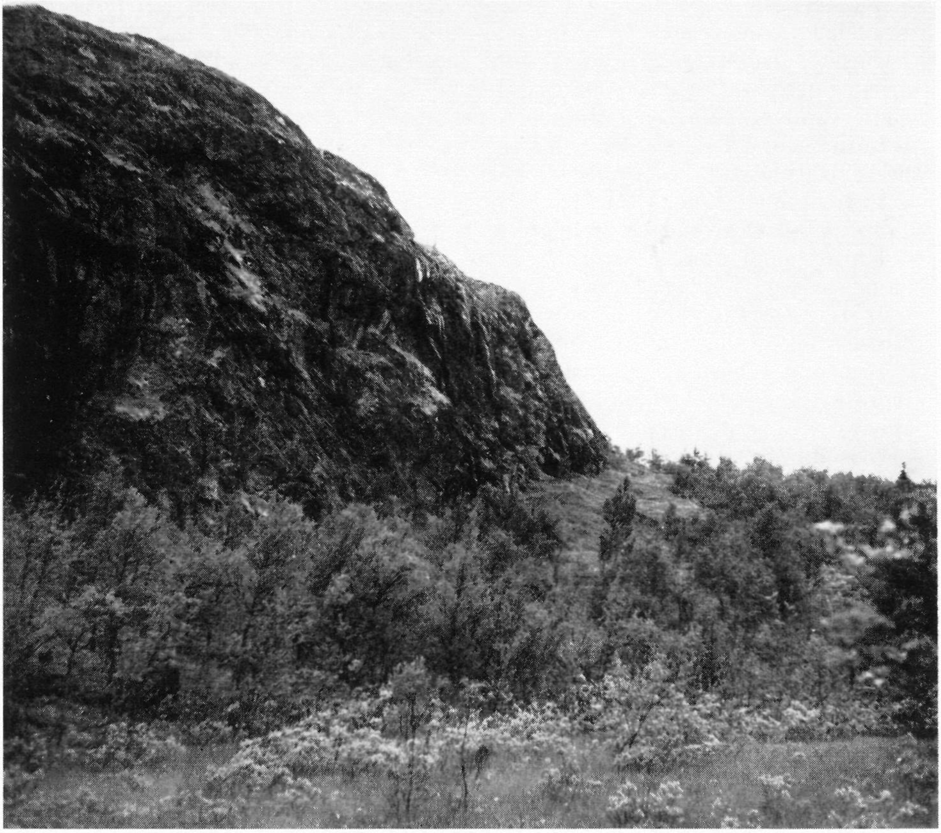

Fig. 1. Hemfjällets nordsluttning. Utsikt åt väster.
The mountain Hemfjället. Bluff at the northern side. View to the westward.

grown up after the burned coniferous forest. Under the north slope at Hemfjället there is a habitat with a rich variety of plants. On the mountain Varåive to the inside of Hemfjället the forest limit lies higher than on Hemfjället.

Bjettarpakte ligger strax N om Laisälven ca. en mil N om Sorsele. (Se generalstabskartan Blad 33 Sorsele.)

Under sommaren 1920 härjades ett parti av Bjettarpaktes barrskogsklädda sluttning av skogseld. Jag besökte området någon dag efter branden. Riset var avbränt, buskarna starkt svedda och många träd framstod som avbrända skelett med nedtill förkolnad bark. Brandzonen sträckte sig på en del ställen upp till blockmarken, men ingenstädes hade elden kastat sig över denna till ovanför befintliga träd. Blockmarkens bredd uppskattades till 30—60 m.

Samma plats besöktes den 21.6.1951. Efter branden hade en lövskog av företrädesvis björk och asp vuxit upp och ersatt barrskogen. På denna nivå, 440—470 m, fanns talrika brända barrträdsstubbar och lågor, som var förkolnade på ytan, samt i utkanten av brännan enstaka stående tallar med brandljud. Den 7.8.1961 besökte jag ånyo berget och utgick från bron över Laisälven (ortshöjd 350 m). Förlandet nedanför berget intogs av en mängd kraftiga, branta åsar, som förlöpte i olika riktningar. På åsarna fanns tallskog med en undervegetation av ris, lavar och något mossa. I åsgropar förekom gräs eller små vattensamlingar. På 360 m höjd började ett område med myrar och småtjärnar, som sträckte sig upp till 420 m. Jag passerade nu den gamla brandzonen och var vid 470 m framme vid blockmarken, som här var ganska torr och fattig på fanerogama växter. På 500 m höjd stod jag vid hammaren. Nedanför stupet fanns ganska kraftiga, glest stående granar i ett några meter brett stråk, som följde hammaren som en smal skogskuliss. Bland granarna fanns en nästan död jättetall samt en del lövträd. På blockmarkens översta del anträffades några jättestora liggande stammar av tall och gran. Vid bergroten syntes gröna fläckar av krypande enbuskar, smågranar, gräs, mossa m.m. Här växte bl.a. kattfot och hallon. I stupet fanns talrika hyllor och fåror med små exemplar av tall, gran och en samt örter.

Bjettarpaktes profil är typisk för ett flyggberg med fullt utvecklad hammare, finjordsremsa och rasmark. Man finner här också en annan egenhet, som är vanlig vid många flyggberg, nämligen en platå med svag dränering ett stycke nedanför rasmarken. Platån karakteriseras av tjärnar och myrmarker.

Hemfjället ligger vid Storvindeln omkring 4 mil NV om Sorsele och höjer sig ett tiotal meter över skogsgränsen. Flygg förekommer endast på nordsidan. Vid besök den 11 och 12 juli 1962 fann jag att sluttningarna var täckta med barrskog (mest gran), som på ca. 600 meters höjd övergick till blandskog med allt starkare björkinslag. Björkregionen började vid 650 m. Skogsgränsen låg på 680 m på sydsidan; på nordsidan gick björkskogen upp till 700 m. På toppområdet fanns ripris, dvärgbjörk och småviden. *Empetrum* förekom mest åt söder, *Vaccinium myrtillus* mera åt norr, *Cornus* och *Trientalis* mest åt norr. Nordflyggets hammare var i sin mest prominenta del ganska kal och brant. Ortshöjden vid basen var 650 m. Omedelbart nedanför hammaren täcktes sluttningen av riklig grönska. Längre ned växte enstaka småbjörkar och på ett avstånd av 25—50 m från stupet en låg björkskog. Nedom hammaren antecknades: *Aconitum, Chamaenerion, Lactuca alpina, Matteuccia, Melandrium rubrum* sparsamt blommande i rätt öppet läge, *Myosotis silvatica* ssp. *frigida, Paris,* ett ex., *Rubus idaeus,* enstaka, *R. saxatilis, Stellaria nemorum,* sparsamt, *Trollius* och *Valeriana sambucifolia.* Grönskan i flygget var särskilt riklig i den del av branten, som var hög och fuktig.

På Hemfjället intar kråkris toppens södra del, medan blåbär växer på den norra. Orsaken är tydligen den, att utsmältningen sker tidigare på sydsidan, varigenom kråkriset gynnas. På grund av sin skogslöshet är sydsluttningen vindexponerad, vilket medför att snötäcket i övre delen av denna icke kan bliva tjockt. Nordsidan åtnjuter däremot ett visst vindskydd av skogarna på platån, vars ortshöjd är ca. 640 m. Lokalklimatet under sommaren kan dessutom gynnas något av att avståndet är rätt stort till Vindelälven, vars vatten särskilt under försommaren verkar avkylande på de närmaste luftskikten.

Ett par kilometer NÖ om Hemfjället ligger fjället Varåive, där björkskogen slutar vid ca. 700 m. Barrskogsgränsen ligger enligt höjdmätaren åtminstone på 670 m. Skogsgränsen är alltså högre än på Hemfjället, vilket tyder på ett lokalklimat med dragning till större kontinentalitet. Kalfjället täcks här över stora områden av en mager, torr hed med ripris och lappljung.

Sven Gaunitz

A note on Pilayella Bory 1823

(Studies in the Biology from Memorial University of Newfoundland No. 145)

ABSTRACT. — The orthography of the brown algal genus *Pilayella* is discussed and the correct spelling is stated.

In an earlier paper Dixon and Russell (1964) discussed the orthography of the brown algal genus name *Pilayella*. Bory (1823) first described the genus as *Pilayella* although Leman (1826) later changed the spelling to *Pylaiella,* reasoning that the alga had been named after the botanist Bachelot de la Pylaie. Following the alteration by Leman later authors used the two orthographic variants quite indiscriminately and, as pointed out by Dixon and Russell it was not until after the adoption of *Pylaiella* by De Toni (1895) that a single spelling was used consistently in the literature, with few exceptions.

The orthographic confusion clearly arose in part through de la Pylaie's habit of varying the spelling of his name (see de la Pilaye 1826; de la Pylaie 1824, 1829). Dixon and Russell (op. cit.) were, nevertheless, able to conclude correctly that Bory's *Pilayella* is perfectly acceptable according to Art. 73 of the International Code of Botanical Nomenclature (see Lanjouw et al. 1966) as a latinization of de la Pylaie's name. That the name of the genus should remain as *Pilayella* is, therefore, indisputable.

A fact possibly overlooked by Dixon and Russell, however, is that Bory was probably aware of the correct spelling of de la Pylaie and recognised this when first describing *Pilayella.* Broyer (1938) has pointed out that the correct rendering of de la Pylaie is de la Pilaie, although Baudouin (1936 b) gave the correct rendering as de la Pilais. The former spelling would appear to be correct. Born at Fougères, Ille-et-Vilaine on May 25, 1786, de la Pylaie's father was a nobleman named René-Roch-Pierre de la Pilaie, his mother Claire-Renée-Geneviève Vigeon, dame de Plessix. In the entry of the birth recorded in the register of the parish church of St.-Léonard the spelling is given as Pilaie (Broyer 1936). The subsequent orthographic changes were made by de la Pylaie himself and according to Baudouin (1936 b) Pylaie is a pseudonym first used in 1810 when de la Pylaie was a lithographer. Further details can be found in Baudouin (1936 a). Since this pseudonym has through common usage become recognised as the correct name of the French botanist, Broyer (op. cit.) has advocated its retention. As a contemporary and associate of de la Pylaie it would seem logical to conclude, nevertheless, that Bory knew the correct rendering de la Pilaie and named *Pilayella* accordingly.

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G. ROBIN SOUTH

Om Festuca pratensis Huds. × Lolium multiflorum Lam. vid Landskrona

Anteckningar om Landskronatraktens flora VII

(Festuca pratensis Huds. × Lolium multiflorum Near Landskrona, Scania, Sweden)

ABSTRACT. — The hybrid *Festuca pratensis* HUDS. × *Lolium multiflorum* LAM. is reported from near Erikstorp, N. of Landskrona in the province of Scania, South Sweden.

På den 1964 nyanlagda golfbanan vid Erikstorp norr om Landskrona har ett av de områden, som sällan eller aldrig klippes, anlagts som en blomsteräng. I denna har in- och utländska växter utsåtts vid olika tillfällen. Huvudparten av det använda fröet har erhållits från en artrik gräsmatta i Lunds botaniska trädgård. Återstoden har erhållits från andra botaniska trädgårdar bortsett från frön av några lågvuxna foderväxter såsom *Anthyllis-*, *Lotus-*, *Medicago*-arter etc.

Denna blomsterängsflora innehåller numera många intressanta växter, bl.a. *Centaurea nigra* L., *C. phrygia* L., *Hieracium pratense* TAUSCH, *H. aurantiacum* L., *Koeleria pyramidata* (LAM.) DOMIN, *Ranunculus acris* L. ssp. *friesianus* (JORD.) R. et F., *Trisetum flavescens* (L.) PB., *Tragopogon pratensis* L. ssp. *orientalis* (L.) VELEN.

Den rika floran har årligen inventerats, varvid arternas frekvens, anpassnings- och spridningsförmåga har antecknats.

Vid en sådan inventering strax före midsommar 1967 upptäcktes två tuvor av ett gräs, som trots påfallande likheter med *Lolium multiflorum* avvek från denna art i flera karaktärer. Framför allt var det strånas och de båglikt lutande gracila axens byggnad, som var speciellt iögonfallande. Praktiskt taget alla småax var vidare försedda med två m. el. m. väl utvecklade skärmfjäll — en egenskap som utmärker några av de ofta mycket *Lolium*-lika hybriderna mellan *Festuca* och *Lolium* i motsats till de rena *Lolium*-arterna. Hos de senare kan dock — åtminstone hos *Lolium multiflorum* LAM. — ett nedre skärmfjäll förekomma i enstaka småax (HERTZSCH 1960 sid. 110).

Andra egenskaper, som tydde på att tuvorna utgjordes av hybriden *Festuca pratensis* HUDS. × *Lolium multiflorum* LAM. var deras ljusa grönska samt ytterblomfjällens välutvecklade borst, som saknas hos den snarlika, relativt vanliga *Festuca pratensis* HUDS. × *Lolium perenne* L.

De funna tuvorna var rikt bestockade med hapaxanth prägel; de saknade nämligen vegetativa bladskott i motsats till ett tidigare fynd av samma hybrid (NILSSON 1952 sid. 87). Möjligen kan detta tyda på, att den ettåriga rasen, *Lolium multiflorum* ssp. *Gaudini* (PARL.) SCH. et KELL., kan ingå i kombinationen i stället för den annars vanliga ssp. *italicum* (A. BR.) VOLK. Antagandet förutsätter emellertid att den annuella livsformen dominerar över den perenna.

Av föräldraarterna förekom på lokalen 1967 *F. pratensis* i 3 exemplar medan *L. multiflorum* liksom tidigare helt saknades. Hybriden måste därför härstamma från utsått frö, med stor sannolikhet härstammande från Lunds botaniska trädgård.

Hybriden *F. pratensis* × *L. multiflorum* är en mycket sällan sedd växt inte bara i Sverige utan även ute i Europa. HOLMBERG (1930 sid. 94) beskrev hybriden på ett exemplar funnet på ruderatmark i Landskrona. Nästa kända fynd är från Lomma, daterat 1935 (WEIMARCK 1963), och därefter följer författarens fynd 1948 på en vägkant mellan Örja och Råga Hörstad i Asmundtorp (NILSSON 1952 sid. 87). Från övriga Norden föreligger inga uppgifter och även från Europa i övrigt är uppgifterna mycket sparsamma, och därtill som det förefaller något osäkra. HEGI (1965 sid. 487) konstaterar om densamma: "*Festuca pratensis* HUDS. × *Lolium multiflorum* LAM. und *Festuca arundinacea* SCHREB. × *Lolium multiflorum* LAM. bedürfen noch eingehenderer Beobachtung. Ersterer Bastard wurde in Schweden gefunden". Hybriden *F. pratensis* × *L. multiflorum* finnes upptagen hos OOSTSTROOM (1965 sid. 761) och ROTHMALER (1963 sid. 45), dock utan att någon av dem anger några lokaler eller uppgifter om hybriden från respektive länder (Holland och Tyskland). Hybriden är ej heller känd från England. CLAPHAM et al. (1962) nämner den i varje fall inte i sin omfattande flora.

CITERAD LITTERATUR

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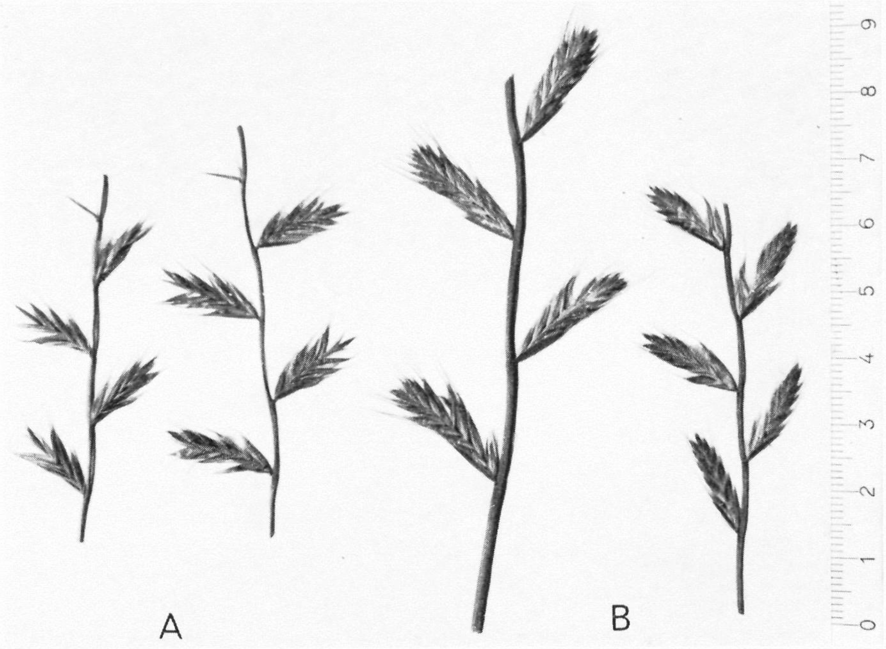

Fig. 1. Ax av A. *Festuca pratensis* HUDS. × *Lolium multiflorum* LAM. och B. *Lolium multiflorum* LAM. (Observera de övre, friställda skärmfjällen hos hybriden.)

Spikes of A. *Festuca pratensis* HUDS. × *Lolium multiflorum* LAM. and B. *Lolium multiflorum* LAM. (Note the upper, detached glumes of the hybrid.)

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ARVID NILSSON

Meddelanden

Utmärkelse

Professor emeritus ARNE MÜNTZING, Lund, har av Kungl. Skogs- och Lantbruksakademien tilldelats Nilsson-Ehle medaljen i guld för sina grundläggande insatser inom den svenska ärftlighetsforskningen.

Hedersledamot i Lunds Botaniska Förening

Vid sammanträde med Lunds Botaniska förening den 9 maj 1969 har professor HENNING WEIMARCK valts till hedersledamot i föreningen.

Hedersdoktorer

i Lund

Den 31 maj 1969 promoverades intendenten vid Naturhistoriska Riksmuseets paleobotaniska sektion, ELSA NYHOLM till fil. hedersdoktor vid Lunds Universitet.

i Uppsala

Den 31 maj 1969 promoverades föreståndaren för Vetenskapsakademiens naturvetenskapliga station i Abisko, laborator GUSTAF SANDBERG, Uppsala, till fil. hedersdoktor vid Uppsala Universitet.

Utnämning

Docent BERTIL NORDENSTAM, Lund, har utnämnts att från 1 juli vara intendent vid Naturhistoriska Riksmuseets botaniska sektion.

Disputationer

I Lund

2.5. 1969: GÖRAN PERSSON: "Genetic Analysis of a Quantitative Character, Far Internode Length, in Barley."

27.5. 1969: TORE MÖRNSJÖ: "Peatland Studies in Scania, South Sweden."

I Stockholm

9.5. 1969: ARNE HYPPEL: "Studies on the Inhibitory Propertion of Some Soil Fungi and Wood Material on the Germination of Conidia and Mycelial Growth of Fomes annosus under Laboratory Canditions."

I Uppsala

10.12. 1968: LARS-KÖNIG KÖNIGSSON: "The Holocene History of the Great Alvar of Öland."

16.4. 1969: JOHAN SANTESSON: "Chemical Studies on Lichens."

25.4. 1969: TORGNY UNESTAM: "Studies on Aphanomyces astaci, Physiology and Parasitic Relationship to the Crayfish."

A Joint Lund and Uppsala Symposium in Ecological Botany

(The report edited by Bengt M. P. Larsson and Hugo Sjörs)

Practical cooperation between departments working in different cities on identical or related scientific fields has usually been restricted to personal contacts, guest lectures or scattered participation in various symposia. The present initiative to bring the majority of the research workers of two institutes together therefore represents something of a new deal. A four days' symposium was arranged at the Institute of Ecological Botany (Växtbiologiska institutionen) of the Uppsala University, on September 27—30, 1967.

The plan for the symposium was simply to present interesting features of the current research of both departments of ecological botany (Lund and Uppsala). The emphasis was on methods rather than on results, and there was no aim at completeness. Lists of all research projects are available from the two departments, however.

The symposium was opened by Nils Malmer, Lund, who gave **"A sketch of a research program in plant ecology".**

At the Department of Plant Ecology of the Lund University a long-time research program has been initiated concerning the primary production and its turn-over, the energy flow, the mineral cycling, the water regime and the dynamics of the vegetation in different types of ecosystem in southernmost Sweden. Different investigations on forests, heaths, meadows, mires, lakes and sea shores have started, partly within the Swedish contribution to the IBP. Some preliminary results are presented at this symposium.

Short Reports on the Lectures of the Sessions

1. Woodland and meadows

Erik Sjögren, Uppsala: **Permanent sample plots in deciduous woods on the island of Öland.**

Since 1955 work on deciduous forest vegetation has been carried out in southern Sweden, concentrated to the island of Öland. This work has included the control in every year of 75—90 permanent quadrates in deciduous forests of very different sociological composition, mainly in the middle part of the island, where the local climatic differences are negligible. The plots, sized 1 m^2, have been investigated especially with regard to the field and bottom layers.

To reduce the sources of error, the cover degrees should be estimated by the same person. The different types of propagation of the species should be taken into consideration. Precipitation figures must be supplemented with notes on the snow cover.

Different kinds of changes in environmental conditions, climatic or others, induce fluctuations in the vegetation, as shown in the sample plots. Some change in the species composition, however, seems to occur even in the absence of marked changes in habitat factors. Whereas slight alteration in single species may be accidental, the correlation with changes in environmental conditions seems more valid when a group of species of similar ecological requirements appear negatively or positively influenced. Field-layer species usually react more rapidly during and after years of abnormally high or low precipitation, but also recover faster than bottom-layer species.

LENNART LINDGREN, Lund: **An inventory of beech forests in South Sweden for conservational purpose.**

In a great number of beech forests (*Fagus sylvatica*) in South Sweden the vegetation within representative sample areas of 1,000 m^2 to 10,000 m^2 has been investigated. Four main types of beech forest may be distinguished: the poor type (without a field layer or with *Deschampsia flexuosa* dominant), the *Oxalis acetosella* type, the *Melica* type (with *Lamium galeobdolon, Stellaria nemorum* ssp. *glochidosperma, Galium odoratum* and *Melica uniflora*) and the *Mercurialis perennis - Allium ursinum* type. The regional distribution of these types shows characteristic features. Proposals for protection of representative forest areas according to the results of this investigation have been presented.

See further Skånes Natur 1968 pp. 109—122 and Blekinges Natur 1969 pp. 36—63.

JAN NILSSON, Lund: **Estimation of production in selfgrown hay-meadows in South Småland.**

The hay meadows studied are not manured. Production accumulates continuously until the end of August. There is a great variation in productivity from spot to spot. Between two adjacent 0.25 m^2 squares the difference may amount to 30 %. At mowing the farmer leaves between 10 and 40 % of the aerial parts of the vegetation. The quantity left depends on the unevenness of the ground and the composition of the vegetation. The yield is rather constant from year to year. The yearly productivity of the investigated meadows amounts to 300 g/m^2 (3 t/ha). These values are significantly higher than those reported from vegetation of similar character in Central Sweden (Dalarna).

See further Sveriges Natur 1968 pp. 125—137.

SVEN BRÅKENHIELM, Uppsala: **Successional change of vegetation and soil in spruce plantations on abandoned fields in North-Eastern Småland.**

For comparison of different stages in the succession from open field to forest six plantations are being studied. The number of years they have been planted ranges from two to twenty-one. The oldest one is completely closed. In each plantation 30 quadrates 0.25 m^2 in size have been spaced in geometric pattern between the rows of young spruce (*Picea abies*). Each year all species are recorded as to coverage, fertility and occurrence of seedlings. Soil samples from the upper ten cm have been collected for analysis with regard to some important soil properties. pH has been found to be about 1.5 units lower in the later stages of succession than in the early ones.

On the abandoned fields successional stages rapidly replace one another since the communities are not closed from the start. The development is soon directed by the influence of the young spruces as they become dominant. Vascular plants mostly disappear but mosses stay though they show signs of starvation. None of the stands studied has so far been thinned. Following thinning some recolonization of such species that endure shade and acidity is to be expected.

HUGO SJÖRS, Uppsala: **Winter grazing grounds for reindeer in Norrbotten county.**

Research has been initiated, in cooperation with Dr. ELIEL STEEN of the Agricultural College, Uppsala, on the serious overgrazing effects of the high population of semi-domesticated reindeer in northernmost Sweden. The field work is carried out by OLOF ERIKSSON and involves an attempt to measure not only standing crop of ground lichens, but also their annual productivity and capacity of recovery in various states of wearing-down through the grazing and trampling. The aim is to get advice as to the tolerable grazing pressure and to find out such methods of management that severe overgrazing could be avoided in the future.

2. Air pollution as indicated by the reduction in epiphytic lichen vegetation

ERIK SKYE, Uppsala. See his thesis which appeared as Acta Phytogeogr. Suec. 52 (1968).

3. Ecology of lake and sea shores

GERMUND TYLER, Lund: **On the effect of phosphorus and nitrogen supplied to Baltic shore-meadow vegetation.** See Bot. Notiser 120 pp. 433—447 (1967).

BENGT M. P. LARSSON, Uppsala: **Water level fluctuation and vegetation on the shores of Lake Vänern.**

The water level of Lake Vänern (the largest lake in Sweden) fluctuates with a pronounced multi-annual cyclicity, which partly remains even after 1938, when the lake was regulated. Before this year the extreme amplitude of water level fluctuation was 2.69 m, which is quite high but only half as large as the corresponding values for some North Swedish lakes. Now the amplitude is ca 2.0 m, still a rather high value for South Swedish conditions.

The effect of this periodic shift in water level on the vegetation growing on various shore types implies important problems. What effects may perennial drowning or draining have on the shore vegetation? Another part of the investigation is aimed at clarifying the importance of exposure. The Point of Hinden offers good possibilities for comparative studies in both these respects. In the Kålland area the bryophytic zonation on rocky shores has been studied with special regard to substrate and exposure. The vertical distribution of the species studied has been analyzed in detail. These data and corresponding data for water level registrations can be compared and correlated.

HANS OLSSON, Lund: **Calcium and phosphorus in two dune areas in South Sweden.**

Sand dunes of two coast areas, Tönnersa (Tö) in southern Halland and Sandhammaren (Sh) in south-eastern Skåne, were compared.

In the soil Ca and P showed higher values in samples from Sh than from Tö. At Sh P seems to be Ca-bound and derived from the mineral component. The higher P-values from Sh probably depend on the mineral composition in the sandy surroundings. At Tö a connection between particle-size fractions and P was observed. An increase in Ca and decrease in P with high concentration of humus, e.g. under heather, was noticed as well as leaching of Ca and P. Wet dune depressions showed conformities in Ca but differences in P.

4. Phycology

KUNO THOMASSON, Uppsala: **Freshwater phycology.**

Freshwater phycological research has a long tradition in Sweden. Consequently the available information about Swedish freshwater algae is rather comprehensive. The best studied lake is the well known Lake Tåkern, about 1000 taxa recorded, and the most exhaustively investigated area is located around Abisko in northernmost Sweden; this area has also attracted many foreign experts.

During post-war decades, construction of hydro-electric plants and reservoirs, which have spoilt the original, usually quite natural conditions in the majority of large North Swedish water-courses, gave an impetus to botanical investigations, including phycological, in a considerable number of freshwaters.

The phycologists of this institute were mostly engaged in such projects during many years. However, for the present there is less phycological study in the northern Swedish watercourses, investigations carried out within and in collaboration with the Lake Mälaren research project being predominant in Uppsala. In addition pioneer studies as to the freshwater algal flora and vegetation of several distant countries have been carried out at this institute. Much importance has been attached to the taxonomic treatment of freshwater algae.

GEORG SCHUISKY, Uppsala: **Phytoplankton studies in lakes in Middle Sweden.**

During the summer of 1966, 32 lakes in the district of Bergslagen were investigated. Physical and chemical conditions were studied in relation to qualitative and quantitative composition of phytoplankton. The mean values of the total plankton volume, which was dominated by diatoms, ranged between 6 and $1500/\mu m^3.10^6$/liter. The larger values indicate a mesotrophic character, especially in the water-course of Kolbäcksån and the two lakes Sörmogen and Norrmogen. The smaller values were found in the strictly oligotrophic lakes, e.g. Klotensjön ($\varkappa_{20}=15$), located in the elevated parts of this district. The figures for total volume also showed that there is a downstream increase in the quantity of plankton in the lakes. This relationship is especially evident in the mesotrophic parts of the investigated area. A list of observed species, which is based upon both the qualitative and quantitative samples, gives valuable information about the ecologic character of these lakes. In Lake Östra Sveten the phytoplankton was dominated by *Asterionella zasuminense* which has but seldom been observed in this country.

PER ERIK LINDGREN, Uppsala: **Some notes on the littoral and submerged vegetation in the estuaries of the River "Göta Älv".**

"Göta Älv" — the only big river of the Swedish West Coast — has two estuaries and attached to them two river arms. The northern arm "Nordre Älv" is only moderately polluted and presents a continuous salinity gradient from freshwater to the surface seawater of northern Kattegat. The river is big enough and the topography favourable enough to present a suite of brackish biotopes with varying salinities. At the very mouth of the river there is oligohaline water with total absence of *Fucus* and with *Enteromorpha ahlneriana* and *Balanus improvisus* as most important marine species. There occur *Typha latifolia, Elodea canadensis, Potamogeton pectinatus, P. perfoliatus, P. crispus, Glyceria maxima, Elatine hydropiper, Callitriche polymorpha, Myriophyllum spicatum* and *Ulothrix zonata.* In the inner part of Nordre Älvs Fjord where the first specimens of *Fucus vesiculosus, Hildenbrandia prototypus* and *Verrucaria maura* are observed, it is still possible to find *Myriophyllum spicatum, Potamogeton perfoliatus, Callitriche polymorpha* and *Elatine hydropiper.* In the outer part of Nordre Älvs Fjord the brackish environment is reflected in the geo-littoral vegetation with an upper *Ulothrix* sociation and lower *Phormidium corium* sociation, and in the hydro-littoral vegetation by *Cladophora glomerata.* Outside Nordre Älvs Fjord the geo-littoral changes into the normal west-coast geo-littoral with *Verrucaria maura, Calothrix scopulorum* and *Caloplaca marina* among the dominants. But *Cladophora glomerata* and *Potamogeton pectinatus* are important far out.

The southern arm — "Göta Älv" — is extremely polluted. As the distance between the estuaries is only 15 km, the recipient sea may be considered as originally similar, and consequently the degree of pollution as the main biological difference. As expected there are striking differences in regard to organisms. From the southern estuary we may note the littoral border formed by *Fucus edentatus,* the frequent occurrence of *Spirulina subsalsa,* the position far out — at higher salinity than expected from distribution data — of the inner limits of *Cladophora glomerata, Fucus spiralis* and *Trailliella intricata.* In the inner part of the southern estuary there are mass occurrences of *Enteromorpha* species, *Ulva lactuca* f. *latissima* and *Mytilus edulis,* and a striking gray "pubescence" of infusoria on *Cladophora glomerata* and other algae. These features obviously are due to the much higher degree of pollution in the southern estuary.

See also Acta Phytogeogr. Suec. 50 pp. 92—96 (1965).

5. Bioclimate and water conditions

LARS PÅHLSSON, Lund: **Microclimatic variation in relation to vegetation and soil.**

Investigations have been performed on an esker east of Dalby, Skåne, concerning the different vegetation on the southern and the northern slopes. The greater insolation on the southern slope implies a larger evaporation from the soil and drier conditions. But this is not the case everywhere. Differences in the structure of the vegetation, e.g. density and height, cause a variation in microclimate and dryness on the southern slope. Surfaces without vegetation, with low mosses and lichens, with *Festuca ovina* and with *Ononis repens* were compared (July 1966). In the *Ononis repens* vegetation the microclimatic conditions near the ground and the soil moisture were about the same as on the northern slope. Some species only found commonly on the northern slope also grow among this *Ononis repens.*

See further Bot. Notiser 119 pp. 401—418 (1966).

JIM LUNDQVIST, Uppsala: **Habitat factors on talus slopes in Pite Lappmark.**

During the investigation the dependence of the talus ecosystem on exposure to the sun and different substrates around the eastern border of the Caledonides was studied. Because of the general trend in large-scale climate, the difference in average air temperature between slopes of opposite exposures is small. The southwest-exposed slope is comparatively warm on bright days. Elevated slopes of any exposure are warmer than level land in clear nights with strong eradiation.

The thermophilous group of the flora was also studied with regard to certain trends in large-scale climate, and correlations between topography, climate, substrate and the biogeographic element shown to exist.

See further Acta Phytogeogr. Suec. 53 (1968).

BENGT NIHLGÅRD, Lund: **Distribution of rainfall in beech and spruce forest, a comparison.**

During the summer 1967 the distribution of the rainfall above ground was studied in one beech forest and one neighbouring, planted spruce forest, situated on Söderåsen, Skåne. Direct down-fall (d), including also dripping from branches and leaves, was measured by rain-gauges, placed on the ground. Stem flow (s) was measured on some trees with special stem-gauges. Interception (i) has been calculated by difference, rainfall on free ground (=in a clearing) regarded as 100 %. According to the variable strength of the rain-showers, the distribution varied as follows: In beech forest (d)=70—80 %, (s)=5—15 %, (i)=5—15 %. In spruce forest (d)=50—60 %, (s)=0—5 %, (i)=35—50 %.

FOLKE ANDERSSON, Lund: **Description of soil moisture in relation to vegetation.**

Two main types of soil moisture regimes may be recognized — waterlogged soil with impaired aeration and non-waterlogged soil with an adequate aeration. In the first case the degree of water filling-up of the pore space and in the second the quantity and the availability of soil water ought to be determined. Descriptions of these properties require knowledge of the following parameters: soil sample of known volume, actual water storage, pore space volume and the relation between soil moisture tension, esp. at field capacity, and the corresponding soil moisture values.

Preferably the observations ought to be carried out at intervals during all the year in order to registrate periods of different water filling of the pore space. But investigations may also be concentrated to one or some days with a characteristic water state in the soil such as field capacity in the spring and extreme dryness during summer or autumn.

See further Bot. Notiser 116 pp. 257—265, 376—395 (1963).

6. Bogs and fens (jointly termed mires)

NILS MALMER, Lund: **Preliminary data on standing crop on a small mire.**

On the investigated mire, situated near Värnamo, Småland, six large-scale plant communities were distinguished and mapped. As the plant cover is very inhomogeneous with many different life-forms represented (trees, scrubs, herbs, graminids, bryophytes and lichens) it is difficult to measure the standing crop and even more to compare it between two plant communities. The preliminary results indicate that when there is a tree layer this forms the greater part of the standing crop. The yearly production seems, however, to be more equally shared between the tree layer and the field+bottom layer.

TORD INGMAR, Uppsala: **Measurements of pH and conductivity at standard carbon dioxide pressure.**

This contribution will be published at a later occasion.

HUGO SJÖRS, Uppsala: **Inventory of mires suited for protection.**

The international Project Telma was presented. An international list will mention only about five large Swedish sites but much more comprehensive national lists should be included in the inventory. In addition, smaller but highly valuable mires could be listed as a third group. Although Sweden is behind such countries as the U.K., Finland and Poland, the inventory has started, and in the summer of 1967 (and also later) work on it has been done by F. Björkbäck, E. Marklund and others.

Göran Svensson, Lund: **Stratigraphical studies of the succession between bog hollows and hummocks on Store Mosse (Småland).**

The studies have been made along two 60 m long sections, which cross three hummock banks. Stratigraphy: 0—2.0 m *magellanicum* peat H 2—3, with the exception of the hummock banks with *imbricatum* and *fuscum* peat; 2.0—2.2 m *Sphagnum* peat H 7—8; 2.2—3.0 m *fuscum, rubellum* and *cuspidatum* peat H 5—6; 3.0—3.2 m *Sphagnum* peat H 7—8; 3.2—4.6 m *fuscum* peat H 5—6; 4.6—5.0 m *Cyperaceae* peat H 8—9; sand bottom. Radiocarbon datings show that the fen was transformed into bog about 2800 B.C., while the two highly humified layers, probably recurrence surfaces, were formed about 500 B.C. and A.D. 850, respectively. The hummock banks are very constant but there can be a slow, irregular succession between the *Sphagnum magellanicum* community of the lower hummocks and the *Sphagnum cuspidatum* community of the hollows.

Mats Sonesson, Lund: **Importance of snow distribution for the differentiation of subalpine mire vegetation in the Torneträsk area.**

The great regional differences in snow cover in the Torneträsk area, Lappland, were pointed out. These differences are allied to differences in the mire vegetation. Also, on the individual mires the snow conditions vary from point to point. The inequalities in the distribution of snow vary between different seasons but are repeated from year to year. During autumn and late spring, when the depth of the snow is small, the variation in its distribution is greatest. The opposite conditions (much snow, less variation) prevail during early spring. Possible explanations of the variation and of its importance to the vegetation were presented.

See further Bot. Notiser 120 pp 272—296 (1967).

Torolf Lönnerholm, Uppsala: **Tentative methods to determine the gradients of O_2 and H_2S in mires and their relation to decay of organic matter.**

This investigation had just started at the time of the Symposium.

Botanisk litteratur
(Botanical Literature)

Wardlaw, C. W.: Morphogenesis in Plants. A Contemporary Study. — Methuen & Co. Ltd, London; distributors Chapman & Hall, London, Barnes & Noble, New York. 1968. 451 pp. 12 plates and several textfigs. Clothbound. Price 90 s.

A smaller volume published in 1952 can be regarded as the first edition of this book because it has the same title, Morphogenesis in Plants. The author of the two books is professor emeritus C. W. Wardlaw, University of Manchester, England.

The present book is a new, enlarged, and entirely revised version. The character of the book is almost encyclopidical. Facts from a large and scattered literature are brought together, which gives the book a particular value of reference. Wardlaw's long experience of morphogenesis makes him most fitting for such a work. Consideration is taken to the new literature in morphogenesis and embryogenesis as well as to older works. Many recent advances are discussed with criticism and discernment. The author shows, with his own remarks, that some recent investigations have yielded results which are as unexpected as they are fascinating and far reaching in their implications.

The author speaks in the preface of a "swansong". If so, it is my hope that the song has just started and will continue for a long time. During the study of the book one never feels that the author is an "old man" surveying an old mine of facts. On the contrary one becomes convinced that the author is as interested of the subject as the reader becomes after acquainting himself with the contents of the book.

In the book, morphogenesis of all major plant organs, is considered in different chapters. A general account of embryogenesis is given as well as a thorough presentation of modern experimental embryology. The second chapter contains a review of some important older works in morphogenesis and ends with a list of notable new literature in the same subject. At the end of the book one also finds a very complete bibliography. The text is accompanied with instructive illustrations.

Some notes on the contents. Phyllotaxis is discussed in chapter IX. There has sometimes been a tendency to neglect phyllotaxis in standard texts and in monographs. The reason may be that it is a difficult topic. Much work has been done on the easily observable, positional differences in leaf arrangement.

But still very little is known about the factors which determine the phyllotaxis. WARDLAW presents some of the new works and ideas in phyllotaxis with particular attention to mathematical analyses and experimental investigations in the subject. These certainly will bring much light over the complex phenomena. The title which the author was tempted to give the chapter, "Phyllotaxis Without Tears", seems to be an appropriate one.

In the chapter dealing with the inflorescence and flower one meets the concept of gonophyll (MELVILLE 1962, 1963). According to this idea the term flower has become modified so that it refers to a biological rather than to a morphological unit. It becomes applicable both to single flowers as well as to condensed inflorescences.

One of WARDLAW's fundamental ideas follows the reader through the entire book. In plant morphogenesis one feels that mathematics, biochemistry, and biophysics have started to play a steadily increasing role, sometimes as it seems on the cost of the plant component. "An ultimate aim in morphogenesis must be an adequate biophisico-chemical synthesis, but always bearing in mind that, basically, something must always be accepted *as given,* namely, the specific hereditary constitution of the species, elaborated and selected over vast periods of time." The large number of plant species and their great morphological diversity are facts and phenomena that cannot be neglected. In the future, morphogenesis probably will have to be a teamwork between scientists of different scope and training.

ÖRJAN NILSSON

EARNEST L. LUTZ SR.: Handbook of plastic embedding of animals, plants and various objects. — Naturegraph Publishers. Healdsburg 1969. 192 pp., 13 full-colour and 59 black and white photographs, 15 drawings and 4 tables. Price $ 3.95 (paper ed.), $ 5.95 (cloth ed.).

This handbook gives in concise form the essential knowledge gained by the author during more than thirty years of intensive research and experimentation.

Different and new types of plastics (e.g. the polyester resin C.M.E.—D 6) are explained and new ideas for using them are given. In chapter 4 and 7 the technique for the preparation and the embedding of botanical objects in convenient plastics are described.

The illustrations, the glossary and the descriptions give good information how to do this technical work without too much difficulty and the handbook as a whole will certainly serve as a useful embedding guide.

INGEMAR BJÖRKQVIST

OLOF ANDERSSON: Lömskt och läckert. Färgfoton av svampar i naturlig miljö. — Corona, Lund 1969. 107 sid., 123 färgfotografier samt textfigurer. Pris häft. 13: 50 kr; inb. 16: 20 kr.

Det är bara några år sedan OLOF ANDERSSON översatte LANGE och LANGES Svampflora från danska språket, och man blir därför något överraskad, då ANDERSSON nu ger sig i kast med att göra en populärvetenskaplig, ganska snarlik bok. Den största skillnaden ligger i bildmaterialet. LANGE och LANGE använde tecknade och målade figurer och ANDERSSON färgfotografier. Båda illustrationssätten har sina för- och nackdelar. Fördelarna med färgfotografering har utnyttjats skickligt i ANDERSSONS bok. Det stora flertalet figurer är utmärkta, såväl ur mykologisk som fotografisk synpunkt.

Helt allmänt kan sägas, att det 60-tal figurer, som är gemensamma för denna svampbok och Lilla uppslagsboken (uppl. 2), är bättre återgivna där. Mot vissa figurer kan eventuellt den anmärkningen riktas, att de ej är tillräckligt informativa. Sålunda visar fig. 32 och 109 för litet detaljer; i fig. 33 har lamellerna på pudrad trattskivling blivit rödaktiga. Fig. 36 och 40 borde kompletterats med upp-och-ner vända fruktkroppar, för att visa de karakteristiskt glesa lamellerna. Ur fotografisk synpunkt har t.ex. färgåtergivningen blivit för röd i fig. 24. Kontrasten ljus-skugga är alltför stor i vissa solbelysta figurer (t.ex. fig. 84 och 95).

Den inledande texten är mycket vederhäftig och trevligt skriven. Den ger svampplockaren en viss inblick i såväl mykologisk systematik, morfologi och ekologi. Svamparnas giftverkan och deras användbarhet som föda behandlas förhållandevis ingående. Författaren lämnar också råd och anvisningar för insamling och tillagning.

Beskrivningarna i anslutning till figurerna är korta men informativa. Det hade varit värdefullt om de viktigaste och skiljande karaktärerna kursiverats. Varje svampgrupp markeras med egen rubrik. Man saknar dock en kort gruppbeskrivning under rubrikerna. Det hade ökat möjligheterna att åtminstone till släkte bestämma sådana svampar, som ej behandlas i boken. Anmärkningen motverkas i viss mån av att det i slutet av boken finns examinationsschema. Man undrar dock hur det går för den icke mykologiskt skolade svampplockaren, då han på första raden möter:

A 1 Sporer (oftast åtta) bildas inuti en sporsäck.
A 2 Sporer (oftast fyra) bildas utanpå en basidie.

Hur tänker sig svampplockaren dessa sporer, säckar och basidier? Är de cm-stora eller mm-stora eller . . . Såväl asci som basidier diskuteras i det inledande kapitlet. Dock tycks inte heller där deras mikroskopiska karaktär bli helt klarlagd för läsaren.

En sak, som förbryllat recensenten är hur man i examinationsschemat skall komma från sid. 97 till sid. 98. Av allt att döma börjar dock på sid. 98 ett nytt examinationsschema, fristående från det på sid. 97.

De gjorda anmärkningarna förtar inte det positiva helhetsintryck, som boken ger. Den rekommenderas som ett bra hjälpmedel i skolornas och universitetens undervisning i kryptogamkännedom. Man önskar dock innerligt, att OLOF ANDERSSON snart skall komma med en fullständigare och mera seriös presentation av sin omfattande forskning inom storsvamparnas systematik och ekologi.

SVEN-OLOV STRANDHEDE