The floral anatomy of *Kniphofia uvaria* Hook. (Liliaceae: Kniphofieae)

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Abstract. The floral anatomy of *Kniphofia uvaria* Hook. is described. The tepals are anatomically similar and one-traced. The stamens are one-traced. The outer whorl consists of shorter stamens. The placentation is parietal, nectary ovarian and septal. The extension of the carpellary ventrals into the style is an important anatomical feature. The trend towards development of an inferior ovary is noted. Evidence from floral morphology and other disciplines is discussed and it is inferred that the alleged affinity of *Kniphofia* and the Kniphofieae with the Aloineae and the Hemerocallideae is rather remote.

Keywords. Floral anatomy; *Kniphofia uvaria*.

1. Introduction

In earlier contributions, the floral anatomy of the Aloineae and Hemerocallideae was presented (Vaikos, Markandeya and Pai 1978, 1981). The tribe Kniphofieae is thought to chiefly comprise of the genus *Kniphofia* (cf. Stebbins 1971) although two more genera *Blandfordia* and *Notosceptrum* are included in it by Hutchinson (1959). The present paper deals with the vascular anatomy of the flower of *Kniphofia uvaria* Hook.

2. Materials and methods

The flowering material was obtained from the Curator, Government Botanical Gardens, Ootacamund. The flower buds were fixed in FAA. The usual paraffin method was followed. The microtome sections cut at 9-12μ were stained with crystal violet using erythrosin as counter stain.

3. Observations

The pedicel contains a ring of three large bundles (figure 1). These are laterally connected upwards to develop an anastomosis (figure 2). The six tepal strands...
emerge first (figure 2). The six staminal strands emerge quickly upwards (figure 3). The remainder of the vascular tissue resolves into three carpellar dorsals and six carpellar ventrals (figure 3).

The hypanthium is adnate to the ovary for a short length (figures 4, 5). The tepals and stamens separate out simultaneously (figure 5). The tepals are united into a tube for a considerable length (figures 5-11). Each of the tepals receives a single vascular bundle (figures 5-11).

The stamens have cylindric filaments (figures 5-8). Those of the outer whorl are antheriferous first and are also shorter (figures 9-10). The inner three stamens are antheriferous at a much higher level (figures 10-11). Each of them receives a single vascular bundle which continues upwards into the connective without a division and ends beneath the tip of the anther (figures 5-10). The connective splits and ends together with the anther lobes (figure 10). The anthers are introrse and two-celled.

The ovary is trilocular at the base with the ovules arranged in two rows in each loculus (figures 4-6). The carpellary ventrals of adjacent carpels are united to form the composite placental bundles which are lodged on septal radii (figures 4-6). These split into the constituent ventrals at the beginning of the ovuliferous zone and bear traces to the ovules of adjacent carpels (figure 6). Upwards, the placenta separate in the centre rendering the ovary unilocular (figure 7). The ventrals of adjacent carpels extend at the inner end of the septa, continue to bear traces to the ovules of adjacent carpels (figure 7) and enter the base of the style (figure 8). The carpellary ventrals end in the basal half of the style.

The septal nectaries are developed from the base of the ovary (figure 4). These open at the base of the style (figure 8). The ovarian loculus is continued upwards into the style as a triradiate canal (figure 8). The stylar canal is closed in the centre in some to result in three cavities (figure 9). It is lined with transmitting tissue. The carpellary dorsals extend into the style (figures 8-9) and end much beneath its tip (figure 10). The style has three grooves along which it splits into three non-vascular stigmatic lobes (figure 11).

3.1. Abnormal flower

This flower has eight tepals, eight stamens and four carpels. The vascular supply is derived in conformity with the tetramerous structure (figure 12). The septal glands are four (figure 13). The style receives four carpellary dorsals and it is four-lobed (figure 14).

4. Discussion

The six tepals are arranged in two whorls and are united to develop a prominent tube. Each of them receives a single bundle and, anatomically, both the whorls are similar. This is a condition observed in many liliaceous genera, e.g., Ophiopogon, Convallaria, Polygonatum, Maianthemum, Eucomis, Asphodelus, Urginea, etc. In the allegedly allied Aloineae and Hemerocallideae (Vaikos, Markandeya and Pai 1978, 1981), the tepals are three-traced; the three traces may arise separately
from the stele or the laterals of the outer and inner tepals may be derived through a bifurcation of the common or commissural bundles.

The stamens are also one-traced; this is characteristic of most lilies studied. The similarity in the vascular supply to the tepals and the stamens does not seem to indicate a staminal origin for the perianth as is sometimes inferred (cf. Leinfellner 1963).

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**Kniphofia uvaria** Hook.


*Abbreviations* D, carpellar dorsal; is, inner staminal strand; L, locule; MIT, median bundle of an inner tepal; MOT, median bundle of an outer tepal; N, nectary; OSt, outer staminal strand; Pl, placental bundle; SC, stylar canal; STY, style.
The outer stamens are shorter than the inner ones. This condition is characteristic of species of Aloineae, Alliaceae and some other genera (Markandeya 1978; Vaikos 1974; Vaikos et al. 1978, 1981). It represents a trend towards differentiation of the two androecial whorls and ultimate reduction of one or more of the shorter stamens or a whorl of stamens as occurs in Alliaceae (Markandeya 1978).

The outer floral whorls are adnate to the base of the ovary indicating a trend towards the development of an inferior ovary. This is a trend which sporadically occurs throughout the many genera and tribes of the family (Markandeya 1978; Vaikos 1974; Vaikos et al. 1978, 1981).

The gynoecium is tricarpellary and trilocular at the base and unilocular upwards. The carpellary ventrals are lodged on the alternate septal radii and bear traces to the ovules of adjacent carpels. The placentation is anatomically and morphologically parietal (cf. Puri 1952).

The nectaries are ovarian and are typical septal glands. They develop at the base of the ovary and open at the base of the style. The placental bundles which lie close to the glands have to be associated with them in their function (Agthe 1951; Frei 1955; Pai and Tilak 1965).

The style receives the carpellary dorsals and the carpellary ventrals, although the latter end early. The extension of the carpellary ventrals into the style is a less advanced feature.

Tetramerous structure is noted in a few flowers. The vascular supply is derived in conformity with tetramery. Tetramerous flowers occur normally in Aspidistra.

The genus Kniphofia forms a component of the Aloineae in the Englerian scheme (of Melchior 1964), whereas Hutchinson (1959) erects a tribe in its name. In the old Bentham and Hooker’s (1883) system it is placed under the tribe Hemerocallideae.

This paper demonstrates that the tepals in Kniphofia are one-traced while in Aloineae and Hemerocallideae they are three-traced (Vaikos et al. 1978, 1981). In the studied plants of the tribes Aloineae and Hemerocallideae, the placentation is axile, while it is parietal in Kniphofia.

In the taxa of the Aloineae studied, all or few stamens are adnate to the base of the ovary and, as a variation, the stamens and the style may also be fused up to the top to develop a prominent column—the gynostemium (Vaikos and Markandeya 1976; Vaikos et al. 1978). In Hemerocallis, the stamens are adnate to the perianth (Vaikos et al. 1981). However, in Kniphofia the stamens are neither adnate to the ovary nor to the tepals.

Embryological evidence shows that Kniphofia is best treated distinct and not as a component of the Hemerocallideae (cf. Di Fulvio and Cave 1964). The study of vessel structure shows the vessels in Kniphofia are less specialised than those in the Hemerocallideae, as also the Aloineae (Cheadle and Kosakai 1971).

Anthraquinones are detected in Aloe, whereas they are absent in Kniphofia (Van Oudtshoorn and Van Rheede 1964).

The karyotype of Kniphofia is symmetric with \( n = 6 \) (Moffett 1932; Stebbins 1971). The Aloineae have the characteristic bimodal \( 4L + 3S \) karyotype (Brandham 1971; Darlington 1963; Stebbins 1971), whereas Hemerocallis of the Hemerocallideae has \( n = 11 \) and the karyotype is not very asymmetric and shows rather a close similarity with Amaryllis (Sato 1942).
Floral anatomy of Kniphofia uvaria

Hutchinson (1959) considers the further development of the Kniphofieae to the Aloineae. Cheadle and Kosakai (1971) consider this as a plausible suggestion for they find the vessels in the Kniphofieae less specialised than those in the Aloineae. Furthermore, “no member of the Aloineae has vessels less specialised than those most specialised in the Kniphofieae”.

Stebbins (1971) infers a karyological affinity between the Kniphofieae and Aloineae and suggests that, “increasing asymmetry and heterogeneity of the relatively symmetrical karyotype of the Kniphofieae, consisting chiefly of the genus Kniphofia, together with the addition of a chromosome to the complement through fixation of a centric fragment, would lead to the asymmetrical karyotype of the Aloineae with $n = 7$”. This appears to be too speculative a statement at the present stage of our knowledge and further karyological studies of more species of the genus should be in order. It may be noted that the bimodal karyotype of Aloineae is clearly marked with chromosomal markers for it. The present study would demonstrate that Kniphofia is best placed distinct from the Aloineae as also the Hemeroallideae. Further studies on more species of the genus are obviously in order for a categorical conclusion.

Hutchinson’s treatment of the tribe may also need a review. Di Fulvio and Cave (1964) doubt the inclusion of Blandfordia in the tribe. Both Blandfordia and Notosceptrum merit a floral anatomical study.

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