

Morphological variability of seeds in East African species of the genus *Hypoxis* L. (Hypoxidaceae)

Justyna Wiland-Szymańska

Department of Plant Taxonomy, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland & Missouri Botanical Garden, St. Louis, MO, U.S.A., e-mail: wiland@amu.edu.pl

Abstract: Morphology and types of the seed testa sculpture in the East African taxa of the genus *Hypoxis* were investigated. Studies have revealed that there are 9 types of the seed testa sculpture in the East Tropical Africa. Distribution of types of seed testa sculpture is unequal among the taxa studied. Some are wide spread and some confined to a single species or variety. Morphology of the seed testa sculpture is a useful taxonomic character for determination of taxa of the genus *Hypoxis* in the East Africa.

Key words: seed, morphology, *Hypoxis*, Hypoxidaceae, East Africa

1. Introduction

The genus *Hypoxis* belongs to the family Hypoxidaceae confined to the lower Asparagoid clade. It occurs in the tropical, subtropical and temperate zones of both hemispheres except Europe. South Africa is regarded as its main center of endemism, and probably a center of origin (Geerinck 1969; Singh & Wiland-Szymańska 2002). East Africa (Uganda, Kenya and Tanzania) is one of its less prominent African centers of diversity harbouring 15 species (Wiland-Szymańska & Nordal 2006).

A systematics of this genus of about 120 species is still not fully understood. This situation is connected with lack of distinctive morphological characters between species, reticulate evolution of some characters and occurrence of apomixis (Wilsenach 1967; Wilsenach & Papenfus 1967; Wilsenach & Warren 1967; Zimudzi 1994). Moreover in taxonomic treatments of African *Hypoxis* (e.g. Baker 1878; Nel 1914; Nordal *et al.* 1985; Wiland-Szymańska 2001) different sets of characters were used in the keys as well as various species concepts.

Seed testa sculpture is believed to be one of the better characters one could use in taxonomically problematic groups (Barthlott 1981). In one paper concerning taxonomy of the genus *Hypoxis* in the Americas (Brackett 1923), it is regarded to be the most important feature for the species delimitation. In literature dealing with the East African species it was chosen as a very useful character

(Nordal *et al.* 1985), or it was almost not considered at all (Baker 1878; Nel 1914).

The aim of this study was a thorough investigation of the types of the seed testa sculpture in the East African taxa of the genus *Hypoxis*. The second aim was to establish, if this character is specific for different taxa and could be used as a feature for the distinction between them.

2. Material and methods

Studies were conducted on about 800 herbarium specimens belonging to the following herbaria: B, BM, EA, K, MO, O, POZG (Holmgren *et al.* 1990). Seeds were examined using light microscope and scanning electron microscopy after coating with gold.

3. Results and discussion

Shapes of seeds of all 15 East African species are very similar (Fig. 1). Their dimensions vary from 1-2 mm in diameter, but they depend on a seed maturity and a number of seeds in a single fruit. Therefore they yield no good character for the species delimitation.

Epidermal cells of the outer integument are black, incrustated with phytomelan (Niemirowicz-Danczenko 1985; Oganezova 1995). They are covered with a layer of cuticle, which plays an important role in seed's coloration. In seeds with a thin layer of adhering cuticle a dye of cells is visible, thus seeds are black when dry

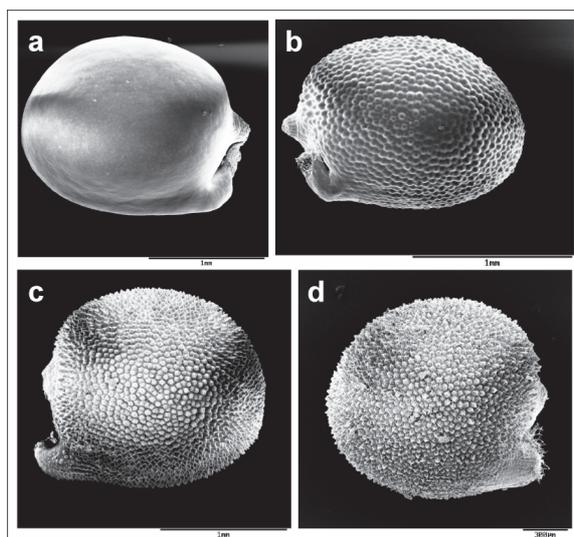


Fig. 1. Black seeds with thin cuticle: a – *H. gregoriana* Rendle (Simon, Festo & Linde 790, POZG); b – *H. nyasica* Baker (Wiland & Mboya 120, POZG). Black seed with thick wrinkled cuticle: c – *H. polystachya* Welw. (Wiland & Mboya 159, POZG). Brown seed with thick and detaching cuticle: d – *H. goetzei* Harms (Wiland & Mboya 97, POZG)

(Figs. 1a, b, 2a-g). Such seeds occur in 9 species (15 taxa). In the rest of East African *Hypoxis* taxa the seeds are brown. This coloration is due to the thick layer of brown cuticle, which is often wrinkled and detached from the epidermal cells (Figs. 1d and 2i). In *H. polystachya*

Welw. thick cuticle is so much pressed to the seed surface, that seeds appear to be black (Figs. 1c and 2h).

Testa cells are isodiametric, 5-7-gonal, with straight boundaries. The anticlinal boundaries may be slightly raised (Fig. 2a), or channeled (Fig. 2b-i). Outer periclinal

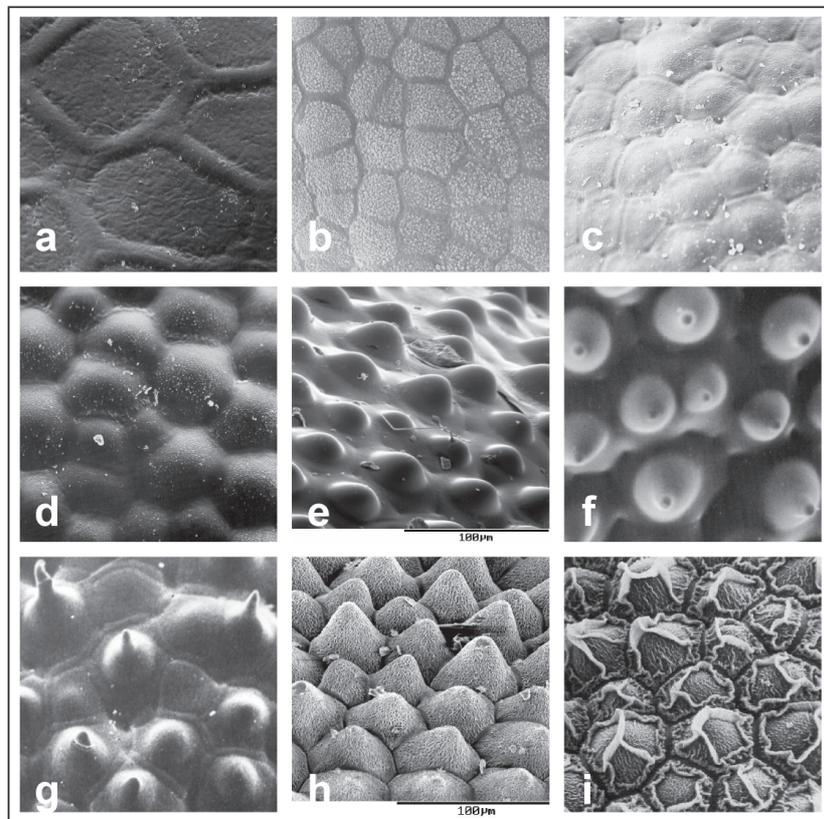


Fig. 2. Types of the seed testa sculpture in the East African species of the genus *Hypoxis*: a – *H. malaissei* Wiland (Bjørnstad 401, K. Fot. I. Nordal); b – *H. gregoriana* Rendle (Kabuye & Ngweni 514, K. Fot. I. Nordal); c – *H. fischeri* Pax var. *colliculata* (Wiland) Wiland & Nordal (Bullock 3414, K. Fot. I. Nordal); d – *H. nyasica* Baker (Eggeling 5796, K. Fot. I. Nordal); e – *H. galpinii* Baker (Wiland & Mboya 57, POZG); f – *H. fischeri* Pax var. *fischeri* (Lye 2079, K. Fot. I. Nordal); g – *H. fischeri* Pax var. *katangensis* (De Wild.) Wiland & Nordal (Richards 2028, K. Fot. I. Nordal); h – *H. polystachya* Welw. (Wiland & Mboya 154, POZG); i – *H. angustifolia* Lam. (Bjørnstad 896, O. Fot. I. Nordal). (Magnification: A x 1000, B-I x 300)

walls of cells may be slightly sunken (Fig. 2a), flat (Fig. 2b), or more or less convex (Figs. 2d-i). The raised convex papillae may be semispherical (Figs. 2d, e), conical (Fig. 2h) or nipple shaped and aculeate (Figs. 2f, g). The papillae can be smooth (Fig. 2e) or micropapillate (Figs. 2b-d).

Distribution of 9 types of seed testa sculpture observed in East Africa is unequal among taxa studied. The most common are sculptures shown on Fig. 2d (6 taxa), Fig. 2e (4) and Fig. 2i (4). Other types are confined to one taxon only: a species e.g. *H. malaissei* Wiland (Fig. 2a) and *H. polystachya* (Fig. 2h) or a taxon of a lower rank e.g. *H. fischeri* Pax var. *fischeri* (Fig. 2f).

So far, in the taxonomic studies of the genus *Hypoxis* in East Africa the seed testa was used only once as the first delimiting character in the key (Nordal et al. 1985). This work presents 6 types of testa of the seeds in the East African species. However, at the time, taxonomy of *Hypoxis* in this area was not completely understood and only 7 taxa were reported. Therefore three types of testa structure were associated with so called „*Hypoxis obtusa*-complex”. Only recent studies of the systematics of this genus in Uganda, Kenya and Tanzania (Wiland-Szymańska & Nordal 2006) have revealed, that it is represented by 15 species (20 taxa). It is another example showing that a proper α -taxonomy is crucial for further investigations.

Morphology of the seed testa sculpture is a useful taxonomic character for determination of taxa of the genus *Hypoxis* in the East Africa. However because of

a fact, that some types of testa occur in numerous taxa, it can not be the only character used for delimitation of species. It is however most useful in determination of taxa of a lower rank e.g. varieties.

Similar studies of seed testa sculpture of taxa of the genus *Hypoxis* were conducted for the Central Africa (Wiland-Szymańska 2001). Comparison of results shows, that in the East Africa one can observe a slightly larger variability of the seed testa sculpture (9 types, 20 taxa) than in the Central Africa (8 types, 23 taxa). There is also a visible disproportion between number of species with thin and thick cuticle in the East Africa. Nine taxa produce seeds with thin cuticle and 5 with a thick one. In Central Africa this proportion is 11:12. So far no connection can be drawn between type of a seed testa sculpture and other morphological characters. There is also no explanation why some species of *Hypoxis* produce a very thick layer of cuticle, and other do not. It can not be treated as an additional protective layer, because seeds with cuticle occur sometimes in fruits of species growing in wet habitats e.g. *H. schimperi* Baker.

Acknowledgments. Support of this study by a grant from the Polish Science Committee is gratefully acknowledged (Project no. 3P04C04224). Fieldwork was possible thanks to a grant from The National Geographic Society # 6891-00. My special thanks are addressed to Prof. Inger Nordal, University of Oslo, for rendering her photographs and other data accessible. I thank Maciej Szymański for help in preparation of this paper.

References

- BAKER J. G. 1878. A Synopsis of Hypoxidaceae. J. Linn. Soc., Bot. 17: 93-126.
- BARTHOLOTT W. 1981. Epidermal and seed surface characters of plants: Systematic applicability and some evolutionary aspects. Nordic. J. Bot. 1: 345-355.
- BRACKETT A. 1923. Revision of the American Species of *Hypoxis*. Contr. Gray Herb. 69: 120-147.
- GEERINCK D. J. L. 1969. Genera des Haemodoraceae et des Hypoxidaceae. Bull. Jard. Bot. État. 39: 66-82.
- HOLMGREN P. K., HOLMGREN N. H. & BAENETT L. C. 1990. Index Herbariorum I. Regnum Vegetabile 120. 693 pp. N.Y. Bot. Garden. New York.
- NEL G. 1914. Die afrikanischen Arten der Amaryllidaceae-*Hypoxidaceae*. Bot. Jahrb. Syst. 51: 287-339.
- NIEMIROWICZ-DANCZENKO E. N. 1985. Hypoxidaceae. In: A. TAKHTAJAN (ed.). Anatomia Seminum Comparativa. Vol. 1, pp. 117-119. Nauka, Leningrad.
- NORDAL I., LAANE M. M., HOLT E. & STAUBO I. 1985. Taxonomic studies of the genus *Hypoxis* in East Africa. Nordic J. Bot. 5: 15-30.
- OGANEZOVA G. G. 1995. On the systematical position of the families Haemodoraceae, Hypoxidaceae, and Taccaceae (the data on the seed structure). Bot. Zhurn. (Moscow & Leningrad) 80: 12-25.
- SINGH Y. & WILAND-SZYMAŃSKA J. 2002. Systematics and phytogeography of African *Hypoxis*. Proceedings of the 3rd Congress of the Southern African Society for Systematic Biology, pp. 43. Grahamstown.
- WILAND-SZYMAŃSKA J. 2001. The genus *Hypoxis* (Hypoxidaceae) in Central Africa. Ann. Missouri Bot. Gard. 88: 302-350.
- WILAND-SZYMAŃSKA J. & NORDAL I. 2006. Hypoxidaceae. In: Flora of Tropical East Africa, pp. 26. Royal Botanic Gardens, Kew.
- WILSENACH R. 1967. Cytological observations on *Hypoxis*: I. Somatic chromosomes and meiosis in some *Hypoxis* species. J. S. African Bot. 33: 75-84.
- WILSENACH R. & PAPPENFUS J. N. 1967. Cytological observations on *Hypoxis*: II. Pollen germination, pollen tube growth and haploid chromosome numbers in some *Hypoxis* species. J. S. African Bot. 33: 111-116.
- WILSENACH R. & WARREN J. L. 1967. Cytological observations on *Hypoxis*: III. Embryo-sac development in *Hypoxis rooperi* and *H. filiformis*. J. S. African Bot. 33: 133-140.
- ZIMUDZI C. 1994. The Cytology and Reproduction of the Genus *Hypoxis* L. In: J. H. SEYANI (ed.). Proceedings of XIIIth Plenary Meeting AETFAT, 1: 535-543. National Herbarium and Botanic Gardens of Malawi, Zomba.