Notes on the Subterranean Plants of *Gymnarrhena micrantha* Desf. (Asteraceae) in Saudi Arabia

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Abstract: Purely subterranean plants are reported for the amphicarpic plant, *Gymnarrhena micrantha* Desf. (Asteraceae). The flowers of the subterranean plants are entirely different from that of the above ground heads. They are described and illustrated for the first time. The differences between the flowers of the subterranean and terrestrial plants have been brought out. A brief description about the vasculature of the florets and the morphology of the hairs on the pericarp are also included.

Key words: *Gymnarrhena micrantha*, Amphicarpic, Saudi Arabia, Subterranean.

Introduction

Gymnarrhena is a monotypic genus, mainly distributed in the drier parts of certain countries in the West Asian Region. Apart from Saudi Arabia, *G. micrantha* Desf. is also reported from Egypt, Palestine, Israel, Jordan, Saudi Arabia, Iraq, Spain and Pakistan (Feinbrun-Dothan, 1977). It is a little herb of the deserts with unattractive heads and is widespread in the Central, Eastern and Northern parts of the Kingdom.

Gymnarrhena micrantha ("Kaff Al-Kalb") is amphicarpic, i.e., producing both subterranean and aerial inflorescences (Chaudhary, 2000; Mandaville, 1990; Koller and Roth, 1964; Zohary, 1937; 1960). The subterranean heads are markedly different from the above ground heads in the morphology of the florets. Koller and Roth (1964) discussed the ecological and physiological significance of amphicarpy in *G. micrantha*. They have noted that, in years of low rainfall, the plant may die out without producing any aerial inflorescence, *i.e.*, resulting in purely subterranean plants. The achenes of the subterranean plants may germinate *in situ*, *i.e.*, within the dead remains of the mother plant and a dense colony of dead subterranean plants of several generations and living subterranean plants of the recent generation would be formed (Fig 1a) (Koller & Roth, 1964). They also obtained purely subterranean plants in experiments with controlled water supply.

Koller & Roth's (1964) study was more oriented towards the ecological and physiological significance of amphicarpy and therefore failed to document the morphological differences between: (a) the purely subterranean plant with only subterranean head, and

(b) the aerial plant having either aerial and subterranean heads or only aerial heads. However, no satisfactory description and illustration of the subterranean plants are available. Recent plant collection around Jabal Quttan falling in the Al-Qassim Province of the Kingdom has given the author an opportunity to collect some purely subterranean plants of the species.

Study of the aerial plants also yielded some undocumented morphological details that deserve documentation. Drawings of the male and female florets of the aerial plants illustrated in Chaudhary's *Flora of the Kingdom of Saudi Arabia* (2000; vol.2, part 2) has become too artistic leading to confusion and needs to be clarified. This short communication documents the above-mentioned information and provides relevant illustrations.

Materials and Methods

The plants of *Gymnarrhena micrantha* from two sources formed the basis of the study: (1) The specimens colleted by the author from the Province of Al-Qassim, Saudi Arabia and preserved in the KACST Herbarium (KACST), and (2) Specimens preserved in other national herbaria, *viz*, the National Herbarium (RIY), Riyadh, and the King Saud University Herbarium (KSU), Riyadh. Descriptive details of the plants are based on microscopic dissections. The drawings were made with the help of a Leitz microscope using camera lucida.

Results and Discussion

Subterranean plant. Figs. 1-3.

Inconspicuous herbs, 5-6 cm tall, growing inside cartilaginous involucral cup of the mother plant; unbranched, rarely sparingly branched. Stem thin, practically absent, sheathed by leaf bases. Leaves 5-6, blade 3-4 cm long, linear, 0.7-1 mm broad, glabrescent, leaf bases concave. Head 1, terminal, sub-terranean. Involucre tubular, formed by induration of the concave leaf bases, cartilaginous when dry. Florets 6-8, homomorphic, disciform, heterogamous, outer florets female, inner ones bisexual but functionally male. Male florets: 2-3, 5-6 x 0.5 mm; pappus tubular, tube 1 x 0.3 mm, 4-angular, lobes 4-5, hyaline, 0.5-1.5 mm long, narrow, acute, laciniate; corolla tubular, tube 1 mm long, 4-angular, lobes 4, 1 x 0.25 mm, white, elliptic-ovate, acute; stamens 5, alternating with the corolla lobes, filaments short, anthers elongate, base auriculate, tip acute, dehiscence longitudinal, introrse; pollen spherical, triporate, ornamented; ovary sterile, 3-4 mm long, narrow; style 2.5 mm long, stigma conical, acute, densely papillate. Female florets: 3-4, enclosed in palea; palea boat shaped, acute, compressed; pappus obsolete, of 5-10 inconspicuous protuberances topping the ovary; corolla tubular, 4.5 mm long, very narrow, lobes 4, as minute protuberances topping the corolla tube; stamens nil; ovary inferior, ellipsoid, glabrous, ovule 1, elongate, compressed, anatropous; style 1, 4.5 mm long; stigma 2, recurved, glabrous. Achenes of the female florets resident in the involucral cup, 2.5 x 1 mm, ellipsoid, indehiscent, narrower towards the base; pericarp thin, hairy at the apex, hairs linear, 2-celled, tip bifid; pappus 6-10, short, ca. 0.5 mm long, inconspicuous, as long as the epidermal hairs; exocarp thin, endocarp made of osteoschlereids, schlerieds thick walled, wavy in outline. Seed 1, spatulate, compressed, seed coat thin. Embryo 2.5-3 x 2 mm, 1 mm thick, cotyledons 2, elliptic, obtuse, flat, appressed, radicle shorter than the cotyledons, 0.7 mm long.

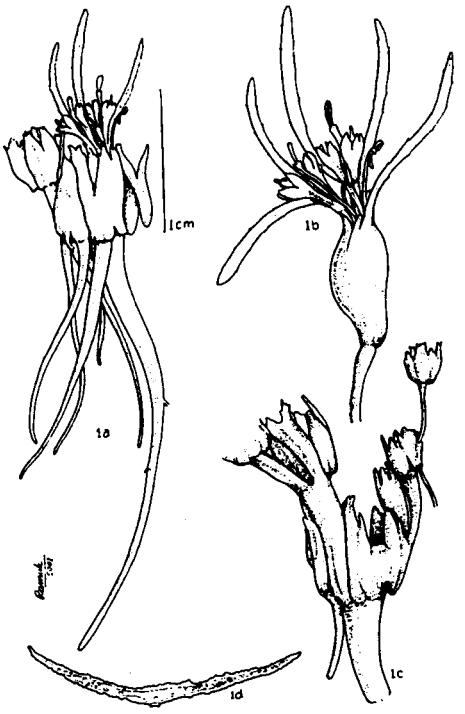

Fig 1. *Gymnarrhena micrantha* – (a) A completely geocarpic colony comprising plants of different generations. The living (plant)(s) of the current generation grow(s) in the cartilaginous remains of its mother (b). A living plant of the current generation and the flowers. (c). Very rarely the geocarpic plant is also dichotomously branched. (d). A 2-lobed foliar trichome; the trichome is medianly attached and ornamented.

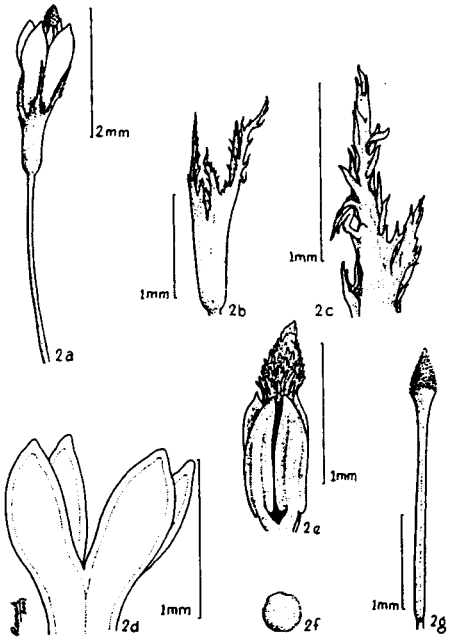

Fig 2. *Gymnarrhena micrantha* – (a). A male flower of the geocarpic plant. (b). The tubular pappus. (c). A laciniate pappus lobe enlarged. (d). Tip of the corolla tube and the petal lobes showing the vasculature (for details see the text). (e). The stamens and the stigma head. (c). A pollen. (g). The style-stigma portion of the pistil.

Specimens examined: Sub-terrannean plants: Saudi Arabia, Al-Qassim Province, Jabal Quttan, 200 km W of Unayzah, 13-2-2001, *Al-Turki & Swarupanandan* 5695 (KACST).

Above ground plant (Fig. 4).

Acaulescent herbs, rosettiform. Leaves 10 cm long, upper smaller, spreading on the ground. Heads 1-3 (-4), of dense glomerule(s); glomerules appressed to the ground, heterogamous, disciform, the central often subterranean. Female florets numerous, peripheral. Male florets few, central. Involucral bracts few, broadly ovate, short, membranous. Receptacular bracts longer, boat-shaped, leathery, whitish at tip, enclosing a floret each; receptacle bearing long bristles at center. Achenes of the female florets obconical, villous, pappus of scabrous bristles and 7-9 pales in the inner row. Achenes of hermaphrodite florets sterile, about 2 mm long, glabrous, pappus of pales connate at base. florets of the subterrannean head fewer, with differently shaped achenes, often devoid of a pappus; staminate florets longer than those in cauline heads.

Specimens Examined: Above ground plants: Ar-Rumah, Feb., 1983, A. Sughair (RIY-7009); Al-Jauf, 1-1-1980, S. Chaudhary (RIY-3022); Harrat al-Harra, 5-4-1987, S. Chaudhary & A. Al-Sheikh, (RIY-11156); Unaiza, spring, 1985, Al-Amin (RIY-11865); Al-Majma, 16-4-1982, Podzorski (RIY-3645).

Vasculature of the florets: *Male floret:* pappus vascular; corolla tube-traces 4, between the corolla lobes, corolla lobe-traces 8, derived from tube-traces by bifurcation below the sinus of the lobes, each lobe receiving 2 traces, marginal, traversing the entire length of the lobes, uniting at the tip, not anastomosing; staminal traces 5, 1 each corresponding a stamen, originating from the tube-traces below the branching for the corolla lobes, fading out before entering the filaments; carpellary trace 1, traversing the entire length of the style and stigma. *Female floret:* pappus evascular; corolla tube-traces 4, traversing only half way the tube and fading out; carpellary traces 2, traversing the entire length of the style, each supplying a stigmatic lobe.

Morphology of hairs on the pericarp: Though the ovary is glabrous, the fertile achenes of the female flowers of above ground heads are profusely hairy. The hairs are 0.5-1.5 mm long, 2-celled, each cell extending the entire length of the hair, bifid at tip. The achenes derived from female florets of the subterrannean plants are only partially hairy, i.e., only at the tip of the achene. These hairs are also of the same morphology as described above, but shorter, being only 0.5 mm long.

Conclusion

The subterranean plant is an inconspicuous herb in rock crevices near foothills of the mountain with only leaves and flowers emerging above ground. The one or two fruits produced per plant remain subterranean and enclosed in the dry cartilaginous involucral cup. The involucral cup offers protection to the seeds and therefore the pericarp remains thin. This seems to be an ecological adaptation to cope with the arid desert environment where rain is less than 20 mm/yr and where rainless years are usual. Koller and Roth (1964) also noted that in years of low rainfall, the aerial shoot fails to develop, resulting in completely subterranean plants. They also obtained

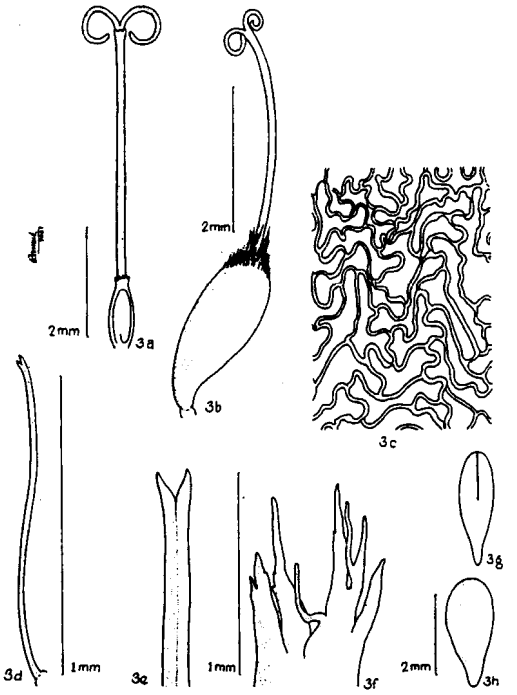

Fig 3. *Gymnarrhena micrantha* – (a). A female flower of the geocarpic plant. (b). An achene with its style. (c). A surface view of the cells of the endocarp. (d). An epidermal hair on the pericarp. Fusion of two linear cells making the hair is seen here. (e). The apical portion of the epidermal hair showing the free tips of the tow cells. (f). Enlarged view of one pappus crowing the achene. (g & h). Two views of the embryo.

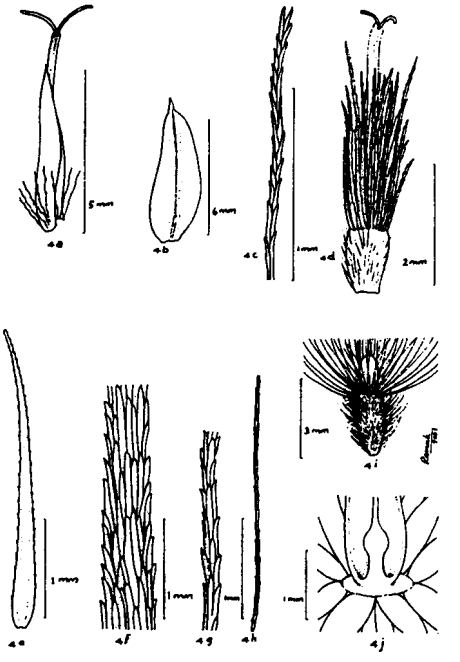

Fig 4. *Gymnarrhena micrantha* – (a). A female flower of the terrestrial plant/ head ensheathed in the bract. (b). A bract encasing the female flower. (e). A receptacular hair enlarge. (d). A female flower with the fertile achene and the pappus. (e). A pale. (f, g & h). Basal, median and apical portions of the pale. (i). A mature achene. (j). The base of the corolla tube dissected to show the apex of the achene.

subterranean plants. They also obtained completely subterranean plant in experimental conditions under controlled water supply. The achenes of the subterranean plants are larger than that of the aerial plants and have only vestigial pappus and hairs, as compared with the rich pappus and hairs of the achenes of the aerial plants. Seeds are therefore not dispersed and germinate within the mother plant's involucral cup. The larger size of the achenes and the vestigial pappus owe to the in-situ germination and the conglomeration of plants of several generations.

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References

Chaudhary, S.A. 2000. *Flora of the Kingdom of Saudi Arabia, illustrated, vol2, part 3.* Ministry of Agriculture & Water, Riyadh.

Fahn, A. 1990. *Plant anatomy,* ed. 4. Pergamon Press, Oxford.

Feinbrun-Dothan, N. 1977. *Flora palaestina,* part 3 (text and plates). Israel Academy of Sciences and Humanities, Jerusalem.

Koller, D. and Roth, N. 1964. Studies on the ecological and physiological significance of amphicarpy in Gymnarrhena micrantha (Compositae). *American Journal of Botany* 51: 26-34.

Mandaville, J.P. 1990. *Flora of Eastern Saudi Arabia,* Kegan Paul International, London jointly with National Commission for Wildlife Conservation and Development, Riyadh.

Zohary, M. 1937. Die verbreitungsokologischen Verhaltnisse der Pflanzen Palastinas. *Beih. Bot. Centr.* 56. Abt. I: 120-1211.

Zohary, M. 1960. Uber einen neuen fall von amphikarpie bei *Gymnarrhena micrantha* Desf., *Feddes Repertorium Beih.* 61: 95-96.

نبذة عن السمات المورفولوجية للأجزء الأرضية لنبات
Gymnarrhena micrantha Desf. (Asteraceae)
بالمملكة العربية السعودية.

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ملخص البحث: تتضمن هذة الدراسة وصفا مورفولوجيا للأجزء الأرضية لنبات مزدوج الثمار *Gymnarrhena micrantha* Desf. والتي تختلف تماما عن مثيلاتها للأجزاء الفوق أرضية . أظهرت هذه الدراسة تفصيلات مورفولوجية للزهيرات والشكل الظاهري للشعيرات والتي تغطي غلاف الثمرة (للجزء الأرضي النباتي) وذلك لأول مرة في الدراسات العلمية المورفولوجية .