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SOME PARASITIC ANGIOSPERMS OF SUDAN: Hydnoraceae, Orobanchaceae, and Cuscuta (Convolvulaceae)

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ABSTRACT. The bizarre holoparasitic angiosperm, *Hydnora johannis* Beccari is common in Sudan along the Blue Nile. Its taxonomy, morphology, floral biology, and uses in Sudan are discussed. Four species of the Orobanchaceae are known from Sudan. *Cistanche phelypaea* (L.) Cout. is a characteristic and common plant of the deserts and semi-deserts of northern Sudan. *Orobanche cernua* Loefl. is known from a single collection. *Orobanche ramosa* L. was apparently introduced about the turn of the century and is now a serious threat to the tomato industry. *Orobanche minor* Sm. is known from only a few collections. Seven species of *Cuscuta* are known from Sudan: *Cuscuta hyalina* Roth. is a widespread species in the northern half of the country; *C. kilimanjari* Oliv. occurs only in the Imatong Mountains of the extreme southern Sudan; *C. planiflora* Ten., is a montane species from the Red Sea Hills and Jebel Marra; *C. chinensis* Lam., and *C. australis* R. Br. are known from only a single gathering each; *C. campestris* Yuncker is reported from Sudan for the first time and is a serious parasite of lucerne in some places; *C. pedicellata* Ledeb., previously known from a single gathering, is spreading through contaminated seed. Notes on the biology and agronomic importance of *Cuscuta* in Sudan are included.

Sudan is the largest country in Africa with more than one million square miles that include a diversity of habitats ranging from the Sahara in the north to the vast swamps of the Sudd region and broadleaf savannas of the south.

The flora of the Sudan needs much additional fieldwork as the entire country is undercollected. Some of the factors contributing to this may be the uniform vegetation of vast areas of the northern half of the country, transport difficulties, and pronounced seasonality which is not predictable for planning collecting work. However, we are very fortunate to have the invaluable contribution of F. W. Andrews in his three volume set, *The Flowering Plants of the Anglo-Egyptian Sudan* (Andrews, 1950, 1952, 1956). More recent work is that of Hassan (1974) on the flora of the Erkowit region in the Red Sea Hills and of Wickens (1976) on the flora of the Jebel Marra massif in western Sudan. The latter work is comprehensive and has provided a valuable update on the nomenclature of many entries in Andrews' work. There has been additional floristic work associated with development projects such as the construction of the Aswan high dam, the Jongley canal, and a recent study on the flora of the Imatong Mountains on the Uganda border (Friis & Rasmussen, 1980), one of the most distinctive floristic regions in the country. However, harbarium work quickly reveals that only three areas of the country have received serious attention: Erkowit, Jebel Marra, and the vicinity of Khartoum.

The most important herbarium resources for Sudan material include: Kew (K); British Museum (Natural History) (BM) where most of Andrews' material is deposited; the herbarium of the University of

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Khartoum (KHU) with perhaps 20 000 mounted specimens; the herbarium of the Botany Section of the Agricultural Research Corporation at Wad Medani (WM) with a few thousand sheets including important early collections of Broun, Myer and some of Andrews; the herbarium of the Forestry Research Center at Soba (KHF) near Khartoum; and a small collection of about 500 sheets in the Department of Agricultural Botany at the Faculty of Agriculture of the University of Khartoum located at Shambat, in Khartoum North, for which I suggest the acronym KHUS.

The purpose of the paper is to provide a taxonomic treatment of some of the groups of parasitic angiosperms studied from July 1982 to January 1984. Descriptions are written from Sudanese material collected by the author and supplemented by herbarium material from Sudan and, where necessary, neighbouring countries. I have examined relevant material in the herbaria noted above as well as Edinburgh (E), Leiden (L) and Zürich (Z). My specimens are deposited at Edinburgh.

It is not standard practice in floristic works to treat parasites as a group. However, in the case of the Sudan, this biological group of plants has enormous impact and great general interest. Thus, I trust one of the benefits of this paper will be to strengthen interest in these plants and stimulate further research and awareness. Treatments of *Striga* and mistletoes will be presented elsewhere.

Parasitic plants pose a few special problems in careful collection and specimen preparation. Here, I am dealing only with those features directly pertaining to the parasitic mode of the plants.

Hosts. Herbarium labels can be a very good source of information on hosts if the host is carefully documented. This involves excavation in the case of root parasites. In general, it is easier to dig the suspected host plant and look for parasitic connections than to dig the parasite and look for connections. In the case of *Cuscuta,* it is helpful to note which plants, if any, are being avoided as hosts. Voucher specimens of the host should be made, even if in sterile condition, with a note on both the label of the host and of the parasite cross-referencing the two.

Haustoria and haustorial connections. These may be fragile and should be preserved in 70% ethanol. Haustorial coils of *Cuscuta,* especially on woody hosts, dry well.

Seeds. Many parasitic plants are easy to grow from seed. Seeds of *Orobanche, Cuscuta,* and *Striga* will remain viable for years if stored dry at room temperature. Seeds from each specimen should be kept separate in case the parasite is suspected of having host-specific races.

Seedlings. Little information on the seedling stages of many parasites is available. Seedlings of Hydnoraceae, Orobanchaceae, *Striga* and some other Scrophulariaceae are subterranean, whereas those of *Cuscuta* are usually found on the soil surface. Seedlings of mistletoes are of systematic importance but care is necessary not to assume that proximity to an adult plant means the seedling is of the same species.

Hydnoraceae

The Hydnoraceae are certainly one of the most bizarre and intriguing of all angiosperm families. They have attracted the attention of botanists for many years but the subterranean habit and tropical distribution has limited the amount of information that could be gleaned. There are only two genera. *Prosopanche* has six species and is restricted to South America. *Hydnora* is a genus of 12 species and is largely African in its distribution (Harms, 1935).

Field studies were conducted at four sites along the Blue Nile in eastern Sudan. The provinces, locations, and approximate latitudes and longitudes are: Blue Nile Province, vicinity of Abu Naama, 12°30′N 34°E; Gezira Province, Um Barona and ARC Research Station, both near Wad Medani, 14°N 32°30′E; Khartoum Province, Dom Island, 15°30′N 33°E. Field studies were carried out from 1982 to 1984, with repeated visits to Abu Naama and Dom Island to trace flower and fruit development.

The paucity of herbarium material of *Hydnora* is easily comprehensible to anyone who has tried to prepare specimens. The process is rather like attempting to press mushrooms in a plant press. This analogy is not far-fetched as the name *Hydnora* is an amalgam derived from *Hydnum,* a fungus, and *Orobanche,* an achlorophyllous root-parasite. In preparing specimens the rhizomes can simply be air-dried but taking care to avoid moulding. The flowers should be spread out and immediately pressed. If this is not done, the flower will dry and break into a myriad of useless fragments. Fruits should be quartered and dried.

Hydnora johannis Beccari in Nuov. Giorn. Bot. Ital. 3:5 (1871); Vaccaneo in Annali di Bot. 20(3):384 (1934) & Atti Accad. naz. Lincei Memorie 5:431 (1934); Mallaise in Bull. Jard. Bot. Nat. Belg. 52:115 (1982). *H.* sp., Broun & Massey, Fl. Sudan 55 (1929); *H. abyssinica* A. Br., Andrews, Fl. Pl. A. E. Sudan 22 (1950). Vernacular name: *tartous* (Sudanese Arabic) from the word *utartis* meaning to hold fast. **Figs. 1 & 2.**

Holoparasitic herbs from an extensive system of massive 'rhizomes' (true morphological nature unknown), spreading laterally from the host, i.e., parallel with the soil surface, to 5 cm wide, terete or sometimes flattened. Periderm well-developed, dark brick-red. Fresh rhizomes flesh-red with sticky exudate, bitterly astringent. Entire rhizome (except tip) covered with wart-like bumps, lacking at apices. Host roots occasionally connected to the rhizome. Latent and active buds scattered along rhizome, usually in clusters of 2–4. Flowers emerging from the soil after the rains. Buds tubular with valvate lobes. Flowers usually 4-merous but occasionally 3- or 5-merous. If adequate moisture present, perianth-lobes patent and resting on the soil (Fig. 1B); if moisture lacking, lobes not reflexed but flower opening by a slight separation of the lobes (Fig. 1C). Flowers 8–22 cm, the length depending on the depth of the rhizome, pedicel 5–9 cm. Perianth tube terete to 4-sided, 3–4 cm in diameter. Ovary inferior, with numerous infolded, pendent placentae; unilocular. Stigmas 4, sessile with distinct grooves on surface. Stamens 4, basifixed with 2 large anthers 2·5–3 × 2–2·5 cm. Pollen very sticky, adhering to the anthers. Perianth-lobes 6–8 cm, 3-sided, differentiated at tip into a glabrous, light pink osmorphoric cucullus with a strongly fetid odor; perianth-lobe below

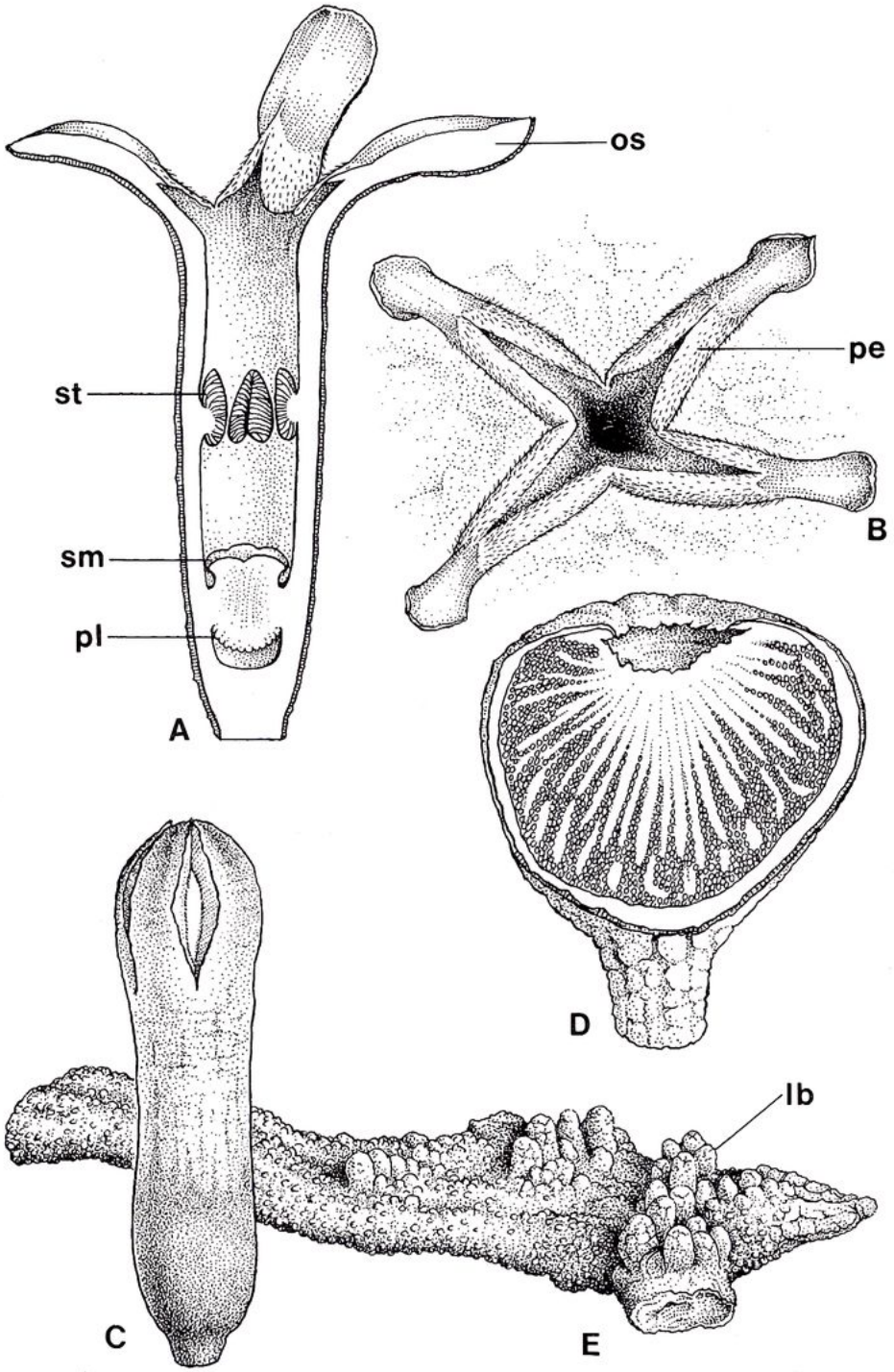

FIG. 1. *Hydnora johannis:* A, half-flower (os, osmophoric region; pl, placenta; sm, stigma; st, stamen); B, open flower on soil-surface showing spreading perianth lobes (pe, perianth-lobe); C, a flower showing only slight separation of perianth lobes at anthesis because of lack of moisture; D, half-fruit; E, portion of 'rhizome' (lb, latent bud). A & B × approx. $\frac{2}{3}$; C, D & E × approx. $\frac{1}{2}$.

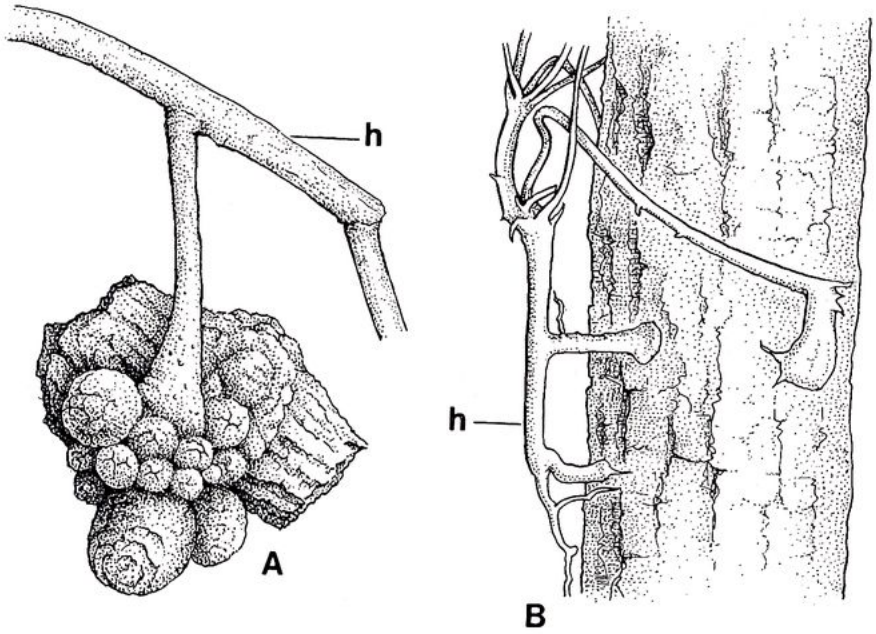

FIG. 2. *Hydnora johannis:* A, young plant with host root (h) attached, part of 'rhizome' removed; B, host-roots (h) attached to mature rhizome. A × approx. $\frac{1}{2}$, B × approx. $\frac{1}{3}$.

cucullus densely pilose, light pink, and not osmorphoric. Fruit fleshy, globose, 10–12 cm wide, many-seeded and entirely subterranean (Fig. 1D). Fruiting pedicel very short and easily separated from the rhizome. Outer layer of fruit a scaly periderm; inner pericarp mealy, white, very sweet. Fruiting placentae similar to inner layer of pericarp in taste and texture. Seeds brown, irregularly shaped, oblong to globose, 1–1·7 mm.

Hydnora johannis is known from Sudan, where it reaches its north-western limit, Ethiopia, Somalia, Kenya, Tanzania and recently, Zaire (Malaisse, 1982). The species just enters the Arabian peninsula, e.g., *Collenette,* 1484, (K).

Specimens examined:
SUDAN. Blue Nile Province, Abu Naama, *Musselman* 6228 (E); Gezira Province, Um Barona, *Musselman* 6129 (E); Khartoum Province, Dom Island, *Musselman* 6133, 6271, 6279A (E).

The genus *Hydnora* needs a revision with special emphasis on field-work. Vaccaneo (1934) lists various names which may be synonymous with *H. johannis*. For example, judging by appearance, *H. solmsiana* Dinter appears similar to *H. johannis* (e.g., Schreiber, 1968). I have not been able to locate the type of *H. solmsiana,* presumably it was destroyed in Berlin.

Morphologically, the most intriguing organ of *H. johannis* is the rhizome. The exact morphological nature of this peculiar and perhaps

unique structure is not known. It is not a true rhizome, of course, in the usual botanical sense, nor is it a root as it has no root-cap (but see Kuijt, 1969) nor any lateral roots.

Excavations at Um Barona (with Dr M. A. Siddig) revealed the following: host roots come in contact with *Hydnora* and in some as yet unknown manner invade the rhizome (Fig. 2A, 2B). This is clearly indicated by sectioning the rhizome at the point of attachment of the host roots. The host root forms a haustorium-like structure from which strands of xylem from the host apparently traverse the rhizome. These strands may be the bundles noted by Kuijt (1969).

We were fortunate to locate a very young plant (seedling?) which appeared similar to that of *Prosopanche* figured in Kuijt (1969, Figs. 5–11).

Careful excavation of a large rhizome-system revealed two acacias as hosts. The most frequent host (also the most frequent tree in the area) was *Acacia nilotica* (L.) Willd. ex Del. but similar attachment was noted in *Acacia seyal* Del. No attachments to other plants were observed. Random excavations in various *A. nilotica* forests along the Blue Nile invariably turned up *Hydnora johannis* and it can be assumed that the plant occurs in most similar habitats.

Standing in a population of *Hydnora johannis* when it is flowering is an unforgettable experience. At the time of flowering, the end of the rainy season in August or September, it is very hot and, in the acacia forest, very humid. The stifling atmosphere is filled with the overpowering stench of the flowers which dot the bare ground like white stars. Beetles are attracted by the odour and crawl (fall?) into the tube. They feed voraciously on the pollen and also crawl on to the stigma, a short distance beneath the ring of stamens. The pollen is very sticky and adheres to the beetles. Pollen-covered beetles were collected and the following identified by R. Madge (Commonwealth Institute of Entomology): *Hybosorus illigeri* Reiche (Hybosoridae), *Trox gemmatus* Olivier (Trogidae), *Catharsius peleus* Olivier (Scarabaeidae), *Onthophagus bituberculatus* (Olivier), *O. sellatus* Klug (Olivier) and *Oncosoma* sp. (all Tenebrionidae). Earlier, Kuijt (1969) had suggested occurrence of beetle-pollination and the present study confirms this.

The most frequent common name for *H. johannis* is *tartous* (from Arabic *utartis* meaning to hold fast). Another is *dambu,* a term of uncertain etymology.

There are several uses for tartous. One is to dig the rhizomes and use them as charcoal, the most common fuel source in Sudan. Local people have told me that tartous is far superior to ordinary charcoal because of its even, intense heat. I attempted to prepare a fire using tartous. Drying the rhizomes takes about a week. At this stage they are very hard and brittle, and rather like ceramic when they break. They burn with an intense heat but are difficult to ignite. Despite this well-known use and the abundance of tartous, I have never seen any of the dried rhizomes in a local market.

A second use is medicinal and is the best known use of tartous even by people who do not know the plant in nature. The rhizomes are dried, powdered and boiled to yield an extremely astringent bitter decoction

which is highly valued as a cure for diarrhoea and other intestinal ailments. This medicinal use is noted on several herbarium labels of *Hydnora* species and they indicate that the bitterness may characterize the genus as a whole.

Lastly, the fruits are eaten, a fact noted by other authors (e.g., Vaccaneo, 1934). In Sudan the fruits mature in late January to March. They are located by finding a slight mound, just cracking the soil surface, in an acacia forest. The mature fruit is about the size of a medium grapefruit and covered by the scaly, brown periderm. The inner wall of the pericarp is white at maturity and has a taste resembling a custard apple (*Annona squamata*) and the texture of an apple. The fruit is very fragrant and sometimes can be located by the odor alone. The bulk of the fruit is made up of the seeds (Fig. ID) embedded in the white, fibrous placentae. This portion of the fruit is also edible but the small hard seeds detract from its enjoyment. In the Blue Nile region, monkeys are common and are known to collect and eat the fruit. Perhaps the most unusual food use is as possible forage for rhinoceroses suggested by the note on *Bally* 7694 (K). One is hard pressed to name another plant pollinated by beetles, dispersed by monkeys, and foraged by rhinos!

However, tartous does not give up all its secrets easily. There is a report in a letter at Kew (letter 12, 1917. xi. p. 101) asking for the determination of fragments of *H. johannis,* as a large quantity from Khartoum had been captured from the Germans during the First World War. The eventual use of the seized cargo remains a mystery.

Orobanchaceae

The Orobanchaceae are a small but conspicuous element in the flora of North Africa and the Middle East. *Cistanche* species are some of the most spectacular of all desert plants, while species of *Orobanche* are the most damaging weeds in tomato, eggplant, tobacco and some other crops (Musselman, 1980). The most recent treatment of the family in Sudan is that of Andrews (1956) but more recent Flora accounts for neighbouring Egypt and Libya are found in Jafri (1978) and Täckholm (1974), respectively.

All Sudanese Orobanchaceae flower during the cool season from approximately October to March. At higher elevations, e.g., Jebel Marra and the Imatong Mountains, the flowering season may be extended. The reason for this is apparently the lower temperatures necessary to induce germination (Musselman, unpublished).

Caution is advised in ascribing a narrow host-specificity for any Orobanchaceae. This family of parasites exhibits some host preference but careful study will show that other hosts are attacked as well (cf. Musselman & Parker, 1982).

The following key is to all species in Sudan.

1. Corolla almost regular, lobes equal, margins entire, exterior of tube lustrous, not inflated or translucent in fruit; calyx tubular, rugose, margins erose; capsules to 2 cm wide; seeds to 1 mm long
Cistanche phelypaea

+ Corolla strongly bilabiate, lobes various, unequal, exterior not lustrous, inflated or translucent in fruit; calyx campanulate, not rugose; capsules 0·5 cm wide; seeds less than 0·5 mm long. . . . . *Orobanche* 2

2. Bracteoles present; calyx not deeply split, unequally 4-toothed; capsule dehiscence obliquely apical . . . . . 1. *O. ramosa*

+ Bracteoles absent; calyx deeply split; capsule dehiscence longitudinal. .3

3. Stems yellow (rarely greyish-silver); spikes dense; corolla-lobes blue at tip, not rugose; bracts shorter than the corolla . . . . . 2. *O. cernua*

+ Stem brown; spike with conspicuous internodes, at least at the base of stem; corolla-lobes cream with purple veins, very rugose; bracts as long as the corolla . . . . . 3. *O. minor*

The Orobanchaceae comprise 15 genera and perhaps 150 species and are best represented in the North Temperate regions of the Old World.

Cistanche phelypaea (L.) Cout., Fl. Port. 571 (1913); Andrews, Fl. Pl. Sudan 150, Fig. 140 (1956); Täckholm, Students Fl. Egypt 509 (1974); Jafri, Fl. Libya 55:3 (1978). *Lanthraea phelypaea* L., Sp. Pl. 606 (1753). *C. lutea* Hoffg. (sic), Crowfoot, Illus. Fl. Sudan Fig. 139 (1928); Hassan, Illus. Guide Pl. Erkowit (1974). *Cistanche lutea* Hoffm. & Link, Broun & Massey, Fl. Sudan 33 (1929). Vernacular names: *erg al tundub, ein al assad, halouk, tartous.*

Perennial from a tuberous base, stems glabrous to 1·5 m tall, to 3·5 cm in diameter, fleshy, unbranched, pale yellow; scales to 1·5 cm long, brown, ovate-lanceolate with a scarious margin. Inflorescence spicate; each flower subtended by a bract as long or longer than the calyx (2 cm); pedicels short bearing two linear bracteoles shorter than the calyx. Calyx tubular or subcampanulate, 1·5 cm long expanding to twice that length in fruit, with 4 large and 1 small lobe; margins scarious, crenulate. Corolla 3·5 cm, slightly arcuate, bright lemon-yellow, fragrant, exterior lustrous, subregular with 5 equal, patent lobes. Anthers densely villous, filaments glabrous bending towards the stigma as the flower ages. Capsule 2·5 cm wide, as wide as long, apiculate. Seeds 0·9 mm, shiny black. Seedlings tuberous, scaly.

A wide-ranging species of North Africa, parts of southern Europe, and the Middle East.

Specimens examined:

SUDAN. Khartoum Province: Dom Island, *Musselman* 6134 (E), 6179 (E); Wauusi, *Musselman* 6238 (E, K). Nile Province: sine loc., *Brent* s.n. (K); Sixth cataract, *Schweinfurth* 717 (K); Mauai, *Schweinfurth* 568 (K); Red Sea Province: Suakin, *Musselman* 6201 (E); Sinkat, *Schweinfurth* 310 (K). Kassala Province: Aqiq. *Jackson* 3922 (K). Gezira Province: Kamlin, *Musselman* 6229 (E, K).

Cistanche phelypaea is found in two distinct habitats in Sudan. Along the Red Sea coast it grows in the transition zone between the salt marsh and desert. Here it is found parasitising *Suaeda monoica* Forssk. (Chenopodiaceae). In the vast desert and semi-desert regions of northern Sudan

it is invariably found parasitising *Capparis decidua* (Forssk.) Edgew. (Capparaceae), one of the most abundant and characteristic shrubs in this region. Sheep and goats apparently graze the plant. This may explain its usual habitat inside dense thickets of *C. decidua* (Sudanese Arabic: *tundub*), protected by the spines of its host.

A clump of flowering *C. phelypaea* is a spectacular sight. It is well known to the local people who refer to it as *erg al tundub* (root of tundub) or *halouk* (strangler), a general term applied to all Orobanchaceae. Perhaps one of the most descriptive names is *ein al assad* (eye of the tiger), an allusion to the large, round, yellow flowers. A confusing common name is *tartous,* a name most commonly applied to the unrelated parasite *Hydnora johannis* Beccari (Hydnoraceae).

There are few local uses for *Cistanche.* A report from Mr Zakaria Saad, forester in El Obeid, noted that *tartous* was considered a potential source of tannin for commercial use at the turn of the century. It is not clear, however, if this *tartous* is *Cistanche* or *Hydnora,* as Broun & Massey (1929) apply the name to *Cistanche.*

The floral biology of *C. phelypaea* needs investigation as the anthers touch the back of the stigmatic surface suggesting a possible form of autogamy, a phenomenon well-developed in *Orobanche* (Musselman, Parker & Dixon, 1982) as well as other genera of the family (Musselman, 1982). Capsule production is always very high, perhaps as a result of such self-pollination. However, the large, showy, fragrant flowers imply a syndrome of insect pollination.

I have not been able to germinate *C. phelypaea* with either natural root-exudates or synthetic germination stimulants known to promote germination in *Orobanche* species (Musselman, 1980).

The perennation of this parasite is likewise an area for further investigation. When the flowering plants are excavated, small tuberous scaly structures are always present on the host root. These are obviously young plants but it is not known how long the plant remains in this condition nor what factors are involved in the emergence of the flowering stem from the soil.

1. Orobanche ramosa L., Sp. Pl. 633 (1753); Broun & Massey, Fl. Sudan 333 (1929); Andrews, Fl. Pl. Sudan 150 (1956); Täckholm, Students Fl. Egypt 506 (1974); Wickens, Fl. Jebel Marra 147 (1976); Jafri, Fl. Libya 55:9 (1978). Vernacular name: *halouk.*

Annual from a tuberous base, glandular-pubescent, usually less than 15 cm tall; first emerging plants much-branched, later plants with few branches or unbranched. Scales triangular, $0{\cdot}75 \times 3$ cm with 8–10 nerves, smaller on upper stem, brown when fresh. Floral bracts similar to scales; bracteoles narrow, linear, as long as or slightly exceeding the calyx. Calyx 0·7 cm, sub-campanulate with 4 acuminate lobes. Corolla 2·7 cm, arcuate, constricted near middle; upper lobes at 90° to tube, lower at a more obtuse angle; entire corolla densely glandular-pubescent, without fragrance, white or blue or tinged with both, veins darker. Corolla persistent in fruit, translucent. Ovary globose; nectary poorly developed. Anthers with short awns; anthers and filaments glabrous but sometimes with a few long hairs at base of filaments. Capsule 4×8 mm, apiculate. Seeds 0·1 mm, brown.

A sub-cosmopolitan weed, occurring in many parts of the world (Musselman, 1980).

Specimens examined:

SUDAN. Southern Darfur Province: Jebel Marra and vicinity, *Sandison* 35, 36 (BM), *Kassas, Khalifa, Mobarak* 689, 492 (KHU), *Wickens* 2712, 2765, (both K), 2457 (K & KHU), *Jackson* 3332 (BM); Zalingei and vicinity, *Wickens* 1331, 1332, 1154 (all K), 1155, 1152 (K, KHU). Red Sea Province: Erkowit, *Maffey* 23 (K), *Aylmer,* 143, 561 (both K), 207 (K, BM), *Ismail* A3491–B (mixed sheet) (WM) Khartoum Province: Khartoum, *Broun* s.n. (K), *Sillitoe* s.n. (WM); Wauusi, *Musselman* 6237 (E, K); Khartoum, *Musselman* 6281 (E).

This is the most important *Orobanche* species in terms of crop-damage in Sudan. It can be expected anywhere tomatoes, potatoes, and eggplant are grown but does not parasitise *Capiscum*. I have seen it on many non-solanaceous crops, however, including cabbage and carrots, and on various weeds.

Orobanche ramosa was apparently introduced into Sudan about the turn of the century, perhaps with contaminated seed. The first report is that of a Mr Sillitoe, Chief Inspector of Forests for the Sudan Government, who collected *O. ramosa* in his garden in Khartoum in 1904 and identified it as *O. minor* (Fide *Sillitoe,* s.n., WM). His misdetermination may be significant for, if *O. ramosa* were already known in Sudan, he would probably have been aware of it. *O. ramosa* is now not only well-established in Sudan but is spreading at an alarming rate and I have seen many large fields of tomatoes decimated by it. These fields are irrigated and the flooding ensures an even innoculum of seeds. More and more acres of tomatoes are being grown in Sudan so the problem is increasing and is heightened by the fact that the winter season is best both for tomatoes and *O. ramosa*.

This parasite was first reported at the Hudeiba Agricultural Research Station (Nile Province) in 1971 and seven years later was considered to have reached epidemic proportions in the province (Hussein, 1983). One of the plants heavily parasitized in tests at Hudeiba was broadbean (*Vicia fava* L.), one of the most important food-crops of the northern Nile region, but this has not been reported under field conditions.

2. Orobanche cernua Loefl., Iter Hisp. 152 (1758); Andrews, Fl. Pl. Sudan 150 (1956); Täckholm, Students Fl. Egypt 506 (1974); Jafri, Fl. Libya 55:17 (1978). *O. cernua* var. *desertorum* Beck, Broun & Massey; Fl. Sudan 33 (1929). Vernacular name: *halouk*.

Annual with a swollen base and a single, large haustorium. Stem stiffly erect, brown, unbranched, to 28 cm, densely glandular-pubescent. Scales 0·7–1·2 cm, brown, glandular-pubescent, acuminate. Inflorescence a dense spike with 9–40 flowers. Bracts 2·2 cm, longer than the calyx, acuminate. Calyx campanulate, 0·25 × 0·7 cm, 4-parted, each lobe unequally bifid. Corolla to 1·2 cm, sparsely glandular-pubescent, strongly arcuate, constructed above the ovary, lobes patent 1·5 mm, usually blue. Corolla inflated and shining in fruit. Filaments glabrous, included. Stigma white; style sparsely pubescent. Capsule 0·9–2 cm.

A widespread, variable species extending from Europe through the Middle East, Central Asia and the Far East. Known in Sudan from only a single specimen with little data, apparently collected along the Red Sea (*Bent* s.n., K).

I have not recognized the varietal status of *O. cernua* var. *desertorum* here. The taxonomy and nomenclature of this group needs considerable attention. *O. cernua* is a strongly autogamous species (Musselman, Parker & Dixon, 1982) and some of the varieties may result from this.

3. Orobanche minor Sm., Eng. Bot. 6: tab. 422 (1807); Andrews, Fl. Pl. Sudan 152 (1956); Täckholm, Students Fl. Egypt 506 (1974).

Monocarpic, generally annual. Stems to 35 cm, unbranched, brown, glandular-pubescent. Scales broad at base of stem, $1 \times 0{\cdot}6$ cm, becoming smaller and narrower near top. Inflorescence a crowded spike with few to 30 flowers; each flower subtended by a single attenuate bract. $2{\cdot}1 \times 0{\cdot}3$ cm. Calyx bifid, each with 2 attenuate lobes, the 2 anterior to 0·8 cm, the posterior to 0·2 cm. Capsule ovoid, $1{\cdot}5 \times 0{\cdot}4$ cm, spiculate. Seeds 0·1 mm, brown.

A widely distributed, almost cosmopolitan species in great need of a revision. Chater & Webb (1972) recognize a complex of 10 taxa under the name of *O. minor*.

Specimens examined:

SUDAN. Red Sea Province: Erkowit, *Maffey* 22 (K), *Ismail* A3491-a (mixed sheet) (WM), Khartoum Province; Khartoum, *Macleay* 286 (BM), *Musselman* s.n. (E). Eastern Equatoria Province: *A.S.T.* 1860 (K); Katire, *Jackson* 837 (BM).

This may be an introduced weed in Sudan. However, the sheet from the Imatong Mountains (*A.S.T.* 1860) could be native but there is not enough data on the label to ascertain this. *Orobanche minor* s.l. is known from many collections on the Ethiopian Plateau (Musselman, unpublished) where it appears to be native. The other collections from Sudan are apparently introductions.

Botanists and agriculturists should be alerted to the possibility of finding two other *Orobanche* species in Sudan. The first is *O. aegyptiaca* Pers., which resembles *O. ramosa* in many ways. However, it is much more robust and has fragrant flowers and densely villous filaments. It is a serious threat to tomatoes, potatoes, eggplant and melons throughout much of its range. *O. crenata* Forssk. is also robust, but is unbranched with a crowded spike of very fragrant flowers. It is a serious problem on broadbeans and other legumes throughout much of the Mediterranean region (Musselman, 1980). Both *O. aegyptiaca* and *O. crenata* occur in Egypt where they cause serious damage to crops.

Cuscuta

Little work on dodders (*Cuscuta*) has been done in the Sudan and there is no recent treatment of the genus in the country. Andrews (1956) recorded four species from Sudan. Since his work appeared, very little

collecting has been done and Sudan remains vastly undercollected so that we have an incomplete and misrepresented picture of the distribution of *Cuscuta*, a problem that cannot be rectified until more ambitious field-work is undertaken.

A second factor in the paucity of dodder collections from Sudan may be the inherent difficulty in determining species, especially in the section *Cuscuta* where, as Verdcourt (1963) notes, the characters are so reticulated as to make a determination difficult.

The vernacular name for *Cuscuta* in Sudan is *hamool* which is of Sudanese Arabic origin. The following key is to the species in Sudan:

1. Stigmas linear; inflorescence of 4–6 flowers, not more than 5·0 mm wide 2
+ Stigmas capitate; inflorescence with more than 6 flowers, or, if less, then up to 8 mm wide 3
2. Style lacking or much shorter than the stigmas; flowers 4-parted, pedicellate; inflorescence lax. . . . . 1. *C. pedicellata*
+ Style present, as long as or longer than the stigmas; flowers 5-parted, sessile or subsessile; inflorescence a dense glomerule. . . . 2. *C. planiflora*
3. Infrastaminal scales absent (some flowers may have very reduced scales but these are never fringed) . . . . . 3. *C. hyalina*
+ Infrastaminal scales present, fringed 4
4. Flowers 6–8 mm diameter, amber; restricted to Imatong Mountains 4. *C. kilimanjari*
+ Flowers less than 5 mm diameter, whitish; northern half of Sudan. . . . 5
5. Processes of infrastaminal scales extending beyond sinuses of corolla; flowers not glandular . . . . . 5. *C. campestris*
+ Processes of infrastaminal scales included; flowers, often densely, glandular 6
6. Corolla-lobes carinate; scales with many fringes. . . . . 6. *C. chinensis*
+ Corolla-lobes not carinate; scales with 3–5 fringes . . . . . 7. *C. australis*

1. Cuscuta pedicellata Ledeb., Fl. Alt. 1:293, icon. tab. 234 (1829); Yuncker, Mem. Torr. Bot. Club 18:271, Fig. 141 (1932); Täckholm, Students Fl. Egypt 436 (1974). *C. arabica* Fres., Crowfoot, Illus. Fl. Sudan Fig. 134–2 (1928); Broun & Massey, Fl. Sudan 324 (1929).

Stems 0·25 mm in diameter. Inflorescence 8 mm wide, 5–6-flowered. Flowers 4-merous, 1·5 × 1·8 mm. Calyx-lobes broadly triangular, somewhat acute at tips; corolla lobes similar, not reflexed in fruit. Stamens shorter than the lobes of the corolla. Infrastaminal scales short, processes not exserted. Infrastylar opening often absent or very small. Style and stigma 0·5 mm long. Capsule translucent, circumsessile.

Egypt, Arabia to central Asia.

Specimens examined:

SUDAN. Gezira Province, Kamlin, *Bey* 440 (WM). Bahr al Ghazal Province, Wau Bussere, *Musselman* 6236 (E, K). Khartoum Province, Omdurman, *Zubier* s.n. (E).

Prior to the last two collections cited above, *C. pedicellata* was known from Sudan only from the single collection of Bey in the 1920 s. Now, the species is apparently being spread as a contaminant of the seed of the important salad plant *Eruca sativa* L. (Brassicaceae; Sudanese Arabic *girgeer*). In fact I have obtained class material of this species by selecting infected *girgeer* in the local market. For seed production, the farmer allows a small portion of the *girgeer* crop to mature then unwittingly harvests seed of both *hamool* and *girgeer*.

2. Cuscuta planiflora Ten., Fl. Nap. 3:250, tab. 220, Fig. 3 (1829); Yuncker, Mem. Torr. Bot. Club 18:292, Fig. 157 (1932); Verdcourt, Fl. Trop E. Afr. Convolvulaceae 9–11 (1963); Täckholm, Students Fl. Egypt 436 (1974); Wickens, Fl. Jebel Marra 143 (1976); Jafri, Fl. Libya 53:5 (1978). *C. brevistyla* A. Braun ex A. Rich., Andrews, Fl. Pl. Sudan 109 (1956).

Stems very delicate, filiform, not more than 0·25 mm in diameter, usually reddish when fresh, both the terminal and lateral stems forming haustoria. Inflorescence a dense glomerule of 4–6 flowers, 3·5 mm wide, usually subtended by a bract. Flowers 5-merous, white, 1·5 × 2 mm. Calyx campanulate, lobes triangular, turgid, fleshy when fresh, usually drying brown. Corolla usually drying white, lobes as long as tube, reflexed in fruit, margins slightly involute. Stamens exserted, with small gland on the connective. Scales with 3–5 processes reaching the summit of the ovary, included, fringed. Infrastylar opening elliptical with a prominent ridge (stylopodium). Stigmas linear, strongly reflexed in fruit. Capsule globose, translucent when mature, circumsessile. Seeds round, 0·8 mm.

Throughout the Mediterranean region, the Arabian Peninsula, East and South Africa. In Sudan, a plant of higher elevations.

Specimens examined:

SUDAN. Southern Darfur Province: Jebel Marra, *Dandy* 115, 191 *Lynes* 147a, 131, s.n., s.n. (BM), 1476 (K), *Wickens,* 2649, 2922 (K), 1721, 1216 (K & KHU), *de Wilde* 5539 (K), *Kassas, Khalifa, Mobarak* 58 (KHU). Red Sea Province: Erkowit, *Musselman* 6181, 6182 (E); Gedain Pass, *Jackson* 2369 (K); Suakin, *Schweinfurth* 964 (BM); 'Nubia', *Bent* s.n. (K).

3. Cuscuta hyalina Roth, Nov. Pl. Sp. Praesert. Ind. Orient. ex coll. Doct. Benj. Heynii 100 (1821); Broun & Massey, Fl. Sudan 324 (1929); Yuncker, Mem. Bull. Torr. Bot. Club 18:235–236 (1932); Andrews, Fl. Pl. Sudan 108 (1956); Verdcourt, Fl. Trop. E. Afr. Convolvulaceae 8 (1963); Täckholm, Students Fl. Egypt 436 (1974). **Fig. 3.**

Stems very delicate, filiform not more than 0·24 mm in diameter, usually reddish or yellowish when fresh. Inflorescence 3–5-flowered; flowers 4 × 2·25 mm. Calyx-lobes attenuate, 1·8 mm. Corolla-lobes attenuate, acute, 1·8 mm reflexed in fruit. Infrastaminal scales usually absent, but if present very reduced (Fig. 3D). Infrastylar opening round, styles as long as the ovary. Seeds usually 3 per capsule, 1·1 mm, dark brown.

East and South Africa, reaching its northern and western limit in Sudan.

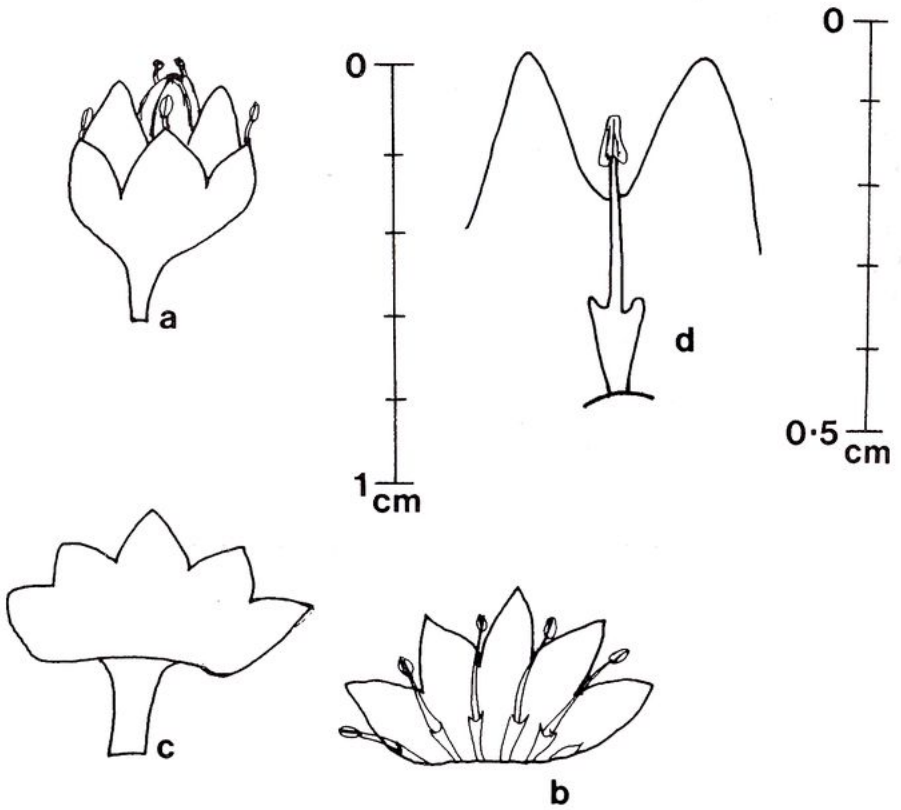

FIG. 3. *Cuscuta hyalina:* a, developing fruit; b, corolla, opened-out; c, calyx, opened-out; d, stamen showing vestige of infrastaminal scale. (Semi-diagrammatic).

Var. *nubiana* Yuncker has only vestiges of scales. However, this does not seem to be a consistent feature as some plants with normal scales may be found in most large populations.

Specimens examined:

SUDAN. Northern Province: Wadi Dongla(?) (Z), Red Sea Province–Suakin, *Crowfoot* (WM); Has Has, *Crowfoot* t. 629 (WM); Suakin, *Schweinfurth* 964 (K, L); Erkowit, *Kassas, Mobarak, Omar* 475 (KHU). Kassala Province: *Kassala, Täckholm, Kassas, Obeid* 390 (KHU). Northern Kordofan Province: El Obeid, *Wickens* 131b (K); Abu Gelagi, *Pfund* 146 (K); El Obeid, *Musselman* 6236 (E). Khartoum Province: Khartoum, *Musselman* 6131 (E).

This is the most widespread and abundant dodder in Sudan. During the rainy season it forms impressive festoons on many different low-gathering hosts but generally seems to favour *Tribulus terrestris* L. (Zygophyllaceae). Another frequent host is *Eruca sativa* L. (Brassicaceae), an important salad plant in much of Sudan. As in *C. pedicellata* the seeds of *C. hyalina* are spread with those of *Eruca* which are similar in size and shape. The appearance of the plant in flower is strikingly different than in fruit. The flowers are narrowly tubular, the fruits globose.

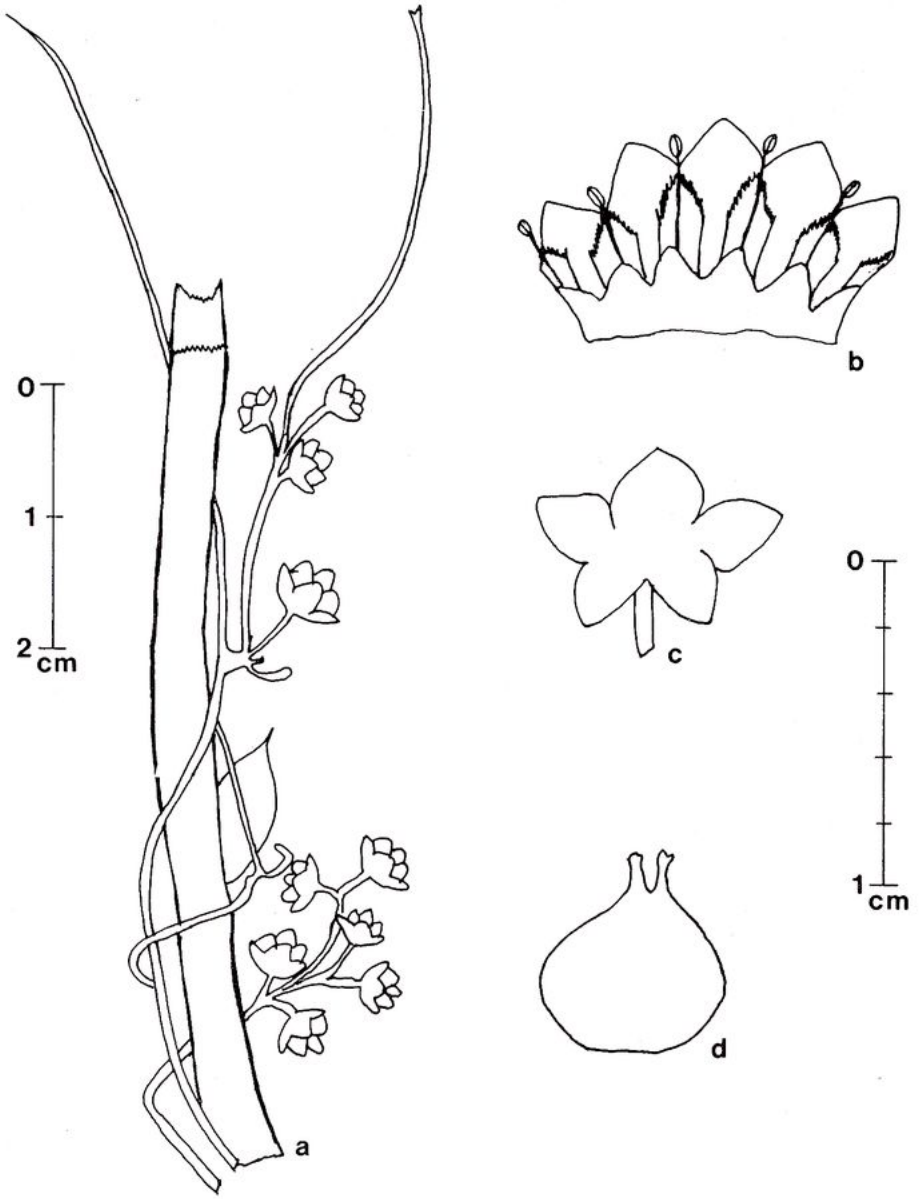

FIG. 4. *Cuscuta kilimanjari, Musselman* 6251: a, habit; b, corolla opened-out to show scales; c, calyx; d, pistil. (Semi-diagrammatic).

4. C. kilimanjari Oliv. in Trans. Linn. Soc., Bot., ser. 2, 2:343 (1887); Andrews, Fl. Pl. Sudan 109 (1956); Verdcourt, Fl. Trop. E. Afr. Convolvulaceae 6–7, Fig. 1 (1963). **Fig. 4.**

Stems rather coarse, 1 mm in diameter, light cream-brown. Inflorescence subtended by a bract, of 2–4-flowers in an open cyme. Pedicels evident, shorter than flowers. Flowers cream-coloured, not fragrant. Calyx broadly campanulate, lobes shorter than the tube, obtuse. Corolla-lobes obtuse, reflexed, separating from the calyx when dry. Infrastaminal scales shorter than the sinuses of the corolla, scarcely fringed. Stigmas capitate; style

and stigma 0·7 mm; style reflexed in older flowers. Infrastylar opening oval.

In Sudan only known from the Imatong Mountains.

Specimens examined:

SUDAN. Eastern Equatoria Province: Upper Talanga, *Musselman* 6263 (E); Itibot, *A.S.T.* 1647 (K).

This is the coarsest dodder in Sudan and the most distinctive. Verdcourt (1963) notes this species as attacking coffee. I have never seen it on coffee in southern Sudan but it is not surprising that it should attack a great diversity of hosts and pose a potential threat to some crops.

5. Cuscuta campestris Yuncker in Mem. Torr. Bot. Club 18:138–40 (1932); Verdcourt, Fl. Trop. E. Afr. Convolvulaceae 5 (1963); Täckholm, Students Fl. Egypt 436 (1974). **Fig. 5.**

Stems yellow, to 0·5 mm in diameter, often forming dense mats on host plants. Inflorescences 3–6-flowered, 5 mm wide. Flowers 3 × 2·5 mm, white, sometimes with a tinge of green. Calyx campanulate, lobes obtuse, 1 mm wide. Corolla-lobes acute to sub-acute, triangular reflexed, 0·8 mm wide, not fragrant. Four or five evenly spaced processes of the infrastaminal scales exserted from calyx. Stigmas capitate, 0·02 mm wide. Infrastylar opening circular, stylopodium absent. Capsule rupturing irregularly. Seeds light brown, 1·5 mm.

A native of North America but widely spread throughout much of the world (Musselman, 1981). Not reported before from Sudan but known from Egypt where it is a fairly recent introduction (Täckholm, 1974) as well as from East Africa (Verdcourt, 1963).

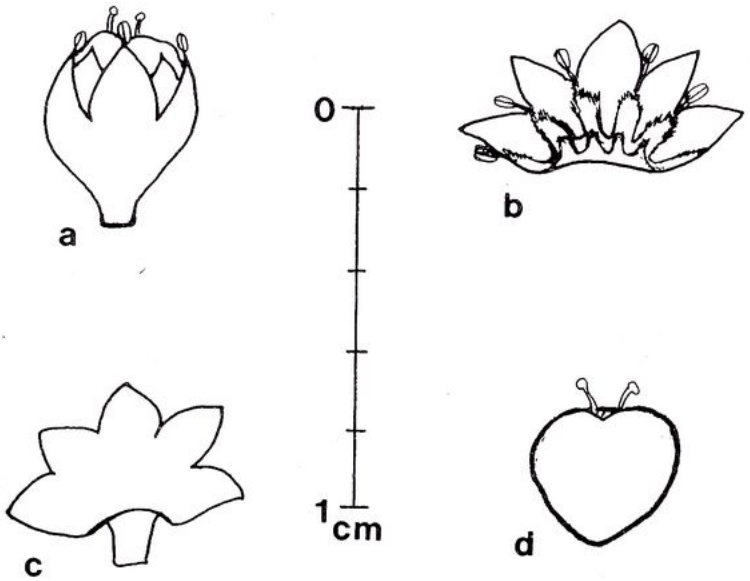

FIG. 5. *Cuscuta campestris:* a, developing fruit; b, corolla opened-out to show scales; c, calyx, opened-out; d, pistil. (Semi-diagrammatic).

Specimens examined:

Khartoum Province, Shambat, *Musselman* 6121 (E); Tuti Island, *Musselman* s.n. (E); *Musselman* 6270 (E).

This species is being widely dispersed through much of Sudan as a contaminant of lucerne (Arabic—*berseem*) (*Medicago sativa* L.). It is possible to find dodder seed in locally produced berseem seed. In addition, it can attack young citrus trees but with no lasting harm.

6. Cuscuta chinensis Lam., Encycl. Meth. Bot. 2:229 (1786); Yuncker, Mem. Torr. Bot. Club 18:209–211 (1932).

Stems slender. Flowers 2–3·5 mm, shortly pedicellate, or nearly sessile, in dense glomerules. Calyx loose about the corolla, ± reaching the corolla lobes, lobes triangular-ovate, also ± thickened below the sinuses, slightly overlapping, obtuse or acutish. Corolla slightly globular, becoming more so as the fruit develops, lobes triangular-ovate, or oblong-ovate, spreading, obtuse, more or less fleshy in a short carina towards the tip. Scales reaching the stamens, fringed with many long processes.

Known from Sudan from a single gathering. Red Sea Province—Tokar, *Bally* 6968 (K). Apparently reaching its western limit here.

7. Cuscuta australis R. Br., Prodr. Fl. Nov. Holl. 1:491 (1810); Yuncker, Mem. Torr. Bot. Club 18:124–127, Fig. 1 (1932). *C. obtusiflora* var. *cordofana* Engelm., Broun & Massey, Fl. Sudan 324 (1929); *C. cordofana* (Engelm.) Yuncker, Andrews, Fl. Pl. Sudan 108 (1956).

Stems slender, 0·5 mm in diameter. Cymes 6–8-flowered, bracteate. Calyx campanulate, lobes obtuse, 1 mm. Corolla-lobes obtuse to subacute, folded inward. Infrastaminal scales narrow, just reaching the sinuses of the corolla, with few (3–5) long cilia. Infrastylar opening small, oval, half as deep as the ovary with a prominent ridge (stylopodium) around the orifice and extending down the sides of the ovary. Seeds light brown, 1·2–5 mm. Capsule dehiscence irregular.

A wide-ranging species through much of Africa, southern Europe and east to Japan. No specimen has been seen but the species was cited by Broun & Massey (1929) as well as Andrews (1956) as occurring in Sudan.

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