Ass. Univ. Bull. Environ. Res. Vol. 9 No. 1, March 2006

AUCES

THE BIOLOGY OF EGYPTIAN WOODY PERENNIALS 2. IPOMOEA CARNEA JACQ

K.H. Shaltout, Y.M. Al-Sodany* and E.M. Eid*

Botany Department, Faculty of Science, Tanta University, Tanta; * Biological & Geological Sciences Department, Faculty of Education at Kafr El-Sheikh, Tanta University, Kafr El-Sheikh.

REVIEW ARTICLE

ABSTRACT:

Ipomoea carnea, a native of South America, grows in dense populations along river beds, banks, canals and other waterlogged (wetland) areas. It has become a naturalized species that invades the canal and drain banks, road sides and field edges in the Nile Delta. This plant propagates vegetatively either by stems which are capable of rooting within a few days or sexually by seeds. The farmers use it as ornamental and hedge plant along the field edges, drain and canal banks. These ornamental uses and reproduction by seeds have aided the plant to disseminate into new regions, especially in terrestrial habitats.]It could be cause obstruction and difficulties in the proper use for cultivated lands and water courses in the Nile Delta[. The rapid growth rate, spread, and adaptability from aquatic to xerophytic habitats indicate that this plant may potentially become another ecological disaster like water hyacinth.

INTRODUCTION:

Ipomoea carnea **was introduced to Egypt for ornamental purpose (Afifi *et al.* 1988a). It was recorded as a naturalized species along canals and drains, road sides, railways, waste lands and field edges in the Nile Delta (Boulos 1995, El-Sheikh 1996 and Al-Sodany 1998). This plant propagates vegetatively by stems which are capable of rooting within a few days. The farmers use it as ornamental and hedge plant along the banks of irrigation and drainage canals. These ornamental uses and reproduction by seeds oftenly lead to increase the plant dissemination into new regions (Chaudhuri *et al.* 1994). Recently, it has become widely spread in other terrestrial habitats and may cause obstruction and difficulties in many habitats in the Nile Delta. The rapid growth rate, spread, and adaptability from aquatic to xerophytic habitats indicate that this plant may potentially become another ecological disaster like water hyacinth (Mohanty and Mishra 1963).**

The present article is the second in a series of review articles dealing with the biology of Egyptian woody perennials (see Shaltout 2003). It aims at providing an overall review of the literature dealt with *Ipomoea carnea* Jacq. population, depicting the ecological conditions of its habitats, evaluating its adaptability to

different environmental conditions, identifying the gaps in the existing information, and focusing the attention of the Egyptian biologists for filling these gaps. This may help in preparing any management plan for controlling this invasive species in its habitats.

TAXONOMY AND NOMENCLATURE:

***Ipomoea* L. is a member of Convolvulaceae which includes about 500 tropical and warm temperate species (Mabberley 1987). Austin (1977) reported that, the name of *Ipomoea carnea* subsp. *fistulosa* (Mart. ex Choisy) has been an object of extended discussion. Ten names have been frequently and widely applied synonymously (Austin and Huaman 1996): *Ipomoea carnea* Jacquin, *I. batatilla* (Kunth) G. Don, *I. crassicaulis* (Benth.) Robinson, *I. fistulosa* Mart. ex Choisy, *I. fistulosa* var. *nicaraguensis* Donn. Sm., *I. albiflora* Chodat and Hassl, *I. fruticosa* Kuntze, *I. gossypioides* D. Parodi, *I. nicaraguensis* (Donn. Sm.) House, *I. texana* Coult. The names *Argyreia superbiens* and *A. splendens* are also referring to *Ipomoea carnea* (Chaudhuri, *et. al* 1994).**

Verdcourt (1963) noticed a close relationship between *I. fistulosa* Mart. ex Choisy and *Ipomoea carnea* Jacquin. Austin (1977) considers *I. fistulosa* Mart. ex Choisy a subspecies of *Ipomoea carnea* Jacquin, with a different geographical and altitudinal range. The criteria that have been used to separate *Ipomoea carnea* subsp. *carnea* and *Ipomoea carnea* subsp. *fistulosa* since 1845 are (after Austin 1977): 1-shrubs in *I. carnea* subsp. *fistulosa* and twining plants in *I. carnea* subsp. *carnea,* 2-lanceolate-elongate leaves in *I. carnea* subsp. *fistulosa* and ovate leaves in *I. carnea* subsp. *carnea,* and 3-mostly glabrous in *I. carnea* subsp. *fistulosa* and pubescent for *I. carnea* subsp. *carnea.* Several authors (e.g. Cook 1987, Mahapata 1978, Sharma 1978, Bhattacharya and Midya 1979,(as quoted by Frey 1995) rejected Austin's decision because Austin (1977) did not specify the examined material and this at least partly accounts for the non-acceptance. Some of the taxonomic confusion may be the seasonal heterophylly at the sub specific level and morphological plasticity. Both taxa are closely related but seem to be geographically separated, which forms the basis for acceptance of the subspecies concept by Austin (1977).

"Tararaqui" is the most common vernacular name for *I. carnea* ssp. *fistulosa* in Bolivia, "Mandiyura" for Paraguay, NE Argentina and Bolivia, "Algodao bravo" for the state Para, Brazil, "Mata cabra" and "Canudo" and "Canudo de lagoa" for Ceara, Brazil, "Algodao do Pantanal" for Mato Grosso, Brazil and "Capabode" for Parnaiba, Piaui, Brazil, "Manjorana" for Amazonia in Brazil (Frey 1995). "Olleiq ek-kibeer" for Nile Delta, Egypt (Al-Sodany 1998).

MACROMORPHOLOGY:

1- Stem and root:

The stem is erect, woody, hairy, more or less cylindrical in shape and greenish in color, monopodially branched, and bearing alternate leaves (Fig. 1). It attains 1.25-2.75 m long and 0.5-0.8 cm diameter. The fresh stem is somewhat flexible, but the dry one breaks with a fibrous fracture exposing a whitish green interior, with hollow internodes and solid nodes. The internodes measure 3.5-6.0 cm in length (Afifi *et al.* 1988b). Chaudhuri *et al.* (1994) added that, the plant is vinelike but stems can grow upwards to a height up to 6 m on terrestarial land, but shorter in the aquatic habitats. The branches are found mostly at the base of the stem which is short and stout, but

firmly rooted in the soil. Sometimes the stem bends along the soil-water surface producing small adventitious roots on the ventral side. The plant has a tap root, bearing numerous lateral rootlets. The root measures 50-60 cm long and 2.0-3.0 cm diameter. Externally, the root is yellowish brown in color, with a rough surface showing longitudinal striation, cylindrical in shape, solid, with flexible fracture when fresh, becoming fibrous when dry (Afifi *et al.* 1988b).

2- Leaf and flower:

The leaf is simple, alternate, exstipulate and petiolate. Petiole is cylindrical, attains 4-7.5 cm length and 2.5-3.0 mm diameter. The leaf blade is cordate with symmetric base, measures 13-23 cm in length and 5.5-9.5 cm in width, with entire margin and reticulate pinnate venation, slightly hairy on both surfaces, the upper surface is dull green and the lower one is paler. Leaf plasticity related to light and moisture conditions was observed by Keeler (1975), Cook (1987) and Frey (1995). Shaded leaves may grow larger than leaves fully exposed to sunlight. In aquatic conditions differences between sun and shade leaves appeared to be higher than in dry conditions.

Fig. (1) : Morphology of lpomoea carnea subsp. fistulosea. (after Meisner 1869)
1- Shoot system 2- Dissected flower 3-Staman 4- Gynaecium 5- Fruit 6- Seed

Keeler and Kaul (1979) mentioned that *Ipomoea carnea* possesses the most complex extrafloral nectary structure known in the genus. The nectary is sunken in the cortex and opens by a narrow orifice in a raised, almost circular mound that is devoid of hairs which are so abundant on the leaf. The mound is visible to the naked eye, and nectar production is copious. A wide duct leads to the orifice from the expanded cortical chamber, which is lined with closely- packed, multicellular, nectar – secreting trichomes. The locule of the chamber is mostly filled by large, irregular lobes of cortical tissue which are largely devoid of secreting trichomes. The nectary of *Ipomoea carnea* is located adjacent to the primary phloem, and there is usually a laticifer between the chamber and the phloem (Fig. 2).

The flowers are axial, solitary or arranged in monochasium scropioid cymose inflorescence. The pedicel is green in color, erect, cylindrical, solitary slightly pubescent, measures 1.5-2.2 cm long and 0.15-0.20 cm diameter. The calyx is persistent, consisting of 5 free quincunial sepals, ovate in shape, with entire margin, symmetric base and acute apex, green in color, nearly glabrous, measure 0.5-0.7

cm long and 0.6-0.7 cm width. The corolla is formed of 5 united petals (sympetalous), delicate, pinkish white in color, with 5 pink to violet coloured strands in the regions of cohesion with each other. The mouth of the corolla has an entire margin, with slight conspicuous depressions at the points of the cohesion of the petals, measure 5.2-6.0 cm long and 1.6-1.8 cm width at its mouth (Afifi *et al.* 1988a).

The androecium is formed of 5 free epipetalous stamens, which are unequal in length; two of them being longer than the others. They are united to the base of the petals for a distance of 4 mm. The basal part of the filament is hairy, pinkish red in color and swollen, while the upper part is filiform in shape and white in color. The filament measures 1.6-2.1 cm long and 0.20-0.25 cm width at its swollen base. The anthers are whitish yellow in color, oblong, basifixed and bilobed opened laterally, and contain yellow pollen grains. The anther attains 0.5-0.7 cm long and 0.20-0.25 cm width. The gynoecium, shows a superior ovary which is bicarpellary, and bilocular. Each locule contains one or two small anatropous basally placented ovules. The ovary is conical in shape, whitish yellow in color and carried on yellowish green hypogenous disc. The ovary measures 0.3-0.4 cm long and 0.15-0.20 cm width. The style is cylindrical, yellowish white in color, measures 1.4 – 1.6 cm long and 1-2 mm width and ending with a bilobed stigma, each attains 0.7-1.0 mm long, and 0.3-0.6 mm width (Afifi *et al.* 1988a).

3-Fruit and seed:

The fruit is a simple dry dehiscent capsule, which opens septifragally and is derived from a superior gynoecium. It is pedicellate, subglobular in shape, with pointed apex and spherical base, greyish green in color when unripe, turning greyish brown on ripening. The fruit shows five persistent sepals and remains of the style at the apex. It measures 1.0-1.5 cm in height, 0.8-1.3 cm in width and contains usually four dark brown colored seeds densely covered with hairs. The pericarp is thin, measuring about 0.1 cm thick, smooth and glabrous with yellowish grey inner surface.

The seed measures 0.4-0.6 cm in length and 0.2-0.3 cm in diameter, dark brown to black in color and derived from an anatropous ovule. It is covered with an easy removable dense pale brown to greyish brown trichomes, which attain 0.7-1.0 cm in length. The seed is three sided, with two flat ventral surfaces that may have a central depression and one convex dorsal surface. The micropyle is represented by a palar scar near the hilum in the central depression of the ventral surface. The raphe is represented by a raised ridge which extends from the hilum at the base to the chalaza at the apex (Afifi *et al.* 1995). Hewson (1988) added that the seeds are covered by a dense, cottony, furry indumentum consisting of slightly glossy, and 0.01-0.02 mm thick hairs that are slightly swollen at the base. Hairs are much longer on the edge of the rounded abaxial surface of the seeds (at the top and at the base of the elliptically complanate cross section). The seeds have a black, 0.3 mm thick, very hard, bilayered testa (Fig. 3).

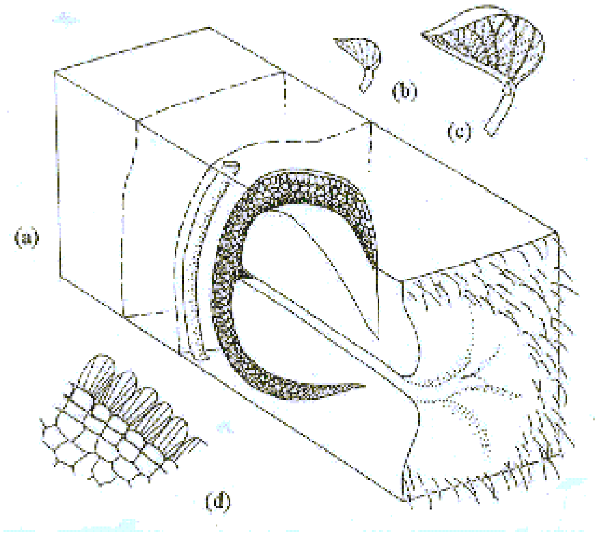

Fig. (2): a-Cut-away section of crypt nectary of lpomoea carnea subsp. fistulosa (concealed chamber filled with nectar-secreting trichomes), b & c- Young leaves of lpomoea carnea showing position of crypt nectary, d-Cross section through capitate nectar-secreting trichomes found on the floor of the crypt nectary (after Keeler and Kaul 1979).

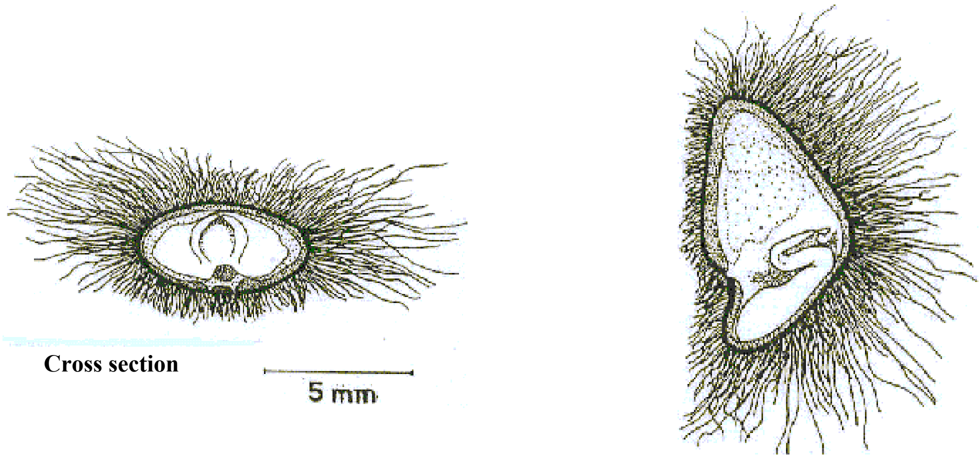

Fig. (3): Cross and longitudinal section of seeds of lopomoea carnea subsp. fistulosa (after Frey 1995)

Clonality however is an important feature of the species. According to Frey (1995), the nautability (ability to float on the water surface) of seed material of *Ipomoea carnea* subsp. *fistulosa* population was tested under different conditions. These tests provided data on the rate of infection by insects, the nautability of unparasitized seeds in fresh water amounted to 11-16 days. Without indumentum the seeds immediately sank. Thus, it may be concluded that seeds are probably water-dispersed.

4-Seedling morphology:

Seedling morphology of *Ipomoea carnea* is a more recent approach, where very early developmental stages show appropriate stability (Duke 1965, Burger 1972). The advantage of using seedling morphology in systematic studies

stems from their uniformity at the juvenile stages, before they are subjected to the diversity of factors prevailing in the case of mature plants (De–Vogel 1980). Seedlings are able to fully develop their cotyledons within the first two weeks of contact with water. Seedlings may then attain 5.5 cm in height. The cotyledons are V-shaped, bilobate with lobes 23 mm long and 8 mm wide (Frey 1995). Das and Mukherjee (1997) reported that *Ipomoea carnea* subsp. *fistulosa* seedling has the following criteria: between diverging lobes was 70º, length of apical notch was 24 mm, length of paracot was 34 mm and ratio of notch and paracot length was 0.70.

MICROMORPHOLOGY:

The anatomy of *Ipomoea carnea* subsp. *fistulosa* has been investigated by Bhattacharyya and Midya (1979), and more extensively by Afifi *et al.* (1988a, b, 1995) and Eid (2002), who studied cross-sections of root, stem, petiole, foliar lamina, seed and flower material. They reported abundant druses of calcium-oxalate in stems, petioles and foliar lamina. On the surfaces (except the roots) simple, unicellular, spiny and peltate glandular trichomes were found. Stomata are present on both abaxial and adaxial sides of the leaves. Stomata are anisocytic and paracytic; there are few peltate glandular and spiny unicellular trichomes on the epidermis.

The petiolar extrafloral nectaries of *Ipomoea carnea* subsp. *fistulosa* belong to the structurally most complex group of extrafloral nectaries (i.e. the crypt nectaries) were reported so far (Zimmermann 1932). These are recessed chambers filled with secreting trichomes, connected to the surface by a duct. Keeler (1977), Keeler and Kaul (1979) studied the anatomy, morphology and role of these extrafloral nectaries. Other studies on the anatomy of the plant were done by Singh *et al.* (1974) on the plasticity of epidermal traits, and Sahu and Santra (1989) on the effects of industrial air pollution on foliar traits in West Bengal (India). The studies of Mohanty and Mishra (1963) and Frey (1995) on the stomatal distribution and leaf area indicated that the xeromorphic plants had a mean leaf area up to four times that of aquatic plants.

DISTRIBUTION:

As quoted by Austin (1977), *Ipomoea carnea* subsp. *fistulosa* is very common throughout the American tropics, ranging from Argentina to the southern states of U.S.A. It also distributed in Dallas, Texas and the southern part of Georgia in U.S.A. (Shinners 1970, Long and Lakela 1971). The plant is considered to have its origin in the Pantanal of Bolivia, Brazil and Paraguay; i.e. the floodplains of the upper Rio Paraguai stretching from Corrientes (28ºS) in Argentina to the Parque National Noël Kempff (15ºS) in Bolivia (Adams 1972, Austin 1982, Keeler 1975, 1979, Standley and Williams 1970). As in many other countries, it has been also introduced and cultivated in other provinces of Argentina, Brazil and Bolivia (Frey 1995). It has not been reported for Barbados (Gooding *et al.* 1965), Barro Colorado Island (Croat 1978), and the Galápagos Islands (Wiggins and Porter 1971).

Verdcourt (1963) reports cultivated specimens of *Ipomoea carnea* subsp. *fistulosa* from Nairobi, Kenya and naturalized populations along the coast of tropical East Africa. It has also been reported from India (Bhattacharyya 1976; Mahapata 1978; Sharma 1978), West-Pakistan (Austin and Ghazanfar 1979), Sri Lanka (Dassanayake and Fosberg 1980), the Malayan archipelago, Java in Indonesia (Van Ooststroom 1953), Okinawa (Walker 1976) and Taiwan (Li *et al.* 1978).

Ipomoea carnea **subsp.** ***fistulosa*** **today may be considered a pan tropical weed, its pan tropical distribution is presumably the result of cultivations (Fig. 4).**

Frey (1995) reported ***Ipomoea carnea*** **subsp.** ***fistulosa*** **from Luxor, Egypt on the border of the Nile. Generally it is distributed in the Egyptian Nile region including the Nile Delta, Valley and Faiyum along the canal banks and in moist waste ground (El-Sheikh 1996, Al-Sodany 1998 and Boulos 2000; but they did not identify it as subspecies** ***fistulosa*****).**

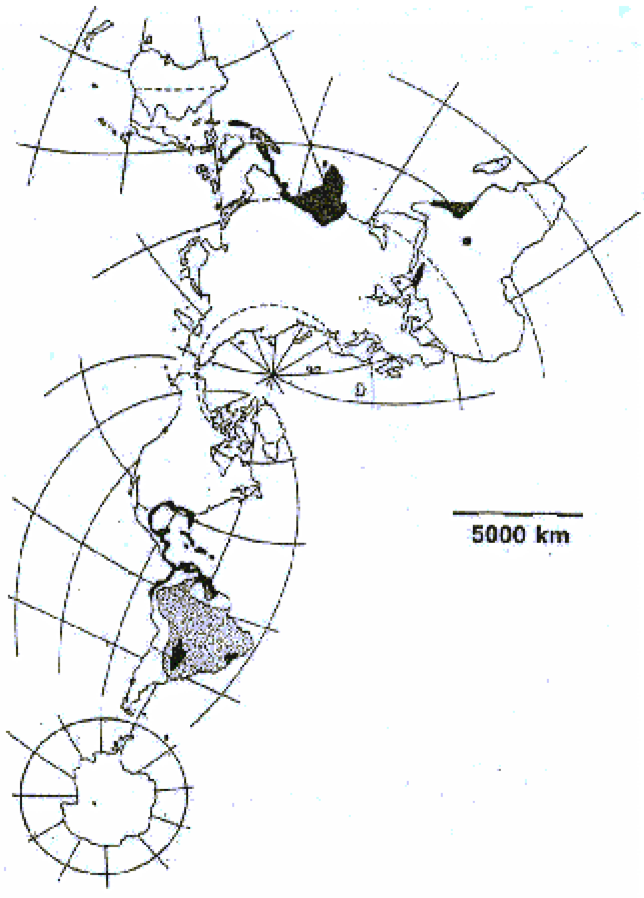

Fig. (4): Distribution of lpomoea carnea subsp. fistulosa. Dark areas : voucher specimens seen or reported; dotted areas: literature references without voucher specimens cited (after Frey 1995)

ECOLOGICAL AMPLITUDE:

Cook (1987) observed that ***Ipomoea carnea*** **subsp.** ***fistulosa*** **grows on dry rocks as well as on the banks of lakes and rivers, in water up to 2 m deep or as components of floating islands in the Pantanal. Also, Bhattacharyya and Midya (1979) and Frey (1995) indicated wide ecological amplitude for this plant as much as they observed it growing in xeric and hydric conditions. This plant was found growing in sandy and silty, nutrient-poor and organic, xeric and hydric conditions, while the plant seemed to prosper best in hydric, nutrient-rich conditions. Shade tolerance was not observed (Frey 1995).**

ASSOCIATED SPECIES:

The total number of species associated to *Ipomoea carnea* populations in the Nile Delta was 84 species: 49 annuals (58.3 %), 2 biennials (2.4 %) and 33 perennials (39.3 %). They belong to 28 families and 71 genera (Eid 2002). The grasses had the highest contribution to the total associated species (20.2%), followed by composites (19.0%), legumes (8.3%), chenopods (7.1%), and crucifers (7.1%). Three species only were recorded in more than 40 % of the studied stands (*Cynodon dactylon*: 72.3%, *Phragmites australis*: 58.5% and *Rumex dentatus*: 43.1%) while four species were recorded in 30-40% (*Aster squamatus*, *Chenopodium murale*, *Convolvulus arvensis* and *Polypogon monspeliensis*). Six species were recorded in 30-20% (*Sonchus oleraceus*, *Malva parviflora*, *Ammi majus*, *Imperata cylindrica*, *Phalaris minor* and *Persicaria salicifolia*). The species inhabiting the canal banks were the highest (63 species: 27.4% of the total), followed by those of drain banks (41 species: 17.8%), field edges (32 species: 13.9%) and waste lands (32 species: 13.9%). On the other hand, the Mediterranean taxa had the highest percentage (27.0%) followed by Irano-Turanian (20.1%), Euro-Sibarian (13.2%), Tropical (13.2%) and Cosmopolitan taxa (11.9%).

PROPAGATION:

***Ipomoea carnea* subsp. *fistulosa* is able to spread rapidly vegetatively, whereas horizontal branches rapidly root along the downward side in contact with the ground, and give origin to many erect side branches. At the tip of the horizontal branch a secondary shrub (i.e. ramet) develops. The laid-down branch becomes a functional stolon, which persists and keeps mother and daughter plant connected (Fig. 5). Individual plants thus can easily expand in each direction with in-line offspring, covering dozens of square meters. This "Guerilla"-type of extension (Lovett-Doust 1981a) contributes most to vegetative regeneration, and thus is a most potential process that may have intriguing consequences for the concepts of individuality and its evolutionary implementations.**

Chaudhuri *et al.* (1994) indicated that the ornamental hedges prepared by planting *Ipomoea carnea* subsp. *fistulosa* stem cuttings have aided this plant to disseminate into new regions. During floods and other natural calamities, plants are swept off river beds and embankments and become established in down stream habitats. The collection of plants for fuel also leads to spread of the plant to other areas. Garden enthusiasts in earlier days have also unknowingly disseminated the plant. Decumbent branches root in the soil before growing upwards establishing new plants separately from the main plant.

Reproduction by seed is also common. Fruits dehisce during winter by the splitting of the dry fruit-wall and the hairy seeds are dispersed by wind as well as water. The seed do not germinate immediately because of a hard seed coat which is impervious to water. In Costa Rica, Keeler (1975) reported 8-9 hours for the anthesis, 1-2 days for the development or abortion of fruits and 4-5 weeks for the maturation of the seeds of *Ipomoea carnea*. Seeds germinate in light within the first three days of contact with water. The germination rate of fully developed seeds attained 17-26%. Seeds took 14-20 days to fully develop the cotyledons. Obligate dormancy was not observed. Eid (2002) indicated that, before puncturing the hilum, the germination percentage of seeds after one week was as follows: 4.0 % in clay soil, 2.0 % in sandy soil,

1.5% in cotton saturated with water and 1.0% in water, with no germination after that time until the end of the experiment after 28 days. After puncturing the hilum, the germination percentage reached 100% after three days only.

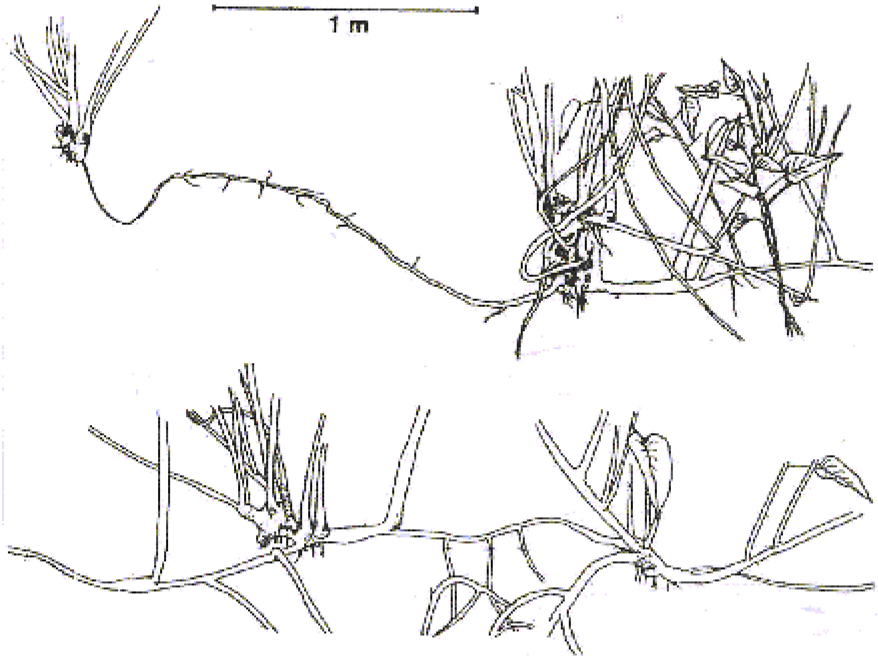

Fig. (5): lpomoea carnea subsp. fistulosa. One genet with several in-line ramets. The lower figure is a continuation of the right portion of the lop figure (after Frey 1995)

PALYNOLOGY AND KARYOLOGY:

Bhattacharyya and Midya (1979) described the pollen of *Ipomoea carnea* subsp. *fistulosa* as pantoporate with 45-50 pores, spheroidal, 76 to 82 µm in diameter. Pores are reported to be circular of ca. 7 µm in diameter, provided with a pore membrane of ca. 1 µm thickness, and an interporal distance of 4-5 µm. Thickness of exine ca. 14 µm, of sexine ca. 11 µm (including spines, which are 9-10 µm long), of nexine ca. 3 µm. Spines are reported to have a flask-shaped structure, broad at base and gradually tapering towards the apex with a pointed tip. There are only a few reports on the karyo morphology of *Ipomoea carnea* spp. *fistulosa* (Rao 1947, Sharma and Chatterji 1957, Sharma and Datta 1958, Sampathkumar 1970, 1979). The karyology of *Ipomoea carnea* subsp. *fistulosa* indicated chromosome numbers were n=15 and 2n=30 (Jones 1964, 1968; Martin 1968; Nakajima 1963). The range of chromosome length was 1.69–3.34 µm and the total chromatin length=71.10 µm (Sinha and Sharma 1992).

Gad El-Karim (2004) found that the cytological features of 25 natural populations of *I. carnea* distributed in seven habitat types in the Nile Delta region in Egypt revealed an inter- and intraplant variations in chromosome number ranging from 18 to 60. The karyotype analysis for cells having 2n = 30 chromosomes representing to the studied habitats revealed a substantial differences in the karyotype structure among the studied accessions. Not

only differences were found in the morphology of chromosomes but also in the mean chromosome length of these accessions. The karyotype of *I. carnea* might be inferred from symmetry to asymmetry as a result of pericentric inversion or unequal translocation. The analysis of seed proteins of *I. carnea* by SDS-PAGE revealed a great variability in protein banding patterns of the accessions under study. This wide inter-population variation observed in accessions from different localities and different habitat types suggests a high genetic diversity among genotypes of this plant. The same author showed a great variation in their genetic structure. Many factors were shown to influence enzyme variation encountered in *I. carnea*, among them reproductive strategy, mating system, life cycle, longevity, mutation, adaptation and selection for environmental changes.

POPULATION DYNAMICS:

The study of Eid (2002) indicated that the growth of *Ipomoea carnea* follows a seasonal pattern where its growth was fastest during September and October. Wide ecological amplitude of this plant has been demonstrated. These results indicated significant differences between its populations in different habitats, regarding to the growth variables (e.g. height, crown diameter, volume and size index); reproductive variables (e.g. number of flowers and fruits); and demographic variables (e.g. natality, mortality and survival).

Generally, *Ipomoea carnea* populations along the railway sides and field edges in the Nile Delta had the lowest means of most of the growth and reproductive variables, while those of the road dividers, road sides and canal banks had the highest. On the other hand it had the highest values of most of these variables during September and October and the lowest during June and July.

The highest flower and fruit production occurred during the period from September to December (Eid 2002). It was indicated that, the flowering time of *Ipomoea carnea* exhibited differences between different habitats in Nile Delta. The flowering began earlier in some habitats (e.g. road sides and canal banks) and later in some others (e.g. railway sides, road dividers and waste lands). Generally, its population in the wet habitats (e.g. drain and canal banks) had leaf area larger than this of the other habitats.

The study of Eid (2002) indicated also that the size frequency distributions of *Ipomoea carnea* populations in different habitats tend to approximate the negative skewed distributions where the big ramets are more preponderant than the small ones. Population natality varies in relation to habitat and time. Waste lands experienced the highest natality, while the road sides and drain banks had the lowest. On the other hand, the natality was higher during the period of October, December and May comparing with the other months. The population of road sides, canal banks and road dividers attained the highest standing-crop, while, the field edges attained the lowest.

PHYTOCHEMISTRY:

***Ipomoea carnea* subsp. *fistulosa* contains acrid latex and abundant druses and crystals (Bhattacharyya and Midya 1979). Tirkey *et al.* (1988) carried out some phytochemical studies, which indicated that the dried powdered leaves contain alkaloids, reducing sugars, glycosides and tannins. Among compounds of the latex are unidentified insecticides, acacetin-7-galactoside, flavone glycoside, and saponin of unknown chemical structure called ipomotocin. The latex contains 1-2% galaktomannan sugar. The most complete account of compounds found in the**

latex of *Ipomoea carnea* subsp. *fistulosa* is given by Legler (1965). Among these are L-rhamnose, D-fucose, D-chinovose (6-deoxy-D-glucose), D-glucose, convolvulinolate (11-hydroxy-pentadecane acid), jalapinolate (11-hydroxypalmitic acid), 7-hydroxy-decane acid, ipurolic acid (3,11-dihydroxy-tetradecane acid). Keeler (1977) analysed the chemical composition of the nectar and found remarkable differences in the content of amino acids (alanine, arginine, asparagine, glutamic acid, glycine, isoleucine and serine) and sugars (sucrose, glucose, fructose, melibiose and raffinose) in petiolar, pedicellar and floral nectar.

COMPETITION:

As quoted by Caldwell (1987), competition between plants is, in many cases, a struggle for light and space (Tilman 1982, 1988). Smith (1982) showed that the quality of the light is, in many cases, an important feature involved in seed germination and competition. Especially in a nutrient-rich environment such as the floodplains of the Pantanal, competition is to be expected on this ecological level. Competitive abilities are correlated with plant architecture, especially with the ability of a taxon to grow rapidly, to spread leaf surface, thereby shade other, competing taxa, and thus weaken, or even eliminate understorey vegetation (Grime 1973 and 1979, Grime *et al.* 1988). *Ipomoea carnea* subsp. *fistulosa* with its high growth rate exhibits extraordinary competitive abilities. In addition, its reproductive and regenerative capabilities are highly developed, and it is adapted to drastic seasonal changes in its environment, with responses such as the development of a thick aerial paraenchymatus around the stem base, which allows for survival in areas flooded during long periods of the year.

POLLINATOR AND THEIR BEHAVIOUR:

Information on pollinators of *Ipomoea carnea* subsp. *fistulosa* is given by Janzen (1980), Keeler (1975, 1977, 1979), Keeler and Kaul (1979), Bentley (1977a, 1977b), Sahu and Santra (1989), Schlising (1970), and Real (1981). Frey (1995) concluded that the species of Hesperidae visiting the flowers earliest in the morning probably contributed most to cross pollination. This is suggested mainly by the behaviour of the observed Hesperidae species. After having exploited the floral nectaries of one flower, it did not fly to the nearest flower of the same plant, but usually flew from plant to plant. Xylocopinae species were observed to do the same. Considering their long flying distances they may be important long distance pollen vectors. *Apis mellifera*, although quite abundant, was not observed to contribute significantly to pollination. It was mostly observed to exploit the pedicellar extrafloral nectaries; only on rare occasions they were covered with *Ipomoea* pollen. Diptera also were not considered efficient pollinators because they did not carry *Ipomoea* pollen either.

ECONOMIC IMPORTANCE:

Ipomoea carnea subsp. *fistulosa* contributes to the mosquito nuisance (Chaudhuri, *et al.* 1994). The high cellulose and volatile solid content of dried stem material is responsible for its successful biogasification. (Sharma 1987, Sharma *et al.* 1989). This plant can be used as a source of green manure which may be due to the addition of essential nutrients to the soil by the leaf incorporation which finally helped the increasing of grain yield (Kondap *et al.* 1981). It is used in farm land for improving the soil fertility in tropical countries like India where it is prevalent (Kondap *et al.* 1981). Aqueous flower extracts at 5% or higher of this plant

showed the greatest nematicidal properties against the second stage of *Meloidogyne incognita* (Nikure and Lanjewar 1981). Aqueous extracts of dried and powdered corolla, senescent leaves and roots of inhibit the shoot and root growth of wheat, sorghum, rice and kidney bean (Jadhav *et al.* 1997). The changes in leaf surface traits can be used as air pollution marker (Yunus *et al.* 1982). Leaf surface also can be used as dust scavengers (Khan *et al.* 1989). The leaves are palatable for various fish species (Frey 1995). The latex of the plant is used in traditional medicine as a topical antiseptic in lesions (Chowdhury *et al.* 1997). Extracts prepared from whole plant in hot, not boiling, water seem to be widely used as antirheumatic remedy in Bolivia. Frey (1995) reported a new use of entire *Ipomoea carnea* subsp. *fistulosa* as a raw material for paper-bag production in the surroundings of Tiruchirapalli and along the Eastern Ghats in India. He reported a rare use of dried stem material as fire- wood in Rajasthan, because of its yellow flame. Van den Berg (1982) reported the use of plant against dermatoses without referring to any sources. Also the wood of the stems can be used in turneries, which seems doubtful considering the low amount of lignin in the soft wood (Sharma *et al.* 1989). It can also cause some problems such as obstruction and difficulties in the proper use of the irrigation, navigation, and fisheries (Chaudhuri *et al.* 1994), poisoning and its effects on the nervous system (Idris *et al.* 1973, Tirkey *et al.* 1987) and toxicity in goats (Indrajit and Pathak 1995). In Egypt, the farmers use *I. carnea* as ornamental and hedge plant along the banks of irrigation and drainage canals (Eid 2002).

CONTROL MEASURES:

Chaudhuri *et al.* (1994) mentioned that manual control measures by cutting and digging of stems, though commonly undertaken, are costly and ineffective. Any remaining stems and seeds that are in the soil easily and rapidly re-infest the cleared areas. In a field trial, a small plot of 0.15 ha was cleared manually by 10 men in 6-10 hour working days. The herbicide 2,4-D (2,4-dichlorophenoxy acetic acid) is known to be effective against *Ipomoea* spp. (Robinson *et al.* 1952) including *Ipomoea carnea* (Singh and Adlakha 1966). Doses of 1 to 3 kg 2,4-D/ha in 0.05% aqueous solution usually provide over 90% control. It was noted that unless plants are thoroughly sprayed, many escape the spray in dense infestations and regrow rapidly. The fine spray of the ordinary compression or power sprayers does not reach sufficiently far or high enough to cover the upper leaves of tall *Ipomoea carnea* plants. Hence high volume sprays of more than1,000 leaves /ha were employed in a fine shower directed towards the top of the weed beds. It was noted that with this volume spray droplets would fall onto the lower leaves as well as smaller understory plants preventing re-growth. Regeneration of about 10% of the original number of plants occurred in areas sprayed at doses of 1 to 2 kg 2,4-D /ha, but usually did not occur at higher application rates.

REFERENCES:

Adams C.D. 1972. *Flowering Plants of Jamaica*. University of the West Indies, Mona, Jamaica.

Afifi M.S., Amer M.M.A. and El-Khayat S.A. 1988a. Macro-and micro morphology of *Ipomoea carnea* Jacq. Growing in Egypt. Part I. Leaf and flower. *Mansoura J.* of *Pharmaceutical Science*, 3:41-57.

Afifi M.S., Amer M.M.A. and El-Khayat S.A. 1988b. Macro-and micro morphology of *Ipomoea carnea* Jacq. Growing in Egypt. Part II. Stem and root. *Mansoura Journal of Pharmaceutical Science*, 4: 88-97.

Afifi M.S., Amer M.M.A. and El-Khayat S.A. 1995. Macro-and micro morphology of *Ipomoea carnea* Jacq. Growing in Egypt. Part III. Fruit and seed. *Mansoura Journal of Pharmaceutical Science*, 11(2): 244-255.

Al-Sodany Y.M. 1998. *Vegetation Analysis of the Canals, Drains and Lakes of the Northern Part of Nile Delta.* Ph.D. Thesis, Tanta University, Tanta, pp. 232.

Austin D.F. 1977. *Ipomoea carnea* Jacq. vs. *Ipomoea fistulosa* Mart. ex Choisy. *Taxon*, 26: 235-238.

Austin D.F. 1982. Convolvulaceae. In: Harling, G. and Sparre, B. (eds.) *Flora of Ecuador.* Swedish Research Council's Publishing House, Stockholm, and pp. 44-45.

Austin D.F. and Ghazanfar S. 1979. Convolvulaceae. In: Nasir, E. and Ali, S.I. (eds.) *Flora of West Pakistan*. Agricultural Research Council, Islamabad, pp. 1-64.

Austin D.F. and Huáman Z. 1996. A synopsis of *Ipomoea* (Convolvulaceae) in the Americas. *Taxon*, 45: 3-38.

Bentley B.L. 1977a. Extrafloral nectaries and protection by pugnacious bodyguards. *Annual Reviews of Ecology and Systematics*, 8: 407-427.

Bentley B.L. 1977b. The protective function of ants visiting the extrafloral nectarines of *Bixa orellana* (Bixaceae). *Journal of Ecology*, 65: 27-38.

Bhattacharyya P.K. 1976. A note on two species of *Ipomoea*, namely *I. carnea* Jacq. and *I. fistulosa* Mart. ex Choisy in Eastern Asia. *Journal of the Bombay Natural History Society*, 73: 317-320.

Bhattacharyya P.K. and Midya A.K. 1979. Studies in the arboreal *Ipomoea* L. of the Indian Botanic Garden. *Bulletin of the Botanical Society of Bengal*, 33: 75-86.

Boulos L. 1995. *Flora of Egypt, Checklist.* Al-Hadara Publishing, Cairo, pp. 283.

Boulos L. 2000. *Flora of Egypt, Vol. 2.* Al-Hadara Publishing, Cairo, pp. 352.

Burger H. 1972. Seedlings of some tropical trees and shrubs, mainly of South East Asia. Center for Agricultural Publishing and Documentation (PUDOC), Wageningen.

Caldwell M.M. 1987. Plant architecture and resource competition. In: Schulze, E.D. and Zwölfer, H. (eds.) *Potentials and Limitations of Ecosystem Analysis. Ecological studies, Vol. 61,* Springer Verlag, pp. 164-179.

Chaudhuri H., Ramaprabhu T., and Ramachandran V. 1994. *Ipomoea carnea* Jacq. A new aquatic weed problem in India. *Journal of Aquatic Plant Management*, 32: 37-38.

Chowdhury A.K.A., Ali M.S. and Khan M.O.F. 1997. Antimicrobial activity of *Ipomoea fistulosa* extractives. *Fitoterapia*, 68 (4): 379-380.

Cook C.D.K. 1987. *Ipomoea fistulosa*: A new problem for India. *Aquaphyte*, 7(1): 12.

Croat T.B. 1978. *Flora of Barro Colorado Island*. Stanford University Press, California.

Das S. and Mukherjee K.K. 1997. Morphological and biochemical investigations on *Ipomoea* seedlings and their interrelationships. *Annals of Botany*, 79: 565-571.

Dassanayake M.D. and Fosberg F.R. 1980. *A Revised Handbook to The Flora of Ceylon, Vol 1.* Amerind Publishing Co. Pvt. Ltd., New Delhi, pp. 508.

De-Vogel E.F. 1980. Seedling of dicotyledons. *Centre for Agricultural Publishing and Documentation* (PUDOC), Wageningen.

Duke J.A. 1965. Keys for the identification of seedlings of some prominent woody species in 8 forest types in Puertorico. *Annals of the Missouri Botanical Garden*, 52: 315-350.

Eid E.M. 2002. *Population Ecology of Ipomoea carnea Jacq. in The Nile Delta Region*. M.Sc. Thesis, Tanta University, Tanta. pp. 118.

El-Sheikh M.A. 1996. *Ruderal Plant Communities of the Nile Delta Region*. Ph.D. Thesis, Tanta University, Tanta, pp. 189.

Frey R. 1995. *Ipomoea carnea* ssp. *fistulosa* (Martius ex Choisy) Austin: taxonomy, biology and ecology reviewed and inquired. *Tropical Ecology*, 36(1): 21-48.

Gad El-Karim M.S. 2004. *Cytological and genetical variations among Ipomoea carnea Jacq. Population in Nile Delta region*. M.Sc. Thesis, Tanta University, pp. 186.

Gooding E.G.B., Loveless A.R. and Proctor G.R. 1965. *Flora of Barbados*. Her Majesty's Stationery Office, London.

Grime J.P. 1973. Competitive exclusion in herbaceous vegetation. *Nature*, 242:344-347.

Grime J.P. 1979. *Plant Strategies and Vegetation Processes*. John Wiley and Sons, Chichester, pp. 222.

Grime J.P., Hodgson J.G. and Hunt R. 1988. *Comparative Plant Ecology: A Functional Approach to Common British Species*. Hyman, London, pp.742.

Hewson H.J. 1988. *Plant Indumentum: A Handbook of Terminology*. Australian Flora and Fauna Series 9. Australian Government Publishing Service, Canberra.

Idris O.F., Tartour G., Adam S.E.I. and Obeid H.M. 1973. Toxicity to goats of *Ipomoea carnea*. *Tropical Animal Health and Production*, 5: 119-123.

Indrajit N. and Pathak D.C. 1995. Induced *Ipomoea carnea* toxicity in goats: clinical and pathomorphological studies. *Indian J. of Veterinary Pathology*, 19 (1): 19-21.

Jadhav P.S., Mulik N.G. and Chavan P.D. 1997. Allelopathic effects of *Ipomoea carnea* subsp. *fistulosa* on growth of wheat, rice, sorghum and kidney bean. *Allelopathy Journal*, 4 (2): 345-348.

Janzen D.H. 1980. Specificity of seed-attacking beetles in a Costa Rican deciduous forest. *Journal of Ecology*, 68: 929-952.

Jones A. 1964. Chromosome numbers in the genus *Ipomoea*. *Journal of Heredity*, 55: 216-219.

Jones A. 1968. Chromosome numbers in *Ipomoea* and related genera. *Journal of Heredity*, 59: 99-102.

Keeler K.H. 1975. *Ipomoea carnea* Jacq. (Convolvulaceae) in Costa Rica. *Brenesia*, 5: 1-5.

Keeler K.H. 1977. The extrafloral nectaries of *Ipomoea carnea* (Convolvulaceae). *American J. of Botany*, 64: 1182-1188.

Keeler K.H. 1979. Distribution of plants with extrafloral nectaries and ants at two elevations in Jamaica. *Biotropica*, 11: 152-154.

Keeler K.H. and Kaul R.B. 1979. Morphology and distribution of petiolar nectaries in *Ipomoea* (Convolvulaceae). *American Journal of Botany*, 66: 946-952.

Khan A.M., Vivek P., Mohd Y., Ahmad K.J., Pandey V. and Yunus M. 1989. Plants as dust scavengers: a case study. *Indian Forester*, 115 (9): 670-672.

Kondap S.M., Yogeswara Rao Y., Wajid A.M., Ramachandra Rao A. and Srirama Raju K. 1981. Studies on the use of *Eichhornia crassipes* and *Ipomoea carnea* weeds as a source of green manure. *Proceedings of 8th Asian-Pacific Weed Science Society Conference,* pp. 153-155.

Legler G. 1965. Die Bestandteile des giftigen Glykosidharzes aus *Ipomoea fistulosa* Mart. ex Choisy *Phytochemistry*, 4(1):29-41.

Li H., Tang-Shiu L., Tseng-Chieng H., Koyama T. and De Vol C.E. 1978. *Flora of Taiwan, Vol IV*. Epoch Publishing Company, Ltd., Taipei, Taiwan.

Long R.W. and Lakela O. 1971. *A Flora of Tropical Florida.* University of Miami, Coral Gabels, Florida.

Lovett-Doust L. 1981a. Population dynamics and local specialization in a clonal perennial (*Ranunculus repens*). I. The dynamics of ramets in contrasting habitats. *Journal of Ecology*, 69: 743-755.

Mabberley D.J. 1987. *The Plant Bock; a portable dictionary of the higher plants*. Cambridge University Press, Cambridge, pp. 707.

Mahapata A.K. 1978. A brief survey of some unrecorded, less known and threatened plant species of Sundarban of West Bengal. *Bulletin of the Botanical Society of Bengal*, 32: 54-58.

Martin F.W. 1968. The system of self-incompatibility in *Ipomoea*. *Journal of Heredity*, 59: 262-267.

Meissner C.F. 1869. Convolvulaceae. In: Martius, C.F.P. (ed.) *Flora Brasiliensis, Vol. VII. Munich. Fleischer. Leipzig*, 7: 200-370.

Mohanty P.K. and Mishra P. 1963. Stomatal distribution in relation to xeromorphy in aquatic plants. *Nature*, 200: 909-910.

Nakajima G. 1963. Karyotype of genus *Ipomoea*. *Cytologia*, 28: 351-359.

Nikure Y.J. and Lanjewar R.D. 1981. Nematicidal potentialities of *Ipomoea carnea* Jacq. *College of Agriculture Magazine*, 54-55.

Rao N.S. 1947. Chromosome studies in the genus *Ipomoea*. *Curr. Sci.*, 16: 156.

Real L.A. 1981. Nectar availability and bee-foraging on *Ipomoea* (Convolvulaceae). *Biotropica*, 13(2): 64-69.

Robinson W.W., Crafts A.S. and Raynor K.N. 1952. *Weed Control- A Text Book and Manual*. McGraw Hill Book Co., Inc., New York.

Sahu A.K. and Santra S.C. 1989. Industrial air pollution and its effect on plant's foliar traits: A case study from West Bengal, India. *Feddes Repertorium*, 100: 177-186.

Sampathkumar R. 1970. Karyotype analysis in some South Indian Convolvulaceae. *Journal of Annamalai University Sciences*, 28: 39-55.

Sampathkumar R. 1979. Karyomorphological studies in some South Indian Convolvulaceae. *Cytologia*, 44: 275-286.

Schlising R.A. 1970. Sequence and timing of bee foraging in flowers of *Ipomoea* and *Aniseia* (Convolvulaceae). *Ecology*, 51: 1061-1067.

Shaltout K.H. 2003. The biology of Egyptian woody perennials. 1. *Nitraria retusa* (Forssk.) Asch. *Ass. Univ. Bull. Environ. Res.* 6(1): 55-71.

Sharma A.K. and Chatterji A.K. 1957. A cytological investigation of some Convolvulaceae as an aid in understanding their lines of evolution. *Phyton*, 9: 143-157.

Sharma A.K. and Datta P.C. 1958. Cytological investigations on the genus *Ipomoea* and

its importance in the study of phylogeny. *The Nucleus*, 1: 89-122.

Sharma M. 1978. Aquatic and marshy angiosperms of Punjab. *Bulletin of the Botanical Society of Bengal*, 31: 52-60.

Sharma S.K. 1987. *Biogas From Ipomoea fistulosa Leaves*. Annual Report of SBI Chair, AHEC. Univ. of Roorkee, India.

Sharma S.K., Saini J.S., Mishra I.M. and Sharma M.P. 1989. Biogasification of woody biomass *Ipomoea fistulosa* plant stem. *Biological Wastes*, 28: 25-32.

Shinners L.H. 1970. Convolvulaceae. In: Correll, D.S. and Johnston, M.C. (eds.) *Manual of the Vascular Plants of Texas*, Renner, Texas, pp. 1241-1261.

Singh C. and Adlakha P.A. 1966. Response of *Cannabis sativa* and *Ipomoea carnea* to the application of 2,4-dichlorophenoxy acetic acid. *Proceedings 2nd Weed Control Seminar*, Department of Agronomy, Punjab Agricultural University.

Singh V., Jain D.K. and Sharma M. 1974. Epidermal studies in *Ipomoea* (Convolvulaceae). *Bangladesh Journal of Botany*, 3: 31-36.

Sinha S. and Sharma S.N. 1992. Taxonomic significance of karyomorphology in *Ipomoea* spp. *Cytologia*, 57: 289-293.

Smith H. 1982. Light quality, photoperception, and plant strategy. *Annual Review of Plant Physiology*, 33: 481-518.

Standley P.C. and Williams L.O. 1970. Convolvulaceae. In: Flora of Guatemala. *Fieldiana, Botany*, 24(9): 4-85.

Tilman D. 1982. *Resource Competition and Community Structure*. Princeton University Press, New Jersey.

Tilman D. 1988. *Plant Strategies and the Dynamics and Structure of Plant Communities*. Princeton University Press, New Jersey.

Tirkey K., Yadava R.P. and Mandal T.K. 1987. Effect of aqueous extract of *Ipomoea carnea* on the hematological and biochemical parameters in goats. *Indian Journal of Animal Science*, 57: 1019-1023.

Tirkey K., Yadava R.P., Mandal T.K. and Banerjee N.L. 1988. The pharmacology of *Ipomoea carnea*. *Indian Veterinarian Journal*, 65: 206-210.

Van den Berg M.E. 1982. Contribução ao conhecimento da flora medicinal do mato Grosso. *Ciência e Cultura*, 34: 163-170.

Van Ooststroom S.J. 1953. *Ipomoea*. In: Van Steenis (ed.) *Flora Malesiana* Ser. I(4). Noordhoff-Kolff N.V., Djakarta, pp. 458-488.

Verdcourt B. 1963. Convolvulaceae. In: Hubbard, C.H. and Milne-Redhead, E. (eds.) *Flora of Tropical East Africa*. Crown Agents for Overseas Governments and Administrations, London, pp. 1-161.

Walker E.H. 1976. *Flora of Okinawa and the Southern Ryukyu Islands*. Smithsonian Institution Press, Washington.

Wiggins I.L. and Porter D.M. 1971. *Flora of the Galápagos Islands*. Stanford University Press, California.

Yunus M., Kulshreshtha K., Dwivedi A.K. and Ahmad K.J. 1982. Leaf surface traits of *Ipomoea fistulosa* Mart. ex Choisy as indicators of air pollution. *New Botanist*, 9: 39-45.

Zimmermann J. 1932. Űber die extrafloralen Nectarien der Angiospermen. *Botanisches Centralblatt, Beihefte*, 49: 99-196.

Ass. Univ. Bull. Environ. Res. Vol. 9 No. 1, March 2006

بيولوجية النباتات الخشبية المعمرة في مصر

٢- نبات أيبوميا كارنيا *Ipomoea Carnea* Jacq

كمال حسين شلتوت* ، يس محمد السوداني** ، إبراهيم محمد عيد**

* قسم النبات – كلية العلوم – جامعة طنطا، **قسم العلوم البيولوجية والجيولوجية – كلية التربية بكفر الشيخ – جامعة طنطا

الموطن الأصلي لنبات أيبوميا كارنيا هو أمريكا الجنوبية، ينمو هذا النبات في تجمعات كثيفة على ضفاف الأنهار، والقنوات والأراضى الرطبة. وقد أصبح من النباتات المتجنسة في مصر، فهو يغزو القنوات والمصارف، وجوانب الطرق وأيضاً حواف الحقول في منطقة دلتا النيل. يتكاثر هذا النبات خضرياً بالجزوع القادرة على التجذير بضعة أيام أو جنسياً بالبذور. ويستخدمه المزارعون كنبات زينة وسياج على حواف الحقول، والقنوات والمصارف، وقد ساعد ذلك على انتشار النبات في المناطق الجديدة، وخصوصاً المواطن الأرضية مما يسبب إعاقة وصعوبات في الاستعمال الصحيح للأراضي المزروعة والمجاري المائية في دلتا النيل. يشير معدل النمو السريع، الانتشار، والتكيف في المواطن المائية والمواطن الجافة إلى احتمالية أن يصبح هذا النبات كارثة بيئية أخرى مثل نبات ورد النيل.