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THE OCCURRENCE OF WHITE GRUB [*ADORETUS VERSUTUS* HAROLD 1869] IN THE SANDY RHIZOSPHERE OF *ACACIA NILOTICA SUBSP. NILOTICA* SEEDLINGS IRRIGATED WITH MODERATELY SALINE WATER

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ABSTRACT

Ten white grub larvae (third instar) were found in the sandy rhizospheres of *Acacia nilotica* ssp. *nilotica* seedlings irrigated with saline water of EC: 9.23 and 12.81dS.m^{-1} for more than two months in Biosalinity Experimental Field, department of Botany, University of Karachi. These larvae were incubated in laboratory. The soil was once sprinkled with tap water to maintain moisture level. After eight days the eight of the larvae died but two turned up into pupa which after around six to eight days gave rise to adult leaf chafer beetle. This organism on the basis of external morphology and genitalia was identified as *Adoretus versutus Harold, 1869*) - a serious pest on rose and several other plants. The grubs appeared to be tolerant to moderate level of salinity

Key Words: White Grub, Leaf Chafer *Adoretus versutus* Harold, *Acacia nilotica* ssp. *nilotica* seedlings, Saline water irrigation.

INTRODUCTION

In the month of November, 2012, during harvest of *Acacia nilotica* ssp. *nilotica* seedlings subject to an experiment pertaining to the salinity tolerance of this plant, a number of white grubs (10 in number) were recovered from the basic (pH: 8.09) sandy loam soil of pots irrigated with saline water of EC: 9.23 and 12.81dS.m^{-1}. The larvae (III instar) along with the soil they inhabited were incubated in ventilated glassware. The soil surface was slightly sprinkled with tap water to maintain moisture. In a week time, eight of the larvae died but two of them underwent pupation which gave rise to adults after 10-12 days of pupation (Fig. 1- 3). Immediately after ecdysis, the beetles attempted to enter the soil. They were removed from the soil and kept in separate glassware for study. One of them was male and another female. The second leaf chafer appeared two days later. The organisms were studied for their external morphology and genitalia. It was compared with the related organisms from the literature and identified as *Adoretus versutus* Harold 1969. The description of this organism is given in the following pages.

Classification

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Coleptera
Super family: Scarabaeoidea
Family: Scarabaeidae
Sub family: Rutelinae
Tribe: Adoretini
Genus: *Adoretus*
Species: *versutus*
Author: Harold 1869.
Common names: Indian Rose beetle / Leaf Chafer beetle/ Rose beetle., Fijian root grub, Fijian cane root grub.

Synonymy

Adoretus bangalorensis Brenske, 1900; *Adoretus insularis* Fairmaire, 1897; *Adoretus vestitus* Boheman, 1858; *Adoretus vitiensis* Nonfried, 1891.

MATERIALS AND METHODS

The specimens of *Adoretus versutus* reared in the laboratory were studied. For the study of genitalia the posterior part of abdomen was removed and boiled in 10% KOH solution for about 3-5 minutes on lamp. It was then washed with water. It was dissected in 10% KOH solution (Kamaluddin, 1993). The examination of various structures was made by placing them in glycerine on slides of glass and observing under calibrated microscope.

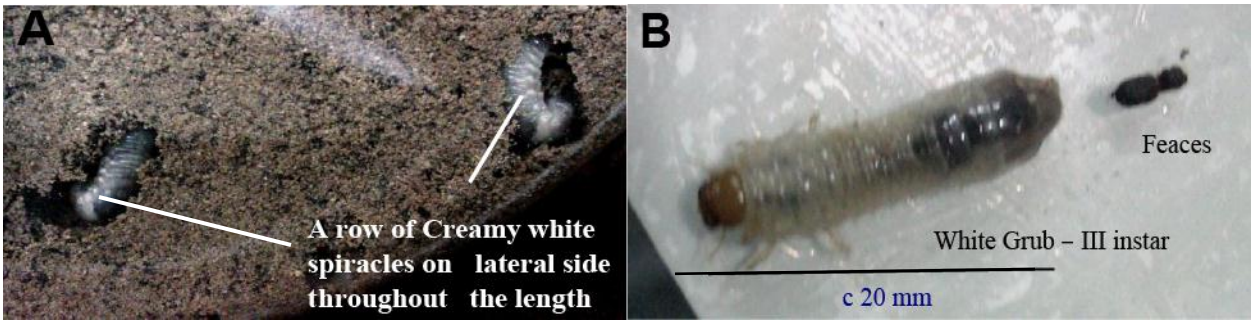

Fig. 1. White grubs of *Adoretus versutus* in soil (**A**) and a single grub taken out in a Petri-plate (**B**). Note that the spiracles are creamy white in colour.

MORPHOLOGY

Larva (White Grub)

Grubs whitish translucent, C-shaped while resting, third instar larva c 20-25 mm in length, larval head reddish brown, last abdominal segment somewhat swollen and dark due to the soil ingested. Spiracles characteristically creamy white in colour (Fig.1). Spiracles 9 pairs *in toto* (one pair prothoeracic and eight pairs abdominal).

Pupa

Pupa is yellowish brown in colour turning dark with time. Full grown pupa is c 16 mm in length. (Fig.2 A-D).

Adult

Pupal ecdysis resulted in separation of external skeleton and emergence of adult. Large dark eyes. Of the reared adults one was female and one male – both brown in colour, c 12 -14 mm in length and c 6-7 mm wide. (Fig. 2E) which is in agreement with Waterhouse and Norris (1987) who reported this insect to measure around 12.8 mm long and 6.8mm wide. Male is smaller than female. Body broader and convex. Underside shining. Scutellum short. Antenna brown, ten-segmented and lamellate. Pronotum dark and less densely punctate in the mid region. The mean distance of the nearest neighbour puncture to the random reference puncture (mid-to-mid of the punctures) was 159.2 ± 5.14 µm (CV: 25%, 87.5 – 312.5 µm) in the mid part of the pronotum and 110.63 ± 4.20 µm (CV: 29.3%; 62.5 – 218.3 µm) in sides of pronotum (fig. 4A).

Clypeus and frons darker (Fig. 2E). Labrum and labium hairy. The tibia of the first legs armed with acute teeth – an adaptation for burrowing in sand. (Fig.4B). Forehead and clypeus are relatively dense punctured. Legs characteristically similar to *Adoretus* in their tibial structure.

Hind wing (1.4 cm long) longer than the fore wing (c 1.0 cm). Elytra or forewing is brown, sclerotized, punctate and with metallic sheen. Fine bristles present all over elytra, pronotum and head. Last Few segments visible below elytra if seen laterally (Fig. 2E). Punctures and setae on elytra are situated on different loci (Fig.5B). On pronotum, however, the setae are enclosed within the punctures in the mid of two slits of the puncture which form roughly semi-lunar structure with a mean diameter of 54.5 ± 1.5 µm. The length of the setae or hairs on elytra and pronotum are comparable, 139.89 ± 6.66 µm and 144.0 ± 5.23 µm, respectively. Fore wing sclerotized, punctate with unrecognizable venation. Puncture size on forewing was 46.23 ± 1.33 µm. Larger setae were thicker setae. The setae on the pronotum are around 130 µm long and 12.8 µm wide in the widest region. Punctures are horse –shoe shaped. Pits on the margins of the pronotum are larger and variously shaped and more like horse-shoe and seldom with a lateral linear extension (Fig. 4 C, D and E). The structural pattern of hind wing shows coastal heterogeneous design as illustrated in Fig. 5 D and E). Hind wing is nearly transparent. Its basal costal part is minutely hairy, whereas the middle part more prominent and bears pre-costal pegs and so appears serrated. It curves much before joint, merges with costa and precostal pegs are internalized. After the joint the coastal surface is quite smooth until it reaches the apex. Bristles forming fibrulae are fine around 48.54 ± 1.77 µm in length and 9.40 – 12.50 µm in thickness at the thickest region. There are seven major veins and two incomplete cells (Fig. 5D) in the wing typical to Rutelinae. There are fine setae nearly all over the surface of the hind wing.

External genitalia withdrawn in abdomen.. These are the typical characters of Scarabaeidae. Aedeagus c 4 mm long. Phallobase longer than parameres. Parameres asymmetrical, longer parameter sinuated laterally at base, dilated at the middle and sharply narrow towards apex. Short paramere broad at the base and gradually narrowing towards apex (Fig. 6).

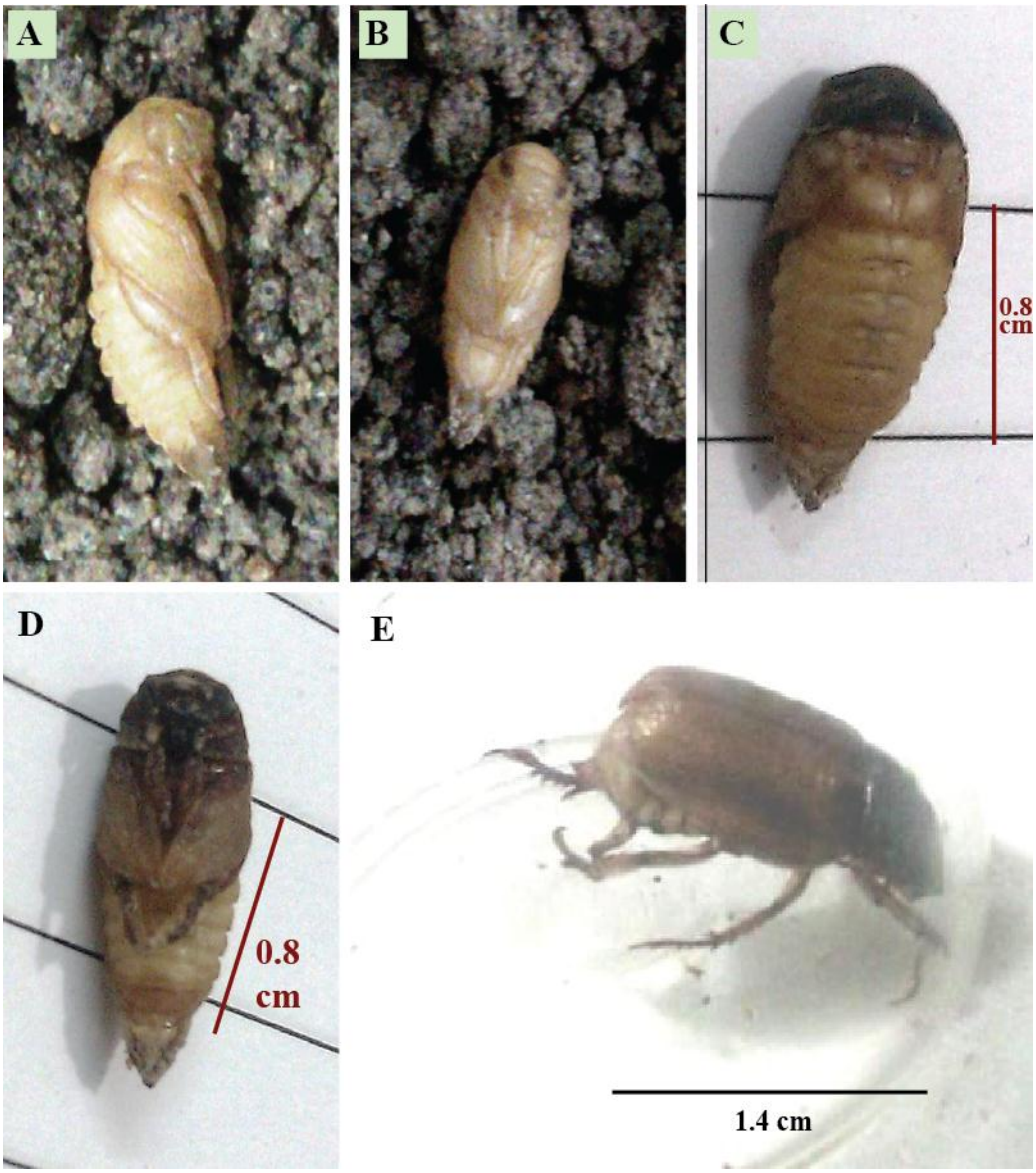

Fig.2. Pupa and the adult Leaf Chafer - *Adoretus versutus* (**A - E**). **A**, Lateral view after two days of metamorphosis of larva to pupa; **B**, Ventral view after four days of metamorphosis; **C**, Dorsal view after six days of metamorphosis , **D**, Ventral view after six days of metamorphosis and **E**, adult in a glassware immediately after ecdysis.

Fig. 3. Exoskeleton of pupa left after ecdysis

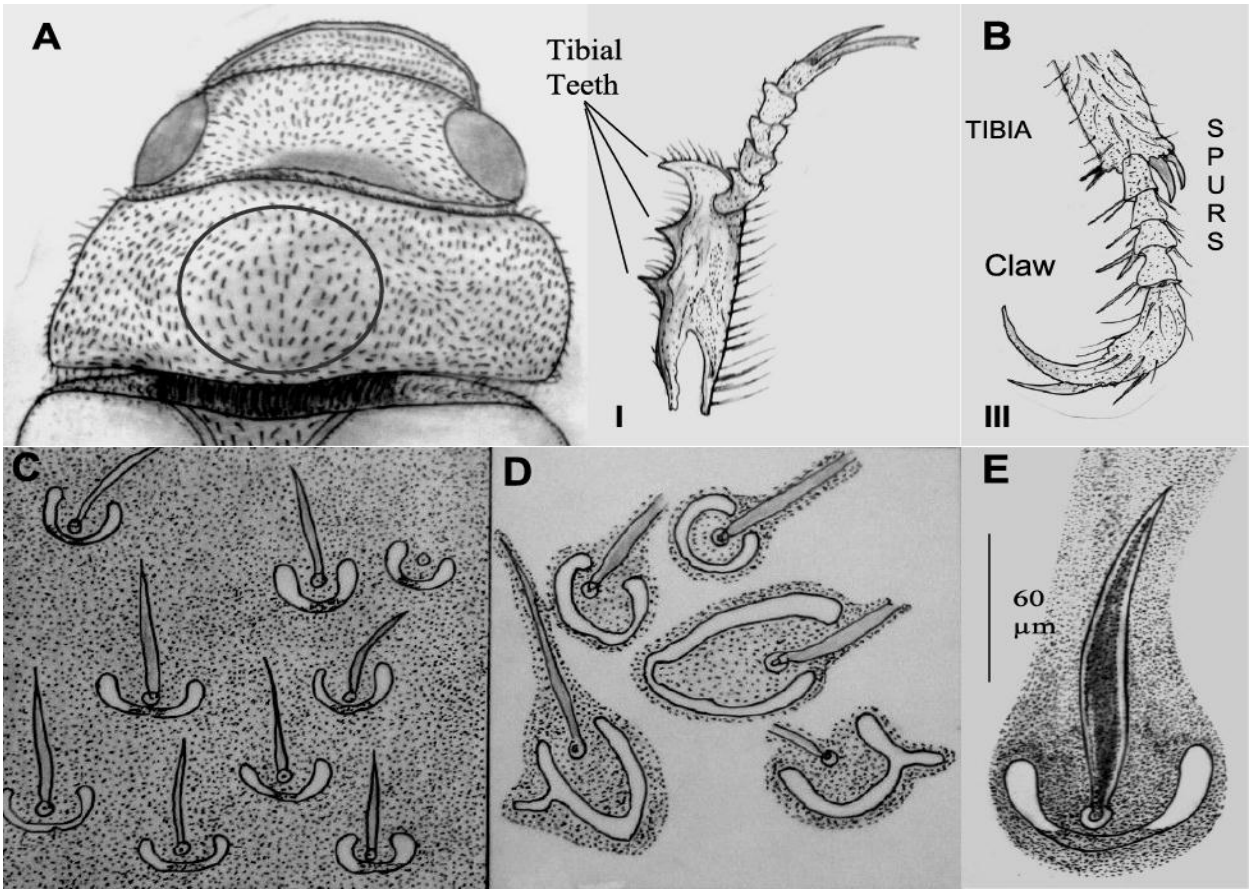

Fig. 4. Structure of pronotum and legs of *Adoretus versutus* (Not drawn to scale). A, Pronotum showing the less densely punctate (shown within a circle) surface of the mid zone; B, First and third legs showing adaptation for burrowing; C, Unlike elytra the punctures on the pronotum bear setae in its mid, D, Variously shaped punctures present on the margin of the pronotum, E, Normal mid-zone puncture of pronotum in enlarged view.

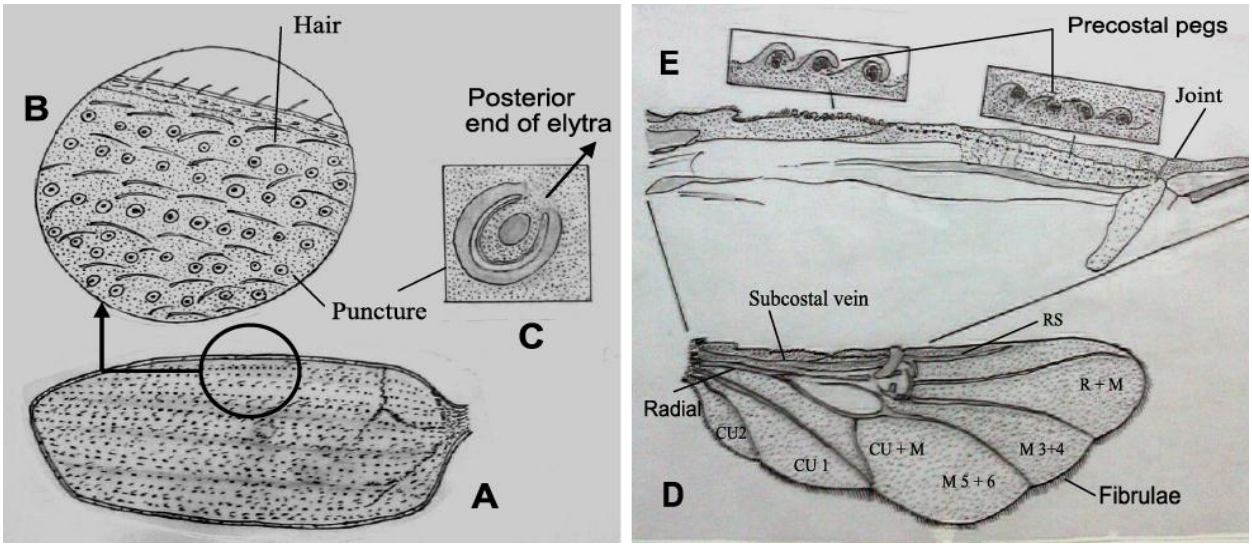

Fig.5. Surface structure of fore and hind wings of *Adoretus versutus.* A, Elytra; B, surface of elytra showing punctures and setae located separately; C, Single puncture enlarged; D, Venation of the hind wing – costal region is enlarged to show the variation in the costal marginal structure of the wing and the precostal pegs. Key to the acronyms: RS, Radio-suctorial vein; M, median vein; R, Radial vein; CU, Cubitus vein.

Distribution

First described in Samoa (Friederichs, 1914). Native to Indian region (Lever, 1945), India including Andaman & Nicobar (Putturam *et al*., 1976; Harris, 1995; Chandra *et al.*, 1995; 2012). Reported from Pakistan in 1960 (Ghouri and Salik, 1960). Bangla Desh (Siddique *et al.*, 2009). Also reported from Sri Lanka, Indonesia, Madagascar, Mauritius, St. Helena, Seychelles, Fiji, Samoa, Tonga, Wallis Islands, Cook Islands, Australasian region (maurtitiusbeetles. myspecies. Info /category.gomy../adoretis-Ver; www.padil.gov.au; ecoport.org/ep? Arthropod= 18686 &entitytype.AR****). Abdullah and Roohi (1968) have reported eight new species of *Adoretus* from Pakistan (including five species probably From Karachi) These species included *A. atiqi* Abdullah sp. n.; *A. saleemi* Abdulla sp. n.; *A. fatehi* Abdullah sp. n.; *A. ismaili* Abdullah sp. n.; *A. baquari* Abdullah sp. n.; *A. iftakharri* Abdullah sp. n.; *A. naeemi* Abdullah sp. n.; *A* . *naeemi* Abdullah sp. n. and *A. tufaili* Abdullah sp. n.. It attacks to shade trees, ornamentals in Uganda. The outbreak of adults defoliate trees (Gentry, 1965).

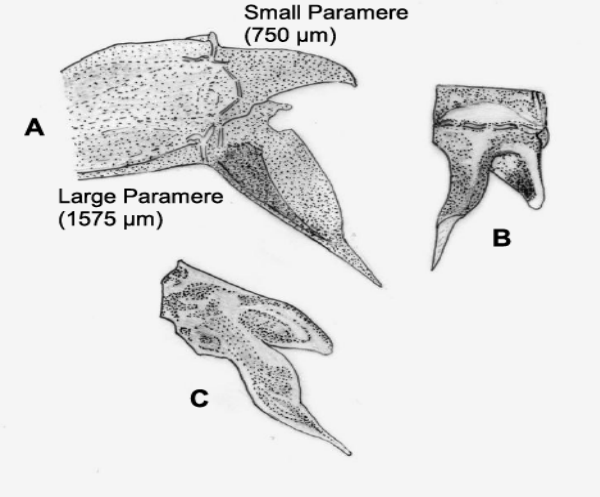

Fig.6. Aedeagus of *Adoretus versutus*. Parameres are asymmetrical.
A, as found in the present study – parameres torn separated; **B**, and **C**, drawn from Aberlenc *et al.* (2004) and Chandra and Venkatraman (1995), respectively.

Fig.7.Rose leaves eaten by *Adoretus versutus* as suggested by the pattern of the damage in form of network. The leaves were collected from the rose plants cultivated in the flower beds of Botany department, University of Karachi (around 20-30m from the experimental field). The beetle collected from there in night resembled to that reared in the lab.

Fig. 8. *A. versutus* captured from the leaves of rose plants of department of Botany, University of Karachi and grape vine leaves in Gulshan-e-Maymar during night hours of April, 2013 (**A**) and a vine leaf eaten by *A. versutus* (**B**).

Host Range

A. versutus attacks on rose and Cocoa but being polyphagous, its host range is quite wide e.g., *Abelmoschus manihot* (in Vanuatu), *Acacia spp., Aclypha sp., Alphitonia zizyphoides, Anacardium occidentale, Arachis hypogaea, Bauhinia sp., Barringtonia sp., Bougainvillea spectabilis, Carica papaya, Citrus lemon, Citrus maxima, Citrus sinensis, Citrus x paradisica, Coffea canephora, Colocasia esculenta,, Delonix regia, Dioscorea sp. Ficus carica, Hibiscus tiliaceus, Ipomoea batatas, Lagerstroemia indica, Litchi sinensis, Loquat tree, Malus pumila, Musa sp., Pachyrhizus erosus, Persia americana, Phaseolus spp., Pometia pinnata, Prunus domestica, Psidium guajava, Pyrus communis, Raphanus sativus, Rosa spp. Saccharum officinarum, Solanum melongeana, S. tuberosum, Sorghum bicolor, Syzygium malaccense, Terminalia catappa, Theobroma cacao, Vigna unguiculata, Vitis sp., Zingiber officinale, Zinnia,* Ziziphus sp. etc. (Grum *et al.,* 1991; Aberlene *et al.,* 2004; Azam-Ali *et al.,* 2006; Bealdoin *et al.,* 1992; Sørensen, 1996; www.plantwise.org; Putturam *et al.,* 1976; Harris, 1995; Thomson, 2006; Anjum, 2010, ecoport.org/ep? Arthropod= 18686 &entitytype.AR****). Grubs in sugarcane soils of Sindh have been reported by the Government of Sindh, Agriculture Department (www.sindhagri.gov.pk). We collected *A. versutus* from rose plants of Botany department University of Karachi and vine leaves in Gulshan-e-Maymar, Karachi in April, 2013 (Fig. 7 and 8).

Identification

The tools to identify Adoretus species are lacking (McQuate and Jameson, 2011). Abdullah and Roohi (1968) have presented key to identification of local species. *A. versutus* is characterized with antennae having last three antennomeres expanded into a plate like structure. The tibia of the first legs armed with acute teeth. The front and hind legs are adapted for burrowing in sand (Chandra *et al.,* 2012). Pronotum is less densely punctate in the mid region and densely punctate in the sides. Parameres are unequal in size. Small paramere is characteristically half in size of the larger paramere. The male genitalia closely resembled to that reported for A. versutus (Chandra and Venkatraman, 1995; Aberlenc *et al.,* 2004). All these are the characterizing traits of *Adoretus versutus*. (Arrow, 1917; Chandra and Venkatraman, 1995; Aberlenc *et al.,* 2004; Jameson, 2005; Chandra *et al.,* 2012). On the basis of external morphology and male genitalia the organism appeared to be a leaf Chafer - *Adoretus versutus* Harold 1869. This species may seldom be confused with *Adoretus lasiopygus* Burm. 1855 in which pronotum is less closely punctate at the sides than in the middle (Abdullah and Roohi, 1968). .

DISCUSSION

In the present studies, *white grubs (Adoretus versutus* Harold) were recorded from the rhizospheric sandy loam soil of *Acacia nilotica* ssp. *nilotica* irrigated with differentially saline water. It is a common and widely distributed species and has partiality for rose leaves. It is however, also found on other plant species. It is polyphagous. Indeed all Rutelinae are the plant feeders. These larvae are reported to feed on roots of all plants especially grasses such as sugarcane. Adult feed voraciously on leaves at night (Ghouri and Salik, 1960). The tribe Adoretini is exclusively distributed in the old world (Jameson, 2005). Genus *Adoretus* is represented by some 90 species. Abdullah and Roohi (1968) have reported eight new species of *Adoretus* from Pakistan - (*A. atiqi* Abdullah sp. n.; *A. saleemi* Abdulla sp. n.; *A. fatehi* Abdullah sp. n.; *A. ismaili* Abdullah sp. n.; *A. baquari* Abdullah sp. n.; *A. iftakharri* Abdullah sp. n.; *A. naeemi* Abdullah sp. n.; *A. naeemi* Abdullah sp. n. and *A. tufaili* Abdullah sp. n.) in addition to *A. versutus* reported by Ghouri and Salik (1960). Since we obtained adults by rearing them in laboratory, we had no data on association and activity of the adult in the field. A number of plants surrounding the experimental field included *Leucaena leucocephala, Albizia lebbeck, Acacia nilotica* ssp. *indica, Pithecellobium dulce, Acacia stenophylla, Jatropha curcas, Conocarpus* sp., *Manilkara zapota, and* the experimental plants *such as Sorghum bicolor, Acacia nilotica var. nilotica, and Zea mays.* For some recent years, roses were experimentally cultivated in an adjacent field on an area of c 1000 m^2 by the research workers of MAHQ Biological Research Centre, University of Karachi. The rose crop was then substituted by tuberoses. Roses are still cultivated in flower beds of Botany department. The eating pattern of the leaves of these plants not only indicated the presence of the A. versutus, the same was collected from there in a night of April, 2013. *A versutus* was also collected feeding on vine leaves in Gulshan-e-Maymar during the same month. Although beetles may aid in pollination in plants, they are the pests of biosecurity concern.

The life cycle of *A. versutus* is completed in three months (Waterhouse and Norris, 1987). Adult *A. versutus* is reported to lay eggs in soil during early part of the rainy season (May-August) in North India. Larvae hatch out in around a week and feed on roots. Adults emerge after showers of rains (Azam-Ali *et al.,* 2006). In larval stage it is injurious to all plants. The larvae move deeper in the soil during drought but may be found close to the surface when the soil is wet (ecoport.org/ep? Arthropod= 18686 &entitytype.AR****). Although found throughout the year, it

swarms from October to May in Mauritius (Charmoy, 1912). Adults feed on foliage of a variety of plants. No data, however, appear to be available regarding its salinity relation. The recovery of healthy larvae of *A. versutus* from sandy soils irrigated with saline water of EC: 9.23 and 12.81dS.m^{-1} indicated the grubs of this organism to be tolerant to moderate level of salinity.

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