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Taxonomy, Distribution and Pest Status of Indian Biotypes of *Acanthoscelides obtectus* (Coleoptera: Chrysomelidae: Bruchinae) - A New Record

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Abstract.- *Acanthoscelides obtectus* (Say) (Coleoptera: Chrysomelidae: Bruchinae) which is Neotropical in origin, is a well known pest of *Phaseolus vulgaris* L., *P. lunatus* L. and other grain legumes in Africa, Australia, Europe, and United States. It has crossed into a few Asian countries, and has now been recorded for the first time from mid hill ranges in Himachal Pradesh, India. The bean weevil has been found infesting different cultivars of kidney beans, *P. vulgaris*, and it is now widely distributed in the Indian Himalayas. It is the first report of its presence in the Indian subcontinent.

Key words: Bean weevil, Indian Himalayas, pest, *Phaseolus vulgaris.*

INTRODUCTION

Bruchids, commonly known as pulse beetles are a serious threat to grain legumes worldwide. Many of the bruchid species have crossed the geographical boundaries and have become cosmopolitan in distribution through human-mediated migrations and import/export of food grain. This has made these pest species highly adaptive, and hence are distributed from temperate to tropical climates. They infest seeds of many grain legumes, both in the field and in storage. The bean weevil, *Acanthoscelides obtectus* (Say 1831) (Coleoptera: Bruchinae) - a pest of Neotropical origin, is a serious pest of kidney beans, *Phaseolus vulgaris* L., *P. lunatus* L., and other grain legumes in Africa (Nahdy, 1994; Abate and Ampofo, 1996; Abate *et al.*, 2000; Msolla and Misangu, 2002; Paul *et al.*, 2010), Australia (Daglish *et al.*, 1993; Keals *et al.*, 1998, 2000; Bailey, 2007), Europe (Alvarez *et al.*, 2005, Schmale *et al.*, 2002), America (Johnson, 1970, 1990; Martin and Edmund, 1991; Kingsolver, 2004; Napoles, 2010), and various other parts of the world (Southgate, 1979). It has been observed for the first time in the Indian subcontinent. However, many other economically important species belonging to genus *Acanthoscelides* have recently been reported from some Asian countries. *Acanthoscelides pallidipennis* Motschulsky 1874 exists in China and Korea, and has been recorded from Japan (Tuda *et al.*, 2001) and *A. puniceus* Johnson 1983 and *A. quadridentatus* Schaeffer 1907 have been reported from Thailand, Vietnam, Malaysia, and Myanmar (Tuda, 2007).

Several new species belonging to the genus *Acanthoscelides* have been reported from the new world, and many new species have been identified in the Neotropical region. Discovery of new species, *A. rossi* from Galapagos Islands (Kingsolver and Ribeiro-Costa, 2001), *A. alonsoi* from Oaxaca, Mexico (Napoles and Yus-Ramos, 2008), *A. dani* from Chiapas, Mexico (Napoles and Kingsolver, 2009), *A. sauli* from Guatemala and Mexico (Romero *et al.*, 2009) and *A. delgadoi* from Mexico (Napoles, 2010) support the presumption that more than 200 species belonging to this genus are still undescribed (Johnson, 1990). *Acanthoscelides* Schilsky 1905 is the largest genus in the tribe Acanthoscelidini proposed by Schilsky in 1905, and has more than 340 species globally (Johnson, 1990). The species *A. obtectus* was reported by Say in 1831 from Louisinia, USA, but placed under genus *Bruchus* Linnaues 1767. *Bruchus tetricus* Gyllenhal 1839 reported from Insula St. Domingo by Gyllenhal in 1839, and *B. incretus* Walker 1859 by Walker in 1859 from Ceylon and *B. varicornis* Motschulsky 1874 from America by Motschulsky in 1874 were synonyms of *A. obtectus* (Bridwell, 1929; Johnson, 1970, 1990). The systematic studies

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of Indian species of bruchids carried out so far did not reveal the existence of this pest species in India. However, phyotosanitary risk of 13 bruchid species in bulk import of legumes has been sounded by National Quarantine Division (Bhalla *et al.,* 2006). Instances of hidden infestations of different species belonging to *Acanthoscelides*, *Bruchidius* Schilsky 1905 and *Caryedon* Schonherr 1823 were advocated by Wadhi and Verma (1972) and Bhalla *et al.* (2006). However, there are no confirmed reports of the presence of *A. obtectus* in the Indian subcontinent (Bhalla *et al.,* 2006). This is the first time that *A. obtectus* is being reported from the Mid-himalayan range in the Indian subcontinent, and was found infesting kidney beans. Its presence in the Indian Himalaya reveals that this pest has invaded all most all the continents of the world, except Antarctica. Besides *Zabrotes* Horn1885, an existing key pest of stored kidney beans, *Acanthoscelides obtectus* has been added as another economically important genus infesting grain legumes in the Indian subcontinent.

MATERIALS AND METHODS

Infested cultivars of kidney beans, *P. vulgaris* harboring different stages of *A. obtectus* were collected from mid-Himalayan ranges of the Indian subcontinent *viz.,* Himachal Pradesh (Nerwa, Chopal, Rampur, Nirmand, Kullu), Uttrakhand (Uttarkashi, Attal, Gopeshwar, Rudraprayag) and Jammu and Kashmir (Bhaderwah, Jammu, Leh). Adults emerging from beans were kept in petri-dishes along with seeds of the host plant under ambient condition in the laboratory. The Indian subcontinent branches off from Great Himalayan range near Badrinath Dham in Uttarakhand State and extends up to Pir Panjal range in Jammu and Kashmir, passing through the state of Himachal Pradesh. This range is wholly mountainous with altitudes ranging between 1500 to 4500 meters above the mean sea level. Different cultivars of kidney beans grown throughout this range pertain to three states in North-West India. Dead adults, both males and females, were treated with 10% w/v hot KOH solution to dissolve the soft muscular tissue, and the treated specimen were washed repeatedly in fresh water, and used for morphological studies, including the genetalia. Internal structures so exposed were again washed with 1% hydrochloric acid water, and then with distilled water and mounted in DPX after dehydrating in different grades of ethyl alcohol. We followed the methods described by Kingsolver (1970) to study the genitalia of bruchids. Morphological as well as genital studies were carried out under a stereoscopic trinocular microscope fitted with image capturing devices. The results of these studies carried out for three years are presented hereunder.

Material examined

3♂, 9♀, 13.IV.2005; 6♂, 12♀, 4. xi. 2005, coll. Thakur Desh Raj. Culture is maintained in BOD incubator in the Department of Biosciences, Himachal Pradesh University, Shimla-5, India.

RESULTS

Acanthoscelides obtectus (Say) 1931
(Fig. 1 A-H)

Bruchus obtectus Say, 1831: 1 (Holotype: Louisiana; depositary unknown, type apparently lost). *B. incretus* Walker, 1859: 261 (Ceylon); *B. tetricus* Gyllenhal, 1839: 22 (Insula St. Domingo); *B. varicornis* Motschulsky, 1874: 239 (America); *Acanthoscelides obtectus* Bridwell, 1929: 42; Johnson, 1970: 67, 1990: 438; Kingsolver, 2004: 130.

Adults of the common bean weevil, *A. obtectus* measured 3.81±0.39 mm in length, 2.05±0.36 mm in width, and were greyish brown in color. Head greyish brown and mouth parts blackish. Antennal segments 1 to 4 filiform, segments 5 to 10 broadened and more serrated, and the segment 11 non-serrated and acute apically. Segments 1-5 grey, 6-10 dark blackish, and segment 11 red orange in color (Fig. 1A). Antennae reaching up to elytral humeri or even beyond. Eyes almost round in shape, and possess median fringe of golden setae, and postocular lobe with orange setae. Frons width smaller than eye. Pronotum rectangular, but slightly longer, and has brownish pubescence. It is notched posteriorly, but demarcated slightly into two parts along the notched area parallel to elytron separation line. Elytra about twice as long as broad,

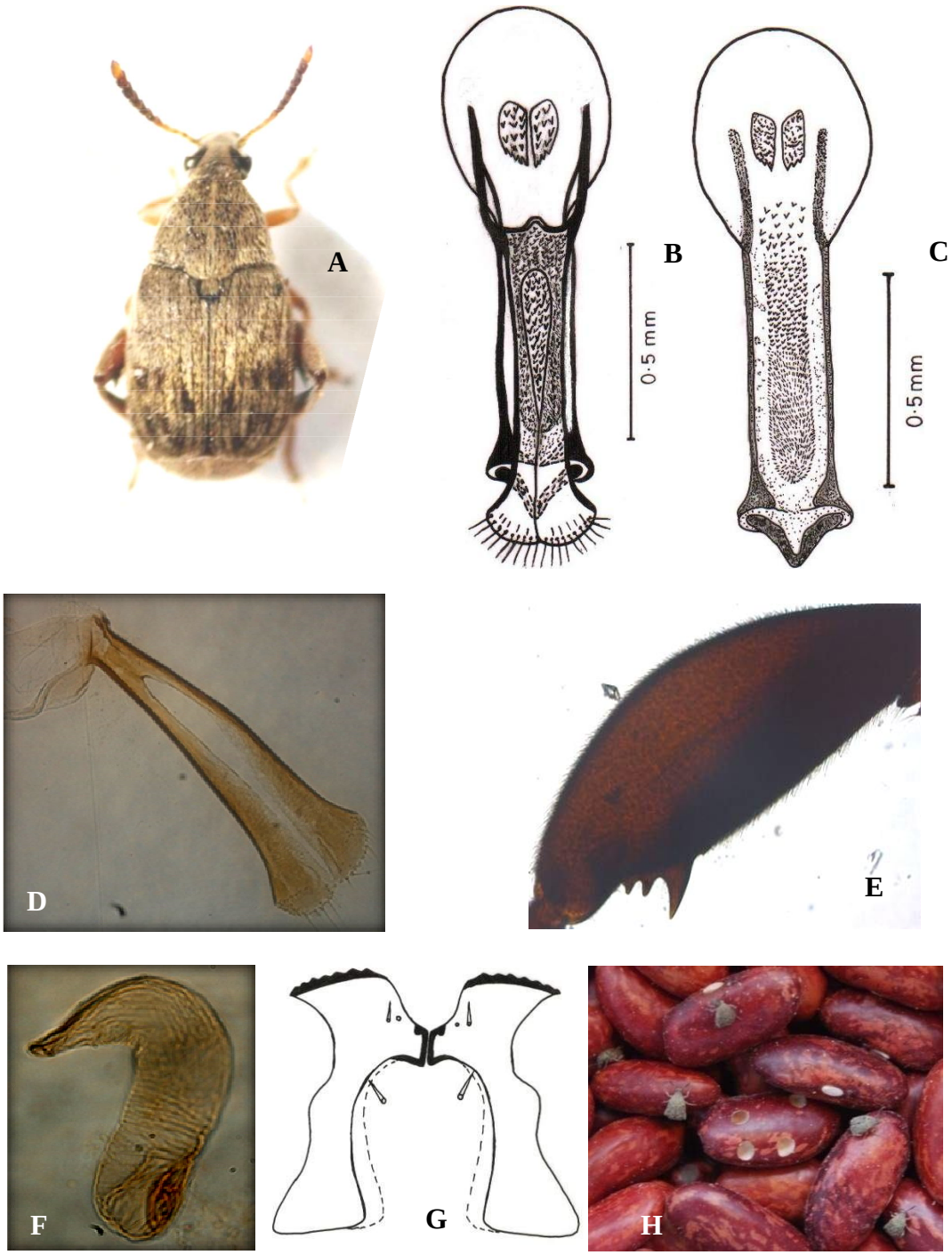

Fig. 1. *Acanthoscelides obtectus*: A, adult female; B, phallus; C, median lobe D, parameres; E, hind femur; F, spermatheca; G, prothoracic plate; H, infested beans with adult insects.

and covered with whitish and brownish setae in between, except the posterior margins, which have golden brown fringes.

This insect is sexually dimorphic, males are active, but smaller in size with a vertical pygidium, whereas the females are bulky, inactive and have a

sub-vertical pygidium. Legs reddish brown, except mid venter femur of meso and meta legs, which are black in color. Femora of hind legs possess three teeth-like spines at the posterior end. Anterior tooth is twice as long as the posterior teeth, with a slight posterior inclination. Posterior teeth equal in size and have similar posterior inclination (Fig. 1E). Femur rounded dorsally, but emarginates ventrally without a carina. Tibia possesses ventral, latero-ventral, lateral and dorsal longitudinal carinae. Dorsal surface of tibia without fossa, and tibial corona has four spines. First tarsomere possesses lateral and ventral carinae. Legs and pygidium covered with dense whitish and golden hair. Pygidium punctuate, broader at the anterior end, and narrows down at the posterior margin, and convex in lateral view. First sternum median flattened and rounded, but slightly longer than the rest, which are similar in size, except the fifth one, which emarginates at the apex in the males and sub-marginate in the females. Ventral region of the thorax and abdomen was covered with dense white hair. Eggs ellipsoidal in shape, white, and are deposited singly, unlike other bruchids which glue their eggs to the surface of pods and seeds but scattered them irregularly among the host seeds. An H-shaped pro-thoracic plate bearing five to seven pairs of black chitinized teeth on outer margin are present in first instar larvae only (Fig. 1G). Grubs are C- shaped, have a snow white body with blackish mouth parts, covered with white shining setae of variable size, and possess three pairs of thoracic legs. Phallus elongated, parameres joined at the base, and spatulate apically (Fig. 1B,C). Outer margins of parameres have greater sclerotization than the inner one, and overlap each other terminally. Long setae of variable size are present on the spatulate margins (Fig. 1D). Median lobe elongated, having broad and rounded base, middle part straight and apex slightly broad with projecting triangular exophalic valve apically. A pair of fine red orange colored plate at the base, and there are many spicules throughout the inner surface on the median lobe. Ovipositor elongated, and supported by two pairs of dorso-ventrally sclerotized rods, which unite sub-terminally. The ovipositor orifice is supported by a single pair, along with numerous setae of variable size. Spermatheca broad at the base and curved and pointed at the apex (Fig. 1F). Species belonging to the genus *Acanthoscelides* are worldwide in distribution, and are monophagous or polyphagous. But *Acanthoscelides obtectus*, reported for the first time from the mid-Himalayan range, is distributed in Uttaranchal, Himachal Pradesh and Jammu and Kashmir, in India at 1500 to 4500 meters above mean sea level. The bean weevil, *A. obtectus* seems to be well adapted on different cultivars of kidney beans, *P. vulgaris* throughout its distribution the range (Fig. 1 H). First instar larva bores into the seed, feeds, grows and moults into successive instars, but no morphological symptoms of its presence appear on the texture of seed, except a circular window, which appears during the later stages when the prepupa gnaws it for adult emergence. Such hidden infestations move across the geographical boundaries as import/export consignments, and pose a greater phytosanitary threat in the new ecological niches due to the absence of natural enemies of in the food chain. This internal mode of life makes them to adapt to a wide range of temperature and humidity, and enables it to be carriedout unnoticed during trade across international boundaries.

Discussion

Arora (1977) studied the taxonomy of bruchids and reported 48 species, including 25 new species from North-West India. Johson (1990) carried out the systematic studies on the seed beetle genus, *Acanthoscelides* and reported 103 species from North-South America. He reported six new species of *Acanthoscelides* from North and Central America. Singal and Pajni (1990) reported six new species belonging to the genus *Callosobruchus* Pic. 1902 from India. Anton (2000) described five new species of *Callosobruchus chinensis* (L. 1758) group, *viz. C. orientalis, C. erimitus, C. nigritus C. antennatus* and *C. montanus* from the Oriental Region and Australia, of which the last two were reported from India. The seed beetle workers while investigating taxonomic revisions as well as carrying out the pioneer studies on bruchids fauna from the Indian subcontinent, never came across this notorious pest species. However, species such as *A. pallidipennis* feeding on seeds of *Amorpha fruticosa* (Tuda *et al.*, 2001), *Megabruchidius sophorae* Tuda

and Morimoto 2004 (Coleoptera: Bruchidae) feeding on seeds of *Styphonolobium japonicum* in Japan (Tuda and Morimoto 2004) and *A. puniceus* and *A. quadridentatus* both feeding on *Mimosa pigra* L. have been reported from Thailand, Vietnam, Myanmar and Malaysian subcontinents of Asia (Tuda, 2007). The bean weevil, *A. obtectus* is a greyish brown, measuring 3.81± 0.39 mm in length, 2.05 ± 0.36 mm in width ,and possesses two pairs of eleven segmented antennae. Body colour greyish brown, mouth parts blackish, antennal segments 1-4 filiform, 5-10 serrated but eleventh was apically acute and red orange in colour. Similar morphological characters of *A. obtectus* have been reported by earlier workers (Say, 1831, Johnson, 1990a, Kingsolver, 2004, Alvarez *et al.*, 2005, Thakur, 2009). Studies carried out on the bruchids reveals that many species belonging to this genus are dispersed woldwide and well adapted on single to multiple hosts. Morphological characters as well as structure of genitalia, ovipositor and spermatheca, etc. of the Indian population of *A. obtectus* are similar to the native population of America described by Johnson (1990a) and Kingsolver (2004). But the pair of plates present in the median lobe of *A. obtectus* described from Galapagos Islands by Kingsolver and Ribeiro-Costa (2001) does not match with the present strain as well as with other populations described by various workers from different parts of the world. *A. obtectus* was recorded from the mid Himalayan ranges in India at 1500 to 4500 m above mean sea level. This pest has been noticed earlier at an altitude above 1500 m, and *Z. subfasciatus* Boheman 1833 up to 1500 m above mean sea level in Mexico, but in Tanzania both the species coexist together; with *Z. subfasciatus* being predominant (Masolwa and Nchimbi, 1991). Eggs were oblong, white, measuring 0.6-0.7 mm in length and laid singly on or near the host pods and seeds similar to the observations made by Alvarez *et al.* (2005). First instar larvae were motile and capable of moving amongst the host seeds, and after selecting a suitable one, bored into them, grew, pupated, and finally emerged as imago after cutting an operculum in the testa of the host seed. These features of this pest species were comparable with the findings of Parsons and Credland (2003). Four snows white, C - shaped larval instars possessing three pairs of thoracic legs and covered with white shining setae and sensillae and an H – shaped prothoracic plate possessing median and lateral teeth only in first instar larva have also been recorded during the development of bean weevil similar to Pfaffenberger (1985) observations on many bruchid species. *A. obtectus* has been reported for the first time from the mid-Himalayan range of India but no report on its invasion from neighbouring countries like Pakistan, Nepal, Bhutan and Sri Lanka has yet appeared. The pest is native of Central America, migrated to Africa in the beginning of 17th century, and in Europe at the end of 19th century and still invading and colonizing new countries (Alvarez *et al.*, 2005). This pest greatly damages the haricot beans and its larvae eat away the seeds usually decreasing the yield by 50-60% and partially damaged seeds lose germination power and usual taste (Alvarez *et al.*, 2005). Many pest species may be transported across the geographical boundaries as hidden pest in legume import/export consignments. Risks of exotic pest species and Pest Risk Analysis (PRA) in order to determine appropriate control measures were alarmed by National Plant Quarantine Division, New Delhi, India (Wadhi and Verma, 1972, Bhalla *et al.*, 2006). The internal feeding mode of bruchids enhances their probability of introduction in new places along with import and export consignments. South American native bruchids species, *A. obtectus* has now widely distributed in Japan, Pacific Islands, West Indies, Poland and most other parts of the Europe except Indian subcontinent (Bhalla *et al.*, 2006). Similarly, Asian species of bruchid, *C. chinensis* has been reported from Europe and North and South America through infested import consignments. The present study has revealed the first record, pest status and geographical distribution of *A. obtectus* in the Himalayan region of Indian subcontinent.

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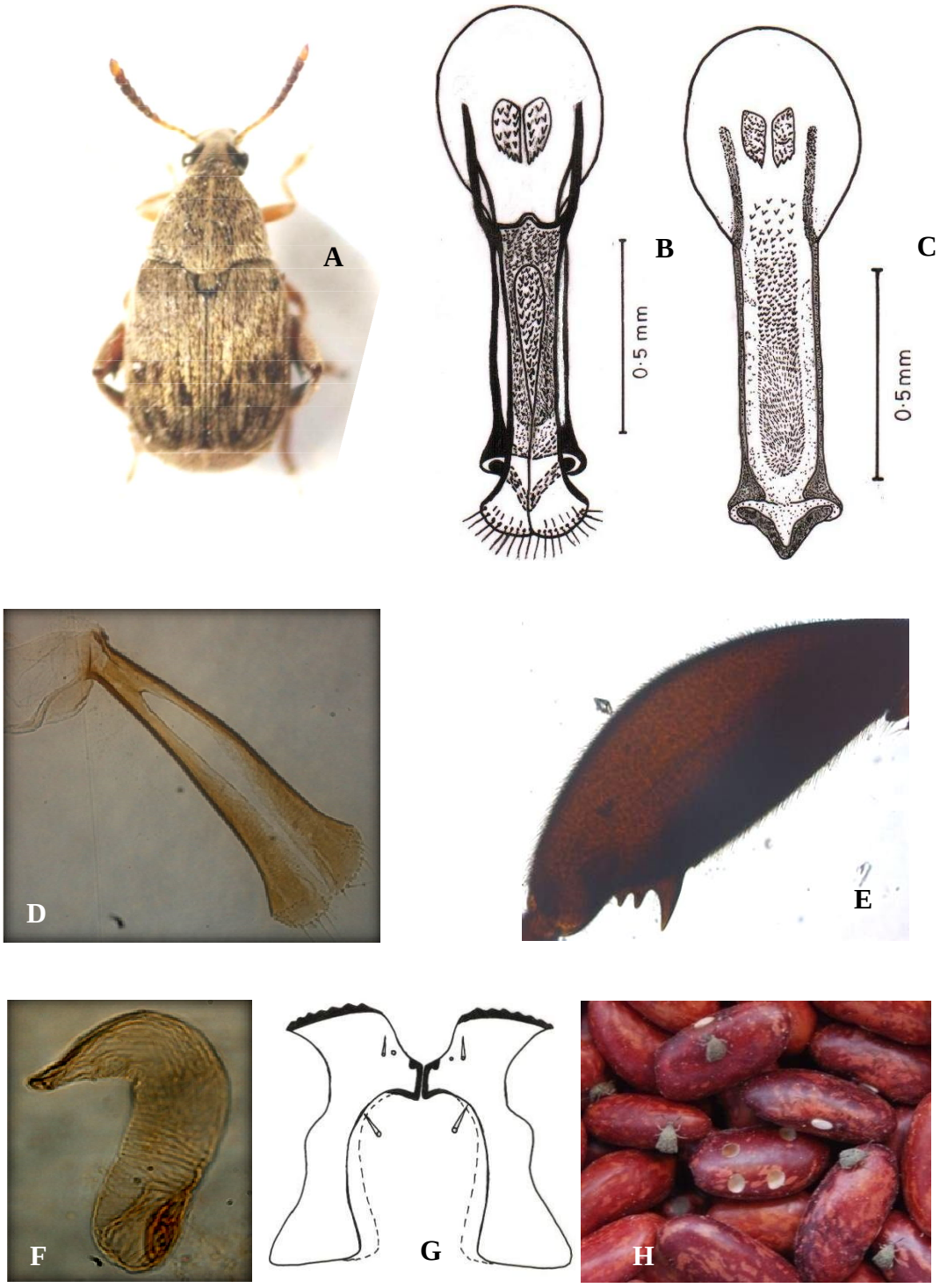

Fig. 1. *Acanthoscelides obtectus*: A, Adult female; B, Phallus; C, Median lobe D, Parameres; E, Hind femur; F, Spermatheca; G, Prothoracic plate; H, Infested beans with adult insects.