Invasion and threats of *Acanthoscelides obtectus* (Say) (Coleloptera: Bruchidae) to kidney beans in India - a first record

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Abstract

Many pest species have crossed geographical boundaries and become cosmopolitan in distribution through human-mediated migrations and the import and export of food grain consignments. These pest species pose constant threats to our agriculture produce and may be responsible for losses worth billion dollars every year. *Acanthoscelides obtectus* (Say), a serious pest of kidney beans, *Phaseolus vulgaris* L., originated in the neotropics and has been reported from Australia, Europe, United States and a few Asian countries. For the first time it has now been recorded from the Indian subcontinent. The increased geographical distribution and anthropogenic domestication and diffusion of grain legumes have adapted this pest species to climates ranging from temperate to sub tropical. This pest species has invaded the Mid-Himalayan region and is a serious threat to local cultivars of kidney beans. This study on *A. obtectus* examines host range and distribution, invasion and threats, life history on different cultivars of *P. vulgaris*, host susceptibility and resistance, damage and loss and number of annual generations.

Keywords: *Acanthoscelides obtectus*, Kidney beans, Pest, Mid-Himalaya, Life history.

1. Introduction

Bruchids, commonly called pulse weevils, are cosmopolitan in distribution and a major problem affecting edible legumes. These beetles pose a threat to our agriculture produce and cause serious loss to grain legumes both in fields and stores. *Acanthoscelides obtectus* (Say) (Coleloptera: Bruchidae) a bruchid beetle of neotropical origin, is a serious pest of kidney bean Phaseolus Vulgaris L. (Fabaceae) and various other pulses in Africa (Silim and Ambrose, 1993; Msolla and Misangu, 2002), Australia (Keals et al., 1998, 2000), Europe (Nadir et al., 2005; Schmale et al., 2002) and America (Johnson, 1990a; 1990b; Martin and Edmund, 1991). This pest is now reported for the first time from India. However, a congeneric species, *Acanthoscelides pallidipennis* Motschulsky exists in China, Korea and Japan (Tuda et al., 2001). But this is the first time that any species of the genus *Acanthoscelides* has been reported from the Mid-Himalayan range of the Indian subcontinent, where it has been found infesting kidney beans. Thus this species now occupies almost all the continents of the world except Antarctica.

Systematic studies of Indian bruchid species so far have not revealed the existence of this notorious pest species from any part of the country. However, the Quarantine Division, New Delhi, India has warned of the phyotosanitary risk of 13 bruchid species in bulk imports of pulses (Bhalla et al., 2006). This has lead to the compulsory X-ray screening of consignments of pulses, immediately on arrival in India, for hidden infestation by species of Acanthoscelides, Bruchidius and Caryedon (Wadhi and Verma, 1972; Bhalla et al., 2006). *Acanthoscelides* obtectus joins *Zabrotes subfasciatus* (Boheman) as an economically important bruchid pest in the Indian subcontinent. In the Mid-Himalayan ranges *Z. subfasciatus* infests beans in field and continues during storage while *A. obtectus* infests stored beans in plains below 1500 m above mean sea level. The effect of both species is to reduce the quality and quantity of beans, rendering them unfit for human consumption and germination.

2. Materials and methods

Infested cultivars of kidney beans, *P. vulgaris* nurturing different developing stages of *A. obtectus* were collected from different Mid-Himalayan ranges of India. Adults emerging from beans were kept in different Petri-dishes along with seeds of host plants under natural environmental conditions to observe the life history traits of pest. The Mid-Himalayan range of Indian branches off from the Great Himalayan range near Badrinath in Uttrakhand state and extends to the Pir Panjal range in Jammu and Kashmir, passing across the state of Himachal Pradesh in India. The range is wholly mountainous with altitudes ranging between 1500 to 4500 m above sea level. Different cultivars of kidney beans (*P. vulgaris*) are

grown throughout the range. Dead adult insects of both sexes were treated with 10% w/v hot KOH solution in order to dissolve away the soft muscular tissue and treated specimens were dissected to expose their genitalia. Internal structures so exposed were washed repeatedly with fresh and acid water and mounted in DPX after dehydrating in different grades of ethanol. The pest was observed using a stereoscopic zoom-triocular microscope fitted with image capturing devices. Results reported here come from three years of continuous study of the insect. Expert opinions were sought to confirm species identity.

3. Results

Adult insects were 3.25 - 4.50 mm long, 1.50 - 2.50 mm wide and greyish brown in colour. Of the antenna, segments 1-4 are filiform, 5-10 broadened and more serrated and segment 11 is non-serrated and acute apically. Regarding colour variations, segments 1-5 are grey or of the same colour as the body, 6-10 dark blackish and segment 11 red/orange. Bean weevils start to infest beans in the field and continue to develop during storage. The pest is sexually dimorphic, males are active, smaller in size with a vertical pygidium whereas females are more bulky, inactive with a sub-vertical pygidium. Like other bruchids, adult A. obtectus do not feed, they are weak flyers and feign death during disturbance.

Freshly emerged adults copulate at any time from about one hour after their emergence. During copulation the male normally raises its fore and middle legs to hold the female. Copulation lasts for 4-5 min. Gravid females lay eggs on and around the host seeds. Eggs are usually deposited singly and unlike other bruchids this pest does not stick its eggs to pods and seeds but scatters them irregularly among host seeds. Eggs are ellipsoidal in shape and oviposition lasts for 6-9 days and the rate of egg lying is high on first day of oviposition period. Freshly laid eggs are milky white, but become transparent before the larvae hatch. Larvae possess three pairs of legs, are white in colour and are covered with white shining setae of variable size. The first instar larva has a large golden head and white elongated body that can be seen through the transparent egg shell. The incubation period is about 9-14 d and first instar larvae bore into the host seed with the help of an 'H' shaped prothoracic plate. Since the eggs are not glued onto seeds it is essential for freshly hatched first instar larva to find the host seeds for food. Entrance holes into the host seed later become plugged by faecal matter and further development of successive larval instars inside the host seed, under favourable conditions, can be completed in 3-4 wk. Pupal development is completed in 18-26 d during March – September but hibernating larvae and pupae take 4-5 months during winter (October - February) and then emerge as adults during March and April the following year. The pest is multivoltine and completes three to four overlapping generation in a year (Table 1).

Table1 Life history traits of Acanthoscelides obtectus on *Phaseolus vulgaris* (values are mean ± SD).

Mating duration (minutes)	Oviposition period (days)	No. of eggs laid per female	Developmental duration (days)	No. of generations completed in a year	Duration of hibernated stages (months)
4-5	7 ± 0.77	53.2 ±7.91	58.6 ± 1.49	3-4	4-5

Since the first instar larvae bore into the seed and then feed, grow and moult into successive instars entirely within the seed, no evidence of their presence appears except circular windows that are created when the last instar larvae gnaw close to the seed coat in preparation for adult emergence (Fig. 1A). Pulses with such hidden infestations move across the geographical boundaries in import /export consignments and may pose a great phytosanitary threat in new ecological niches due to the absence of natural enemies. This internal mode of life protects them from variations of temperature and humidity and enables them to be carried unnoticed during trade across the international boundaries. All the larval instars are voracious feeders and develop at the cost of legume proteins so that heavily infested beans are often reduced to empty shells (Fig. 1B).

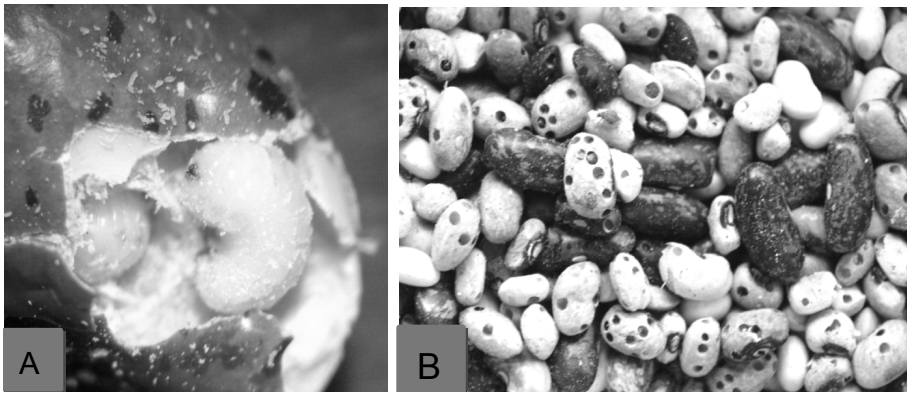

Figure 1 Last instar larvae of *A. obtectus* just below the seed coat of (A) *P. vulgaris* and heavily (B) damaged beans.

4. Discussion

Previous taxonomic revisions and pioneer studies on the bruchids fauna from unexplored areas of the Indian subcontinent have not previously mentioned this notorious pest species (Thakur, 2008). But now *A. obtectus* has been reported from the Mid-Himalayan range which extends across the three major states of the Indian territory and ranging between 1500 to 4500 m above sea level. *Acanthoscelides obtectus* seems well adapted to different cultivars of kidney beans (*P. vulgaris*) throughout this range. Observations to date suggest that the morphology, behaviour and pest status *A. obtectus* in India is no different from the same pest in other countries/continents reported by Masolwa and Nchimbi (1991), Nadir et al., (2006) Parsons and Credland (2003), and Pfaffenberger (1985).

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