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Species

Expanded distribution and first host-plant record of *Adoretus incurvatus* (ohaus, 1905) on grapevines in Jammu and Kashmir, India

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ABSTRACT

Insect pests constitute a major constraint to grape cultivation, disrupting ecological stability, reducing vine vigour and reduce the efficiency of implemented control measures. In the temperate grape growing regions of Jammu and Kashmir, India, systemic documentation and reports about insect pests of grapes is still not inadequate to devise sustainable plant protection modules. In this study, *Adoretus incurvatus* (Coleoptera: Scarabaeidae), a scarab beetle is recorded for the first time from Jammu and Kashmir, marking a expanded geographical distribution and also the first documented association of the species with cultivated grapevines. Specimens were identified with help of published standard morphological keys. Characteristic feeding damage on grape foliage was described, and population dynamics and seasonal incidence were monitored. The influence of key abiotic factors (temperature, relative humidity, and rainfall) on beetle abundance was analysed through correlation studies. This report of expanding geographical record and novel host association emphasizes the importance of frequent monitoring and more studies on lesser known insect-host records from the region.

Keywords: Rose beetles, Sahebi, Hussaini, Rutelinae, Novel host record

1. INTRODUCTION

Grapevine (*Vitis vinifera* L.,) belonging to family vitaceae, reported to be originated in Western Asia and parts of Europe. As per latest estimates, it is the third most important fruit crop worldwide, making up approximately 16% of total global fruit production. While majority of grape producing countries across world utilize most of their produce for wine production, nearly 90% of India's grape output is marketed as fresh table fruit. Despite it's economic importance, grape cultivation is highly susceptible to arthropod infestations, with more than 650 species of insects and mites reported worldwide and over 100 species reported in India alone (Sunitha, 2017). In absence of proper management and timely intervention, pest-induced yield losses may reach as devastating as 80% (Mani et al., 2014). One of the significant pests affecting grapevines belongs to the genus *Adoretus* Dejean, 1833 (subfamily Rutelinae,

family Scarabaeidae), which is indigenous to Africa and Asia. However, two species have become established in Europe. The Genus *Adoretus* shows high species diversity with nearly 460 described taxa, most of which are highly polyphagous, causing nsubstantial defoliation on various field crops, fruit trees, and ornamentals (Krajcik, 2007).

In India alone, around 47 species have been reported to occur (Chandra et al., 2012), several of which are sporadic but potentially serious pests of grapevines, particularly during the vegetative growth and berry-development stages. Out of which, *Adoretus bicolor* has been reported to skeletonize grape leaves and also attack peanut (*Arachis hypogaea*) as well as rose (*Rosa* spp.) in various parts of India (Ahmed, 1977; Kumar et al., 2009). Also, *Adoretus incurvatus* (Ohaus, 1914) is noted mostly as a localized species, with confirmed reports from northern and central India. Particularly from Bihar, Haryana, Himachal pradesh, Maharashtra and Tamilnadu. While some related species like, *A.lasiopygus* and *A.versutus* are known to have wide geographical occurances, the distribution of *A.incurvatus* appears fragmented and geographically limited (Jagdale et al., 2023). In the current report, we document the first authenticated record of *A.incurvatus* from Jammu and Kashmir, along with first ever verified report of its plant association with grapevine as a host plant.

2. MATERIAL AND METHODS

Identification of Insects

Our study at SKUAST-K, Kashmir, began in May 2024 under the title of "Identification and Seasonal Incidence of Arthropod Pests of Grapes in Kashmir", which focused on three grape varieties namely, Sahebi, Hussaini, and Thompson Seedless. Weekly surveys were conducted to estimate pest counts in 15 randomly tagged vines from two main grape growing districts of Kashmir (Srinagar and Ganderbal). Insects were captured using plastic covers, preserved in 70% ethanol, and analyzed at RTCPPPM, SKUAST-K, with a stereo microscope (Olympus SZX16) and LCmicro V2.4 software. Identification of Scarab beetle specimens was carried out based on external morphological characteristics and aedeagal structures as described by Sarkar et al., (2016) & Ohaus, (1914).

Host confirmation

To confirm grape (*Vitis vinifera* L.) as a host of *Adoretus incurvatus*, a no-choice feeding assay was conducted under natural vineyard conditions. Adult beetles (N = 15), collected from naturally infested vines, and were transferred onto healthy, asymptomatic terminal branches of cultivars Sahebi, Hussaini and Thompson seedless. Each experimental unit consisted of single branch enclosed in a fine-mesh nylon bag (0.5 mm pore size; 40 × 60 cm) to prevent escape and exclude other arthropods. Five replicate branches were used for the beetle treatment, along with five bagged control branches without beetles in all three cultivars. Each branch to be infested, received 1-2 adults and was maintained in situ for 14 days under prevailing field conditions. Leaf defoliation was recorded daily as percentage of leaf area affected or consumed by the beetles and beetle survival and feeding activity were monitored. Leaf area loss was quantified using digital image analysis in ImageJ software (Version 1.53, National Institutes of Health, USA). Three randomly selected leaves from each tagged branch were photographed on Day 0 and Day 14 using high resolution camera against a white background with a millimeter scale included foe calibration.The protocol followed standard methodology used by Ebbenga et al., (2022) for assessing defoliation of *Popillia japonica* on grapes. Percentage defoliation was calculated using the formula

$$\text{Defoliation (\%)} = \left(\frac{\text{Damaged Area}}{\text{Total Leaf Area}}\right) \times 100$$

3. RESULTS

Taxonomic accounts

a) ***Adoretus incurvatus***

Order - Coleoptera
Family - Scarabaeidae Latreille, 1802
Subfamily - Rutelinae MacLeay, 1819
Tribe - Anomalini MacLeay, 1819
Genus - *Adoretus* Dejean, 1833
Species - *Adoretus incurvatus* Arrow, 1917

Dichotomous Key to Selected *Adoretus* Species (Reported from the Himalayan Belt) (Modified from Sarkar *et al.*, 2016 & Ohaus, 1914)

1. Sides of pronotum medially angulate …… **2**
1'. Sides of pronotum evenly rounded …… **6**
2. Head medially raised near base …….. **3**
2'. Head medially not raised near base …….. **4**
3. Head coriaceous; scutellum with membranous margin; mid claw dilated at base; parameres elongate, unequal, base broad, one with medial tooth, apex bilobed ……..…… ***Adoretus testaceus* (Hope, 1831)**
3'. Head punctured; scutellum without membranous margin; mid claw not dilated; parameres elongate, unequal, base straight, apex bilobed ……..…… ***Adoretus ariel* (G. J. Arrow, 1917)**
4. Head rugose; clypeus cut away at sides; pronotal margins elevated; parameres elongate, slender, pointed; aedeagus not bilobed…… ***Adoretus lemniscus* (Arrow, 1915)**
4'. Head punctured; clypeus rounded at sides; pronotal margins not elevated …… **5**
5. Parameres elongate, unequal; base sinuate, apex sharply conical …… ***Adoretus versutus* (Harold, 1869)**
5'. Aedeagus short and broad, forceps-like; apex blunt, slightly lobed, symmetrical; dorsal surface with nodular projections ("Höckerchen") …… ***Adoretus incurvatus* (Ohaus, 1905)**
6. Scutellum sides straight …… **7**
6'. Scutellum sides sinuate, curved, or rounded …….. **10**
7. Body pale testaceous; clypeus medially notched …… ***Adoretus boops* (Wiedemann, 1821)**
7'. Body brown testaceous; clypeus not medially notched …… 8
8. Fronto-clypeal suture laterally raised; scutellum without membranous margin …… ***Adoretus serratipes* (Arrow, 1914)**
8'. Fronto-clypeal suture not raised; scutellum with membranous margin …… **9**
9. Parameres short, base broad, apex blunt …… ***Adoretus minutus* (Brenske, 1898)**
10. Elytra with 2 or 3 raised longitudinal lines on each disc …….. **11**
10'. Elytra without raised longitudinal lines …….. **13**
11. Scutellum with membranous margin; head granular; elytra with 3 raised lines …… ***Adoretus lasiopygus* (Burmeister, 1855)**
11'. Scutellum without membranous margin; head coarsely punctured; elytra with 2 raised lines …… **12**
12. Parameres elongate, apex blunt; dorsal surface finely strigose …… ***Adoretus rugosus* (Arrow, 1914)**
13. Elytra with membranous lateral margin fringe extending to apex; posterior margin of propygidium sharply keeled and bristle-fringed (*simplex* group) …….…… **14**
13'. Elytra without membranous lateral fringe; propygidium not keeled …… [other species]
14. Median dark stripe present on dorsum from clypeus to elytral apex; thorax and abdomen dark brown; elytral primary costae distinct…… ***Adoretus incurvatus* (Ohaus, 1905)**
14'. Median dark stripe reduced or absent …… **15**
15. Dark marking restricted to vertex only; elytral costae sharply defined and puncture rows deepened posteriorly …… ***Adoretus progrediens* (Ohaus)**
15'. Dark marking absent or limited to head and pronotum …… 16
16. Dark markings absent; elytral costae weak or barely indicated; underside yellow …… ***Adoretus simplex* (Arrow,1917)**
16'. Dark markings present on forehead, vertex, pronotum, and along margins of scutellum; Cosate of elytra looks weakly convex; parameres looks bifid apically with sculpture resembling scar …… ***Adoretus afghanus* (Machatschke, 1958)**

Morphological characters of *Adoretus incurvatus*

Material examined: India; 4 ♂; 3♀

Collected specimens of Adult *Adoretus* beetles were observed to be moderately sized, typically ranging from 8 to 12 mm in length (Males around 11 mm), with a rounded to oval, convex body that exhibits a reddish-brown hue overall. The coloration features a brownish tinge dorsally, except in the anterior portion of the clypeus and margins of pronotum, extending upto tibial segements of legs,

which are pale yellow in colour. The tarsi of all leg pairs have darker reddish-brown hue, while the ventral surface is reddish-brown and densely clothed in greyish setae (Fig 3).

Head

The head bears a broad, semicircular clypeus with gentle curvature but narrows toward the front middle, often appearing slightly notched. The eyes are prominent, fringed, and the body surface is densely punctate with pale coloured setae. Antennae are 10-segmented, terminating in a distinctive three-segmented lamellate club.

Thorax

The pronotum is densely and coarsely punctuate, most puntures bear short pale grey setae; anterior angles are nearly right angled, and lateral marging are smoothly rounded. The scutellum is small and triangular, finely punctuate, with sparse whitish grey setae; epipleura are reduced. Legs are slender and suited for grasping foliage as well as shallow burrowing. The fore tibiae bear three distinct teeth like structures, with proximal two positioned close together. Tibial segments of mid and hind legs, has two parallel transverse carinae (Ctenidia) along the outer margin, mostly with scale like setae (Fig 3). Tarsal segments number to five that, elongates distally and a larger claw like structure are present in fore and middle tarsi which appears to be bifid laterally. In contrast, hind tarsal claws remain simple, with the smaller claw measuring nearlt three-quarters of the length of the larger.

Abdomen

The abdomen is largely concealed beneath the elytra, with only the pygidium distinctly exposed. The pygidium bears parallel lateral carinae and is densely clothed with pale white setae, which are more concentrated and thicker toward the apex. The elytra are uniformly reddish – brown, lacking prominent markings, and exhibit rows of deep punctures arranged in parallel series, interspersed with scattered grey setae; faint longitudinal striae may be visible.

Male Genitalia

The aedeagus is trilobed, comprising a well – sclerotized median lobe that is elongated, gently curved, and tapering apically, bounded by paired parameres arising from a broader phallobase. The parameres are symmetrical and oriented nearly perpendicular to the phallobase; they are broad at the base, gradually narrowing distally, and medially fused, forming a deep U-shaped apical emargination. A distinct basal piece connects the genital segments (Fig 3.).

Seasonal incidence and Symptoms in grapes

The seasonal incidence of *Adoretus incurvatus* was monitored from May 2024 to May 2025 over two consecutive seasons. Incidence of these beetles was not observed during the standard meterological weeks (SMW) 18 -26 (late April to early July) in all three grape cultivars under study. Incidence of adult beetles was initially observed during SMW 27 -28 (02 -15 July), with earlier onset and comparatively higher infestation levels in Thompson seedless, followed by Sahebi, whereas Hussaini showed minimal infestation. Peak adult abundance occurred during SMW 29- 30 (mid to late july), with maximum mean population of 2.42 adults per 15 vibes in Thompson seedless and 2.28 adults per vines in Sahebi per week (Fig 1). Adults of *Adoretus* beetles were observed feeding on grapevine foliage, causing defoliation with irregular shot holes on leaves. The beetles, mostly active during evening and night hours, were seen hanging on leaves while feeding (Fig 4). Population levels peaked during July and August, coinciding with the fruit set and bunch closure phases (Table 1).

Table 1. Average Population of adults of *Adoretus incurvatus* in Grapes during May 2024- May 2025

May 2024- May 2025 (SMW)	**Avg no.of.adults of *Adoretus incurvatus*/15 vines**		
	Sahebi	**Hussaini**	**Thompson seedless**
Location	**SGR**	**SGR**	**SGR**
Week 18 to Week 21 (30 Apr – 03 June)	0	0	0
Week 22 (28 May – 03 Jun)	0	0	0

Week 23 (04 Jun – 10 Jun)	0	0	0
Week 24 (11 Jun – 17 Jun)	0	0	0
Week 25 (18 Jun – 24 Jun)	0	0	0
Week 26 (25 Jun – 01 Jul)	0	0	0
Week 27 (02 Jul –08 Jul)	0	0	0.28
Week 28 (09 Jul – 15 Jul)	0.42	0	0.85
Week 29 (16 Jul – 22 Jul)	1.14	0	2
Week 29 (16 Jul – 22 Jul)	1.14	0	2
Week 30 (23 Jul – 29 Jul	2.28	0	2.42
Week 31 (30 Jul – 05 Aug)	1.71	0.71	1.71
Week 32 (06 Aug – 12 Aug)	1.14	0	1.14
Week 33 (13 Aug – 19 Aug)	0.57	0	0.42
Week 34 (20 Aug – 26 Aug)	0	0	0

(Location: SNR – Srinagar)

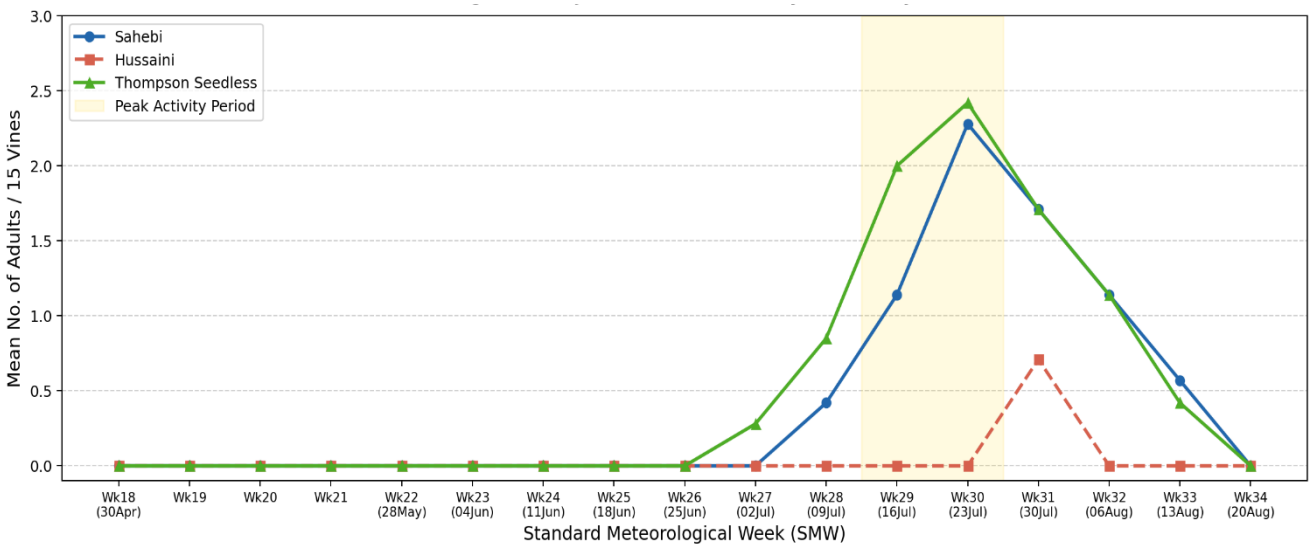

Figure 1. Seasonal incidence of *Adoretus incurvatus* on three grapevine varieties at Srinagar (SGR), Jammu & Kashmir (May 2024–May 2025).

Quantification of Foliar damage

Adults of *Adoretus incurvatus* actively fed on grapevine foliage under no-choice conditions, Digital image analysis using Image J revealed moderate levels of foliar damage at the end of 14 days. Mean defoliation percentage was seen to be varying, indicating difference in preference of beetles across three cultivars. Highest damage was seen in Thompson seedless with 15.61%, followed by Sahebi with mean defoliation percentage of 12.88% and cultivar Hussaini recorded comparitively lower defoliation with 9.19% (Table 2). Across all replicates (n=15), the overall mean defoilation was 12.56%. Feeding damage was characterized by shot oval to irregular shot holes and marginal leaf consumption. Control branches exhibited negligible damage (< 1%), indicating that observed defoliation was due to beetle feeding rather than any other factor.

Table 2. Mean percentage defoliation across replicates in three cultivars under study

Rep	Sahebi (%)	Hussaini (%)	Thompson Seedless (%)	Rep Mean (%)	n
T1	12.50%	8.77%	15.55%	12.27%	9
T2	13.30%	9.70%	16.07%	13.02%	9

T3	11.70%	8.00%	14.30%	11.33%	9
T4	14.39%	10.51%	16.93%	13.94%	9
T5	12.51%	8.96%	15.18%	12.22%	9
Mean	12.88%	9.19%	15.61%	12.56%	45

Correlation of weather parameters with the population of *Adoretus incurvatus*

Correlation analysis between the incidence of *Adoretus incurvatus* and prevailing weather parameters revealed varietal differences, with temperature emerging as the most influencial factor (Fig 2.) In sahebi, pest incidence showed a moderate positive correlation with minimum (r = 0.387) and maximum temperature (r = 0.489), revealing the positive effect of rising temperatures on population buildup. Minimum relative humidity had a weak negative impact (r = -0.216), while maximum relative humidity indicated a lesser positive correlation (r =0.074). Other parameters like Rainfall (r = 0.061) and wind speed (r= -0.041) were found to be major factors influencing incidence. In case of cultivar Hussaini, correlation analysis with minimum and maximum temperature (r = 0.170 and r = 0.225, respectively) data shown a positive but weak influence. Minimum relative humidity had a weak positive association (r = 0.125). Whereas, Rainfall (r = -0.040) and wind speed (R = -0.036) were seen to be less influencial on population buildup as seen in Sahebi.

In Thomspon seedless, stronger positive correlations were observed with minimum (r = 0.413) and maximum temperature (r = 0.496) explaining higher incidence in this cultivar. Whereas, Minimum relative humidity showed a relatively stronger negative correlation (r = -0.255). Maximum relative humidity had a negligible positive impact (r =0.038) on beetle population. While, Rainfall (r = 0.014) and wind speed (r = -0.099) showed moreover no impact. Overall, the findings indicate that *A. incurvatus* incidence is primarily influenced by temperature, particularly in Thompson Seedless and Sahebi, where earlier pest appearance was also recorded. Relative humidity, rainfall, and wind speed played comparatively minor roles.The illustration of correlation analysis as heatmap (Fig. 2) shows the differential influence of weather parameters on beetle population across varieties and supports the conclusion that increasing temperature is the most influencial factor. The observed temperature dependence may partly explain the species' apparent range expansion into temperate viticultural regions such as Kashmir. These findings were significant because there were no identified host plant reports for *Adoretus incurvatus* beetles anywhere in literature.

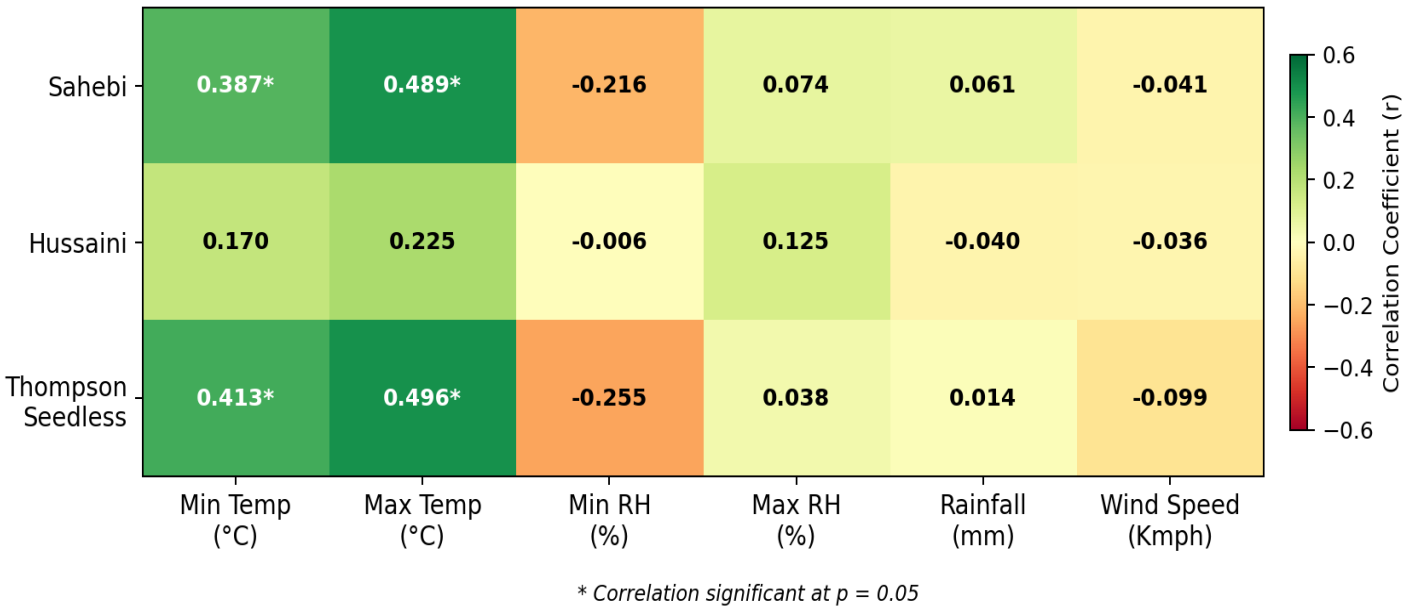

Figure 2. Correlation Heatmap of weather parameters with population of *Adoretus incurvatus* on Grapes

a)

b)

c)

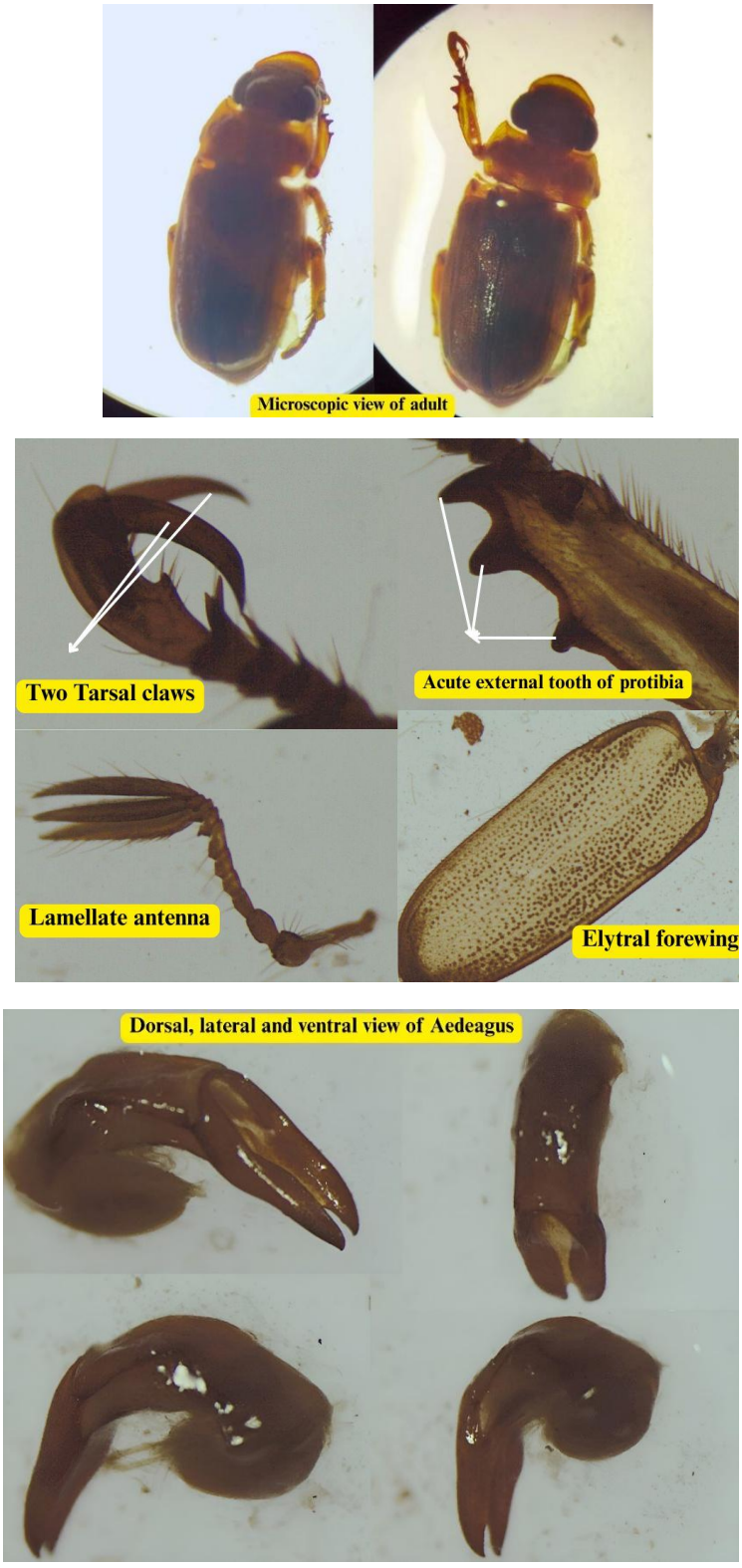

Figure 3. Important Morphological characters of Rose beetles

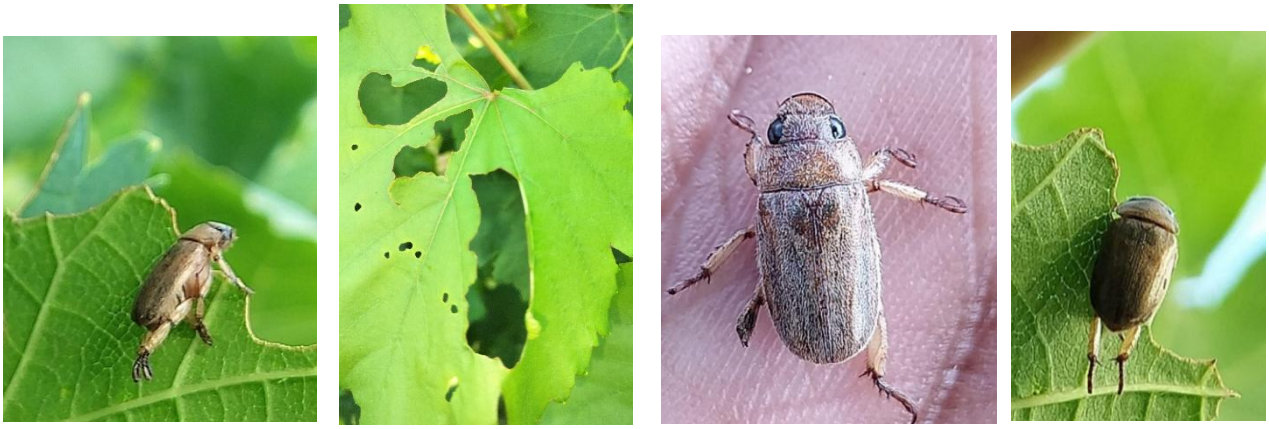

Figure 4. *Adoretus incurvatus* - Adult beetles defoliate the leaves showing shot holes, Adults seen hanging in leaves during evening and night times**.**

4. DISCUSSION

Distribution of this species confirmed though available literature shows that this species is found in Bihar, Haryana (Mittal, 1981; Chandra, 1986), Himachal Pradesh, Maharashtra and Tamil Nadu, which confirms that the species is not observed in Jammu and Kashmir, ascertaining our findings. External morphological features observed by us for identification of the beetles were found to be same as given by Ohaus (1914). Aedeagus characters peculiar to this species observed by us were found to be consistent with diagrams and sketch given by Machatschke (1958) and pictures given by Kumar (2023) ascertaining the identification. And these characters described us along with clear photographs will help scienitifc platform in discriminating other cyptic species. For instance, a look-alike species *Adoretus afghanus* described by Machatschke (1958) has the same external morphological characters with subtle differences, like the presence of a distinct bristle fringe on the posterior margin of the pronotum in *A. incurvatus*; *Adoretus afghanus* completely lacks such a fringe. Even he groups *Adoretus incurvatus*, *A. progrediens*, and *A.simplex* as a kinship group called 'simplex group' based on paramere structure. We observed the distinct morphological characters that can be used to differentiate *A.incurvatus* from two species and described them in detail. Various other species like *A. ranunculus* was reported on cocoa (*Theobroma cacao*) in the Philippines (Calcetas et al., 2021). Also, the highly polyphagous *A. sinicus* recorded from more than 250 plant species belonging to 56 families throughout Asia and the Pacific Islands (McQuate & Jameson, 2011). *A. tenuimaculatus*, damaging 186 species across 42 families in China, Japan, and Taiwan (Lee et al., 1997) and the widely distributed *A. versutus*, which injures cocoa, coffee (*Coffea arabica*), rose, vegetables, and many ornamental plants across Asia, Africa, Australasia, and numerous Pacific islands (Waterhouse & Norris, 1987). Reports of *Adoretus incurvatus* mostly indicated collection of beetles through sweeping and random collections using light traps, rather than field collections from direct feeding on any host crops. We confirmed the host of this beetle for the first time by direct feeding observations on field and also through the netting procedure given by Ebbenga et al., (2022). The correlation of weather parameters with population of these species also provides significant insights as the new host observation in a new geographical location along with correlation of population with major weather parameters can provide insights for future ecological studies related to this species and also further host exploitation and pest status for this species elsewhere.

5. CONCLUSION

The present study documents the first confirmed record of *Adoretus incurvatus* from the union territory of Jammu and Kashmir in India. Also, the first ever host plant record for this species, redefining the lesser-known role of this species in the ecosystem as a pest of economically important fruit crop. Seasonal monitoring showed incidence of these beeetles coinciding with fruit set and bunch closure stages of grapevines, implicating the need for continous monitoring and devising feasible control measures in future studies.

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Author Contributions

MADHANRAM G, SHAHEEN GUL, SURIYA S – Wrote the manuscript and data analysis

VENGATESHKUMAR M, MAHESHWARI S, CHARANKUMAR B.T – Reviewed the Manuscript and generated figures and document alignment.

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Conflict of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

Informed consent

Not applicable.

Ethical approval & declaration

In this article, the animal regulations are followed as per the ethical committee guidelines of Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar -190025, India; the authors observed the distribution and first host-plant record of *Adoretus incurvatus* (ohaus, 1905) on grapevines in Jammu and Kashmir, India. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation. Also, the ethical guidelines for plants & plant materials are followed in the study for species observation, identification & experimentation.

Data and materials availability

All data associated with this study are present in the paper.

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