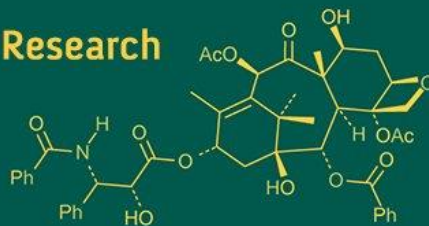


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Biology and morphometrics of the sugarcane whitefly, *Aleurolobus barodensis* maskell, under laboratory conditions

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Abstract

The biology and morphometrics of the sugarcane whitefly, *Aleurolobus barodensis* Maskell, were evaluated under laboratory conditions (29.71 ± 3.65 °C; $43.60 \pm 7.43\%$ RH) on variety Co-86032 during *Kharif* 2025 utilizing stereo zoom microscopy. Stalked eggs (0.26×0.16 mm) deposited on the lower leaf lamina hatched in 8.97 ± 0.93 days with $92.00 \pm 8.47\%$ viability. Development proceeded through three sessile, waxy fringed nymphal instars totalling 13.23 ± 1.65 days (instars I, II, and III lasting 3.23 ± 1.04 , 4.80 ± 1.03 , and 5.20 ± 0.92 days, respectively), followed by an 11.60 ± 1.07 days puparia stage. Adults emerged at a rate of $89.81 \pm 4.12\%$ via a T-shaped exuvial slit, exhibiting a female-biased sex ratio of 1:3.46 (male: female). The female reproductive cycle comprised pre-oviposition (2.90 ± 1.06 hours), oviposition (34.36 ± 1.83 hours), and post-oviposition (5.37 ± 1.13 days) phases, yielding a mean fecundity of 65.77 ± 15.22 eggs. Marked sexual dimorphism was evident females were physically larger than males in length (1.92 ± 0.13 mm vs. 1.31 ± 0.10 mm) and abdominal breadth (0.75 ± 0.07 mm vs. 0.30 ± 0.08 mm). Consequently, females outlived males in both adult longevity (42.63 ± 2.27 vs. 26.77 ± 1.52 hours) and total egg to death lifespan (35.58 ± 2.07 vs. 34.92 ± 2.05 days).

Keywords: *Aleurolobus barodensis*, biology, morphometrics, fecundity, sexual dimorphism

1. Introduction

Sugarcane (*Saccharum officinarum* L.) is a vital Indian cash crop with ancient roots in the Indo-Gangetic plains. This profound heritage is documented in the 5,000-year-old *Atharvaveda* (Gujja *et al.*, 2009) [15] and preserved in its botanical nomenclature, which derives from the Sanskrit word *sharkara* (James and Tate, 2004) [18]. The crop's historical allure was famously captured when Alexander the Great and his army arrived in India, marvelling at the plant as a "sweet reed" capable of producing honey. Sugarcane accounts for roughly 60 per cent of global sugar production, yielding white sugar, brown sugar and jaggery. Beyond sucrose, it is a critical resource for bioethanol, bioenergy and valuable combustible by products like bagasse and molasses used in industrial fuelling (Dodiya *et al.*, 2023; James and Tate, 2004; Koohzad *et al.*, 2017; Del Milagro Jorrat, 2018) [9, 10, 18, 19, 7]. Globally, sugarcane spans over 27 million hectares to provide 80 per cent of table sugar and 40 per cent of biofuels, with India and Brazil projected to dominate world output through 2032 (OECD/FAO, 2023) [25]. Domestically, India produces 475.61 million tonnes across 5.69 million hectares, of which Gujarat locally contributes 13.49 million tonnes from 1.90 lakh hectares (Anonymous, 2025) [1]. As a long duration crop, sugarcane is highly vulnerable to biotic stresses, facing attacks from over 1,500 pest species globally and 228 specifically in India (Long and Hensley, 1972; David and Nandagopal, 1986, Dodiya *et al.*, 2023) [9, 10, 6, 5]. Thriving in fluctuating subtropical climates, these pests severely restrict both cane production and sugar recovery, causing estimated yield losses of 20-25% (Geetha *et al.*, 2018) [14]. A sound understanding of insect-host interactions and true host plant resistance is fundamental for effective integrated pest management, as pseudo-resistance may influence pest performance and the interpretation of resistance mechanisms (Dodiya and Italiya, 2022) [8]. Whiteflies are among the most destructive sap-sucking insect pests, causing significant economic losses in agricultural and horticultural crops worldwide.

Besides direct damage through phloem feeding, whiteflies excrete honeydew that promotes the growth of sooty mould, thereby reducing photosynthetic efficiency and market quality of crops (Dodiya *et al.*, 2024) ^[11]. Whitefly (Hemiptera: Aleyrodidae) are significant sap-sucking pest of sugarcane, with *Aleurolobus barodensis* Maskell standing out as the most economically devastating species. Historically, *A. barodensis* has caused severe yield limiting outbreaks across Indian states, including notable epidemics in Gujarat and Maharashtra (David, 1992) ^[5]. Throughout their egg, nymph and adult life cycle, the sap-sucking nymphs cause the most damage by turning leaves yellow or pinkish. This feeding severely stunts early crop growth and degrades juice quality later in the season (Minaei *et al.*, 2010) ^[23]. Understanding the biology, seasonal incidence and population dynamics of insect pests is fundamental for developing effective and sustainable integrated pest management (IPM) strategies (Dodiya *et al.*, 2025) ^[12]. Effective management of *A. barodensis* requires localized biological data, which is currently limited. Therefore, this study details the sugarcane whitefly's biology and life history to bridge this knowledge gap, providing critical baseline data to predict outbreaks and mitigate extensive crop damage.

2. Materials and Methods

In order to study the life history of sugarcane whitefly, a laboratory trial was carried out at Biocontrol laboratory, Department of Entomology, NMCA, NAU, Navsari during *khari*, 2025 at 29.71 ± 3.65°C temperature and 43.60 ± 7.43 per cent relative humidity. The morphometric parameters of all life stages of *A. barodensis* were studied under a cilika trinocular stereo zoom microscope fitted with a tablet integrated digital head (Maker: Medprime; Version: MPT/MKT/2025). The obtained data were analyzed by using descriptive statistics.

2.1 Test insect rearing technique

Sugarcane whitefly was reared in the laboratory condition for the present investigation as per the methodology suggested by Kunjadia (1988) ^[20] and Askarianzadeh and Minaeimoghadam (2018) ^[2] with slight modifications. Sugarcane crop, variety Co-86032 was raised in pots as well as micro plot (12 m × 4 m) behind Biocontrol laboratory for the present investigation. Initial culture of sugarcane whitefly was obtained by collecting adults from the infested field with the help of aspirator and also damaged leaves were brought to biocontrol laboratory in perforated polyethylene bags and released on potted sugarcane plants. Selected leaf of potted plant was covered with polythene bag to prevent escape of released insects. To provide aeration, pin holes were made in the polythene bag covers. After about 24 hours, bags with insect were removed and eggs laid on leaves were counted based on size of egg strip. Freshly laid eggs on the leaves of potted plants were marked by drawing circle around them and they were observed for the study of life history of *A. barodensis*. Thus, all the pots prepared were kept behind Biocontrol laboratory and utilized for further investigation.

2.2 Egg

Freshly laid eggs were examined daily at room temperature to monitor changes in their shape, size, and color. A counted number of these eggs were continuously observed until a

nymph emerged, which marked a successful hatch. This daily monitoring allowed for the calculation of the average incubation period, while the hatching percentage was determined by calculating the ratio of successfully hatched eggs to the total number of eggs initially kept under observation.

$$\text{Egg hatchability (\%)} = \frac{\text{Number of nymph hatched out}}{\text{Total number of eggs observed}} \times 100$$

2.3 Nymph

To determine the nymphal instars of *A. barodensis*, daily microscopic observations were conducted against a light source from egg hatching until pupation. Moulting between stages was confirmed by the presence of shed exuviae on the leaves, allowing researchers to accurately record the shape, size, and color of each specific instar.

2.4 Puparium (Plural: Puparia)

The morphology specifically the shape, size, and color of *A. barodensis* puparia was examined. Additionally, the pupal period was determined by measuring the duration from the initial formation of the puparium until the successful emergence of the adult.

2.5 Adult

Adults emerged under the laboratory condition were observed under microscope to study their shape, size, colour and the sex difference.

2.6 Sex ratio

To determine the sex ratio, 1,000 adult sugarcane whiteflies were collected from the micro plot using an aspirator and examined under a microscope. The specimens were differentiated by sex, with females specifically identified by the presence of an ovipositor.

2.7 Oviposition

To study the oviposition period, infested leaves with puparia were maintained in water filled glass jars (20 × 15 cm), supported by an Expanded Polystyrene Sheet (EPS). The leaf ends were submerged through slits sealed with cotton to prevent insects from entering the water, and the jars were secured with muslin cloth. Freshly emerged male and female pairs were isolated daily into separate jars and provided with a fresh sugarcane leaf for feeding and egg-laying. The reproductive timeline was recorded in three phases: pre-oviposition (adult emergence to the first egg laid), oviposition (the duration of active egg laying), and post-oviposition (the cessation of egg laying until the female's death).

2.8 Fecundity

To determine fecundity, 30 set of male and female of *A. barodensis* collected from the micro plot were isolated in glass jars (20 × 15 cm). The eggs laid by each mated female were counted daily during the morning hours until her death, with the total number of eggs produced over her entire lifespan recorded as her overall fecundity.

2.9 Adult longevity

Longevity of male and female were calculated separately from the date of emergence till the death of adult.

3. Results

Eggs

Female sugarcane whiteflies laid eggs exclusively on the lower leaf lamina, strictly avoiding the midrib and sheath. The eggs are typically laid in single and occasionally double lines, with the highest density found on the middle and distal portions of the leaf. When freshly laid, the eggs were creamy yellow, conical, and had a round base with a stalk at one end. After a few hours, they turned light brown to grey, eventually darkening to a shiny black just before hatching (Photo 1). The eggs measured 0.21 to 0.32 mm in length (average 0.26 ± 0.03 mm) and 0.11 to 0.21 mm in breadth (average 0.16 ± 0.03 mm) (Table 1). The incubation period (Table 2) averaged 8.97 ± 0.93 days, with an overall range of 8 to 11 days. The hatching percentage of *A. barodensis* eggs ranged from 70 to 100 per cent (mean = $92 \pm 8.47\%$).

Nymph

During the study of its biological attributes, the nymph of *A. barodensis* underwent two moults, resulting in three nymphal instars. The moulting was determined by the presence of exuviae. Eggs hatched via longitudinal rupture of the chorion, releasing tiny, pale-yellow first instar nymphs (crawlers) equipped with three pairs of legs. These active nymphs migrated a few centimetres across the leaf to locate suitable feeding sites. Upon settling, their colour changed to shiny black, and they became sessile, remaining permanently attached throughout subsequent developmental stages until adult emergence (Photo 1). First instar nymphs measured 0.30-0.40 mm (mean = 0.35 ± 0.03 mm) in length and 0.16-0.23 mm (mean = 0.20 ± 0.02 mm) in breadth (Table 1). Duration of first instar nymph varied from 2 to 5 days with mean duration of 3.23 ± 1.04 days (Table 2). Freshly moulted second instar nymphs were larger and more flattened than first instars, featuring a gently convex dorsal surface. Their initial light black coloration gradually darkened with maturity, accompanied by the secretion of a white, waxy substance that accumulated along the body margins to form a prominent, characteristic smoky white fringe (Photo 1). The morphometric parameters of second instar *A. barodensis* nymphs (Table 1) ranged from 0.59 to 0.75 mm in length (mean: 0.67 ± 0.05 mm) and 0.27 to 0.35 mm in breadth (mean: 0.32 ± 0.03 mm). Data presented in Table 2 revealed that the duration of the second instar nymph ranged from 3 to 7 days, with an average developmental period of 4.80 ± 1.03 days. The third instar nymph resembled the second instar in overall morphology but was distinguishably larger, exhibiting an oval to elongated oval body shape. Freshly moulted nymphs appeared dark in coloration and were surrounded by a well-developed, highly conspicuous white waxy marginal fringe (Photo 1). The morphometric parameters of third instar *A. barodensis* nymphs (Table 1) ranged from 1.30 to 1.62 mm in length (mean: 1.45 ± 0.09 mm) and 0.56 to 0.70 mm in breadth (mean: 0.62 ± 0.04 mm). The third instar duration ranged from 4 to 7 days. The total nymphal developmental period of the sugarcane whitefly ranged from 11 to 17 days, with a mean duration of 13.23 ± 1.65 days (Table 2).

Puparium

Freshly formed puparia were oval, ash coloured, and morphologically identical to the final nymphal instar except

for an increase in size. Over several days, they gradually darkened to black, developed a covering of white waxy powder across the body, and formed a distinct marginal waxy fringe (Photo 1). The morphometric data (Table 1) indicated that pupae ranged from 2.36 to 2.97 mm in length (mean: 2.28 ± 0.23 mm) and 0.99 to 1.29 mm in breadth (mean: 0.99 ± 0.15 mm). The puparium period (Table 2) ranged from 10 to 13 days, with a mean duration of 11.60 ± 1.07 days.

Adult

Newly emerged *A. barodensis* adults exhibited weak flight capability and were characterized by a pale yellow head, red eyes, and a pale yellow abdomen that broadened medially before tapering posteriorly. The wings were smoky white, occasionally mottled with dark spots. Pronounced sexual dimorphism was observed, females were noticeably larger with a broader abdomen terminating in a needle-like ovipositor, whereas males possessed a spindle-shaped abdomen equipped with terminal, pincer-like claspers for copulation. Both nymphs and adults utilize piercing-sucking stylet mouthparts to extract phloem sap from host plant tissues (Photo 1). The morphometrics of adult *A. barodensis* (Table 1) demonstrate distinct sexual size dimorphism, with females being significantly larger than males. Female body length ranged from 1.64 to 2.12 mm (mean: 1.92 ± 0.13 mm), with an abdominal breadth of 0.65 to 0.89 mm (mean: 0.75 ± 0.07 mm). Conversely, adult males exhibited smaller dimensions, measuring 1.10 to 1.47 mm in body length (mean: 1.31 ± 0.10 mm) and 0.21 to 0.45 mm in abdominal breadth (mean: 0.30 ± 0.08 mm). Adult emergence was characterized by a 'T' shaped exit slit on the puparium dorsum, marking the completion of the developmental period. Adult emergence ranged from 76.92 to 95.65 per cent, with a mean rate of 89.81 ± 4.12 per cent (Table 2). Female fecundity ranged from 31 to 92 eggs, with a mean capacity of 65.77 ± 15.22 eggs (Table 2).

Sex ratio

Observations on 1,000 laboratory reared adults (235 males, 765 females) demonstrated a female bias (Table 2), with the male to female sex ratio ranging from 1:2.22 to 1:5.00 (mean: 1:3.46).

Oviposition period

The pre-oviposition, oviposition, and post-oviposition periods lasted 2 to 5 hours (mean: 2.90 ± 1.06 hours), 31 to 38 hours (mean: 34.36 ± 1.83 hours), and 4 to 7 days (mean: 5.37 ± 1.13 days), respectively (Table 2).

Adult longevity

Adult survival ranged from 38 to 46 hours for females (mean: 42.63 ± 2.27 hours) compared to 25 to 30 hours for males (mean: 26.77 ± 1.52 hours), demonstrating significantly greater longevity in *A. barodensis* females (Table 2).

Total Life Cycle

The data presented in Table 2 indicate that the total lifespan of females ranged from 32.58 to 39.83 days (mean: 35.58 ± 2.07 days), whereas male lifespan varied from 31.13 to 39.04 days (mean: 34.92 ± 2.05 days).

Table 1: Morphometrics of various life stages of *A. barodensis* under laboratory condition

Life stages	Length (mm)	Breadth (mm)
	Mean ± S.D	Mean ± S.D
Egg	0.26 ± 0.03	0.16 ± 0.03
Nymphal instars		
First	0.35 ± 0.03	0.20 ± 0.02
Second	0.67 ± 0.05	0.32 ± 0.03
Third	1.45 ± 0.09	0.62 ± 0.04
Puparium	2.28 ± 0.23	0.99 ± 0.15
Adult		
Female	1.92 ± 0.13	0.75 ± 0.07
Male	1.31 ± 0.10	0.30 ± 0.08

Table 2: Duration of various life stages of sugarcane whitefly, *A. barodensis* under semi laboratory conditions (2024-25)

Sr. No.	Life stages	Sample size	Duration in day(s)		
			Min.	Max.	Mean ± S.D.
1.	Incubation period	30	8.00	11.00	8.97 ± 0.93
2.	Egg hatchability (%)	300	70.00	100.00	92.00 ± 8.47
3.	Nymphal period				
	1 st Instar	30	2.00	5.00	3.23 ± 1.04
	2 nd Instar	30	3.00	7.00	4.80 ± 1.03
	3 rd Instar	30	4.00	7.00	5.20 ± 0.89
	Total nymphal period	90	11.00	17.00	13.23 ± 1.65
4.	Puparium period	30	10.00	13.00	11.60 ± 1.07
5.	Pre-oviposition period (hrs)	30	2.00	5.00	2.90 ± 1.06
6.	Oviposition period	30	1.29	1.58	1.43 ± 0.08
7.	Post-oviposition period (hrs)	30	4.00	7.00	5.37 ± 1.13
8.	Adult emergence (%)	30	76.92	95.65	89.81 ± 4.12
9.	Sex ratio (Male: Female)	30	1: 2.22	1: 5.00	1:3.46 ± 0.79
10.	Adult longevity				
	Male	30	1.04	1.25	1.12 ± 0.07
	Female	30	1.58	1.92	1.78 ± 0.10
11.	Total life cycle				
	Male	30	31.13	39.04	34.92 ± 2.05
	Female	30	32.58	39.83	35.58 ± 2.07
12.	Fecundity (No. of eggs/female)	30	31.00	92.00	65.77 ± 15.22

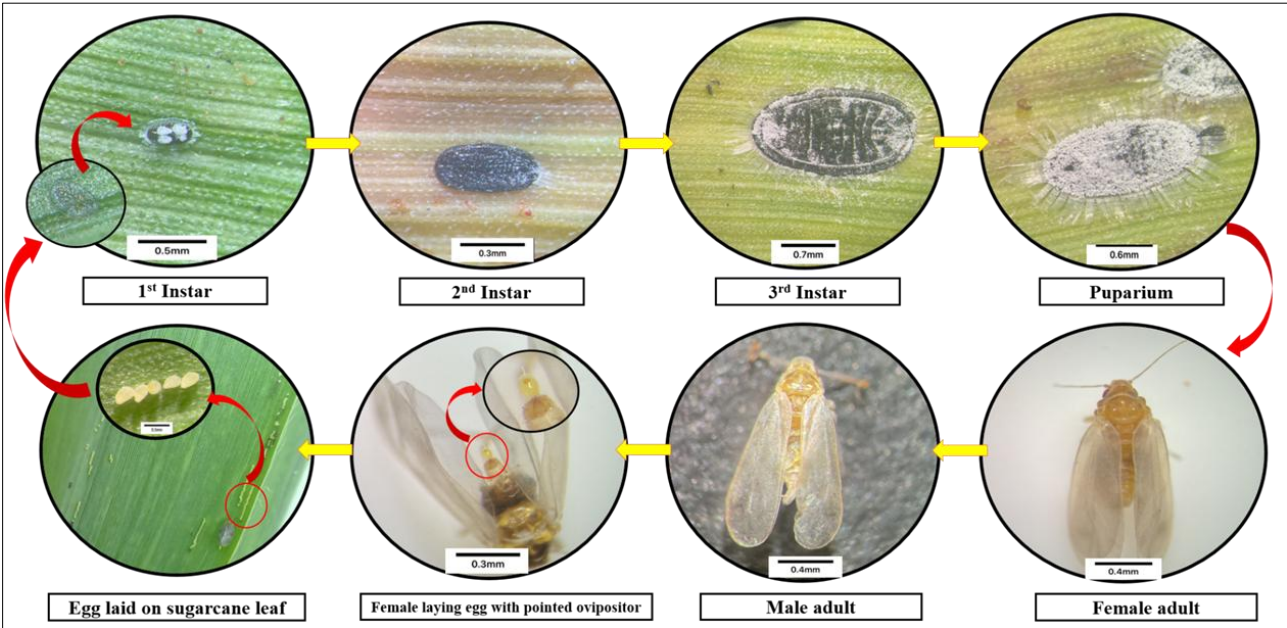


Photo 1: Life cycle of sugarcane whitefly, *A. barodensis*

Discussion

The observed oviposition behavior laying eggs in single linear arrangements along the leaf lamina with higher densities on middle and distal sections corroborates earlier

reports (Kunjadia, 1988; Thumar & Kapadia, 1995; Bhatti *et al.*, 2025; Likhith *et al.*, 2025) [20, 1]. Egg morphometrics (mean: 0.21 ± 0.02 × 0.12 ± 0.02 mm) also conform to previous studies on sugarcane whitefly (Kunjadia, 1988;

Charernsom & Suasa-ard, 1989; Likhith *et al.*, 2025)^[20, 1], though notably smaller than *A. rugioperculatus* ($0.3426 \pm 0.0028 \times 0.1720 \pm 0.0034$ mm; Elango *et al.*, 2026), with variations likely driven by regional agro-climatic factors. The observed incubation period aligns with Kunjadia, 1988^[20] (8.16 ± 0.51 days), Charernsom and Suasa-ard, 1989 (8.97 ± 0.63 days), Thumar and Kapadia, 1995 (8.80 ± 0.56 days), and Likhith *et al.*, 2025 (8.68 ± 0.52 days), showing partial agreement with Askarianzadeh and Minaeimoghadam, 2018^[2] (6.85 ± 0.92 days) and Bhatti *et al.*, 2025 (7.33 ± 1.03 days), but diverging from the 15-17 days period recorded by Inayatullah (1984). Furthermore, egg hatchability corresponded closely with Kunjadia, 1988^[20] (95.75%) and Likhith *et al.*, 2025 (95.00%), with minor inter study discrepancies attributable to meteorological conditions. Documentation of three nymphal instars agrees with extensive prior research (Inayatullah, 1984; Kunjadia, 1988; Thumar & Kapadia, 1995; Askarianzadeh & Minaeimoghadam, 2018; Bhatti *et al.*, 2025; Likhith *et al.*, 2025)^[1, 20, 2, 1], contrasting only with Charernsom and Suasa-ard (1989), who reported four instars for *A. barodensis* a deviation likely influenced by environmental differences. Morphometrically, first instar nymphs corroborated Kunjadia, 1988^[20] ($0.34 \pm 0.03 \times \sim 0.18$ mm) and Likhith *et al.*, 2025 ($0.36 \pm 0.01 \times \sim 0.18$ mm), partially conformed to the larger dimensions of Elango *et al.*, 2026 ($0.41 \pm 0.007 \times 0.26 \pm 0.05$ mm), and diverged from the smaller morphometrics of Charernsom and Suasa-ard, 1989 ($0.29 \pm 0.01 \times 0.15 \pm 0.01$ mm). The observed shiny black coloration and mean first instar duration aligned with Kunjadia, 1988^[20] (2.43 ± 1.04 days) and Thumar and Kapadia, 1995 (2.53 ± 0.64 days), but differed from durations reported by Charernsom and Suasa-ard, 1989 (1.61 ± 0.67 days), Likhith *et al.*, 2025 (4.78 ± 0.44 days), and Bhatti *et al.*, 2025 (5.27 ± 1.19 days). Second instar morphometrics partially confirmed findings by Kunjadia, 1988^[20] (length: $0.48\text{-}0.63$ mm, mean: 0.57 ± 0.06 mm; breadth: 0.30 ± 0.03 mm) and Likhith *et al.*, 2025 (length: $0.44\text{-}0.60$ mm, mean: 0.54 ± 0.05 mm; breadth: 0.30 ± 0.03 mm), but contrasted with smaller dimensions recorded by Charernsom and Suasa-ard, 1989 ($0.52 \pm 0.04 \times 0.26 \pm 0.01$ mm) and larger measurements of *A. rugioperculatus* ($0.83 \pm 0.08 \times 0.38 \pm 0.04$ mm; Suriya *et al.*, 2023). Second instar duration matched periods documented by Inayatullah, 1984 (4-6 days), Kunjadia, 1988^[20] (3-5 days), Thumar and Kapadia, 1995 (4.21 ± 0.70 days), and Likhith *et al.*, 2025 (3-5 days), whereas Charernsom and Suasa-ard (1989) and Bhatti *et al.* (2025) observed slightly longer durations of 5.24 ± 0.67 and 5.73 ± 1.33 days, respectively. For the third instar, observed morphometrics partially aligned with *A. barodensis* measurements by Kunjadia, 1988^[20] (length: $1.14\text{-}1.23$ mm, mean: 1.20 ± 0.03 mm; breadth: $0.57\text{-}0.66$ mm, mean: 0.61 ± 0.03 mm) and Likhith *et al.*, 2025 (length: $1.16\text{-}1.24$ mm, mean: 1.21 ± 0.02 mm; breadth: $0.58\text{-}0.71$ mm, mean: 0.62 ± 0.03 mm), while exceeding smaller dimensions reported by Charernsom and Suasa-ard, 1989 ($0.98 \pm 0.12 \times 0.47 \pm 0.06$ mm). Third instar duration corresponded closely with Inayatullah, 1984 (5-6 days), Charernsom and Suasa-ard, 1989 (5.77 ± 1.13 days), and Bhatti *et al.*, 2025 (5.83 ± 1.68 days), partially conforming to shorter periods observed by Kunjadia, 1988^[20] (4-5 days, mean: 4.42 ± 0.51 days) and Likhith *et al.*, 2025 (3-5.5 days, mean: 4.35 ± 0.84 days). Total nymphal duration corroborated Likhith *et al.*, 2025 (13.06 ± 1.63 days), showing partial agreement with shorter periods of Kunjadia,

1988^[20] (10.85 ± 1.34 days) and Thumar and Kapadia, 1995 (11.87 ± 1.46 days), but diverging from longer durations documented for *A. barodensis* by Charernsom and Suasa-ard, 1989 (17.11 ± 1.46 days) and Bhatti *et al.*, 2025 (16.83 ± 1.94 days). Comparable *A. barodensis* pupal dimensions were documented by Kunjadia (1988)^[20], Charernsom and Suasa-ard (1989), and Likhith *et al.* (2025), who observed mean lengths of 2.04 ± 0.39 , 1.9 ± 0.33 , and 2.03 ± 0.28 mm, alongside mean breadths of 0.98 ± 0.19 , 0.88 ± 0.15 , and 0.95 ± 0.23 mm, respectively. The puparium period strongly aligns with Inayatullah, 1984 (10-12 days) and Likhith *et al.*, 2025 (10-12 days; mean: 11.05 ± 0.79 days), partially conforms to Kunjadia, 1988^[20] (10.67 ± 0.98 days) and Thumar and Kapadia, 1995 (10.80 ± 0.93 days), but diverges from Bhatti *et al.* (2025), who reported a shorter average of 9.23 ± 1.43 days (range: 8-13 days). Present adult morphometrics differ slightly from Kunjadia (1988)^[20] and Likhith *et al.* (2025), who recorded smaller mean body lengths for female *A. barodensis* (1.71 ± 0.12 mm and 1.79 ± 0.18 mm, respectively) and males (1.18 ± 0.09 mm and 1.24 ± 0.08 mm, respectively), alongside narrower abdominal breadths for females (0.66 ± 0.04 mm and 0.64 ± 0.06 mm) and males (0.26 ± 0.03 mm and 0.27 ± 0.05 mm). The observed male to female sex ratio aligns with Thumar and Kapadia, 1995 (1:3.08 for *A. barodensis*), showing a similar female biased trend to Gurmali and Naveen, 2023 (1:2.47 for *B. tabaci*), but contrasting with the higher female predominance recorded for *A. barodensis* by Kunjadia, 1988^[20] (1:4.75). Present findings differed from the notably shorter mean pre-oviposition periods of Kunjadia, 1988^[20] (1.15 ± 0.13 hours), Thumar and Kapadia, 1995 (1.13 ± 0.09 hours), and Likhith *et al.*, 2025 (1.18 ± 0.17 hours); active oviposition aligned closely with Likhith *et al.*, 2025 (1.43 ± 0.29 days), but deviated from the shorter durations of Kunjadia, 1988^[20] (29.27 ± 0.80 hours) and Thumar and Kapadia, 1995 (29 ± 0.21 hours); and post-oviposition diverged from the shorter mean periods recorded by Kunjadia, 1988^[20] (2.20 ± 0.25 hours), Thumar and Kapadia, 1995 (2.10 ± 0.21 hours), and Likhith *et al.*, 2025 (2.20 ± 0.25 hours). Observed fecundity conforms closely to Minaeimoghadam *et al.* (2009)^[24] for *N. andropogonis* (mean: 61.80 eggs/female), but diverges from lower mean rates documented for *A. barodensis* by Inayatullah, 1984 (54.00 ± 15.00 eggs/female), Kunjadia, 1988^[20] (51.00 ± 9.90), Thumar and Kapadia, 1995 (50.08 ± 10.33), and Likhith *et al.*, 2025 (52.25 ± 8.20). Adult longevity conforms closely to Kunjadia (1988)^[20], who recorded mean lifespans of 28.6 ± 2.20 hours (range: 26-35 hours) for males and 32.62 ± 0.65 hours (range: 31.25-34.00 hours) for females, but diverges sharply from Askarianzadeh and Minaeimoghadam (2018)^[2], Bhatti *et al.* (2025), and Likhith *et al.* (2025), who documented substantially longer lifespans for the sugarcane whitefly at 4.15 ± 0.35 , 3.00 ± 0.77 , and 3.47 ± 0.42 days for males, and 6.00 ± 0.66 , 3.73 ± 1.14 , and 4.81 ± 0.39 days for females, respectively. Finally, comparable total lifespans were reported by Likhith *et al.* (2025) for *A. barodensis*, averaging 37.59 ± 2.28 days for females and 36.24 ± 2.20 days for males, which aligns with the mean egg to adult developmental period of 32.17 ± 3.35 days documented by Thumar and Kapadia (1995).

Conclusion

The laboratory evaluation of *Aleurolobus barodensis* Maskell reveals critical biological traits that contribute to its severity as a specialized pest of sugarcane. Its life cycle

spanning approximately 35 days from egg to adult death is strongly reinforced by a female-biased sex ratio (1:3.46), high egg hatchability (92%), and substantial female fecundity (averaging ~66 eggs). Morphologically, the development of a prominent white waxy fringe from the second nymphal instar onward, culminating in a waxy puparium, provides the insect with significant physical protection against environmental stressors and conventional contact insecticides.

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