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Biology of common banded awl *Hasora chromus* Cramer reared in *Pongamia pinnata* (L.) Pierre at Bhubaneswar, Odisha

Jyoti Kumari and MK Tripathy

Abstract
Study was carried out on the biology and population dynamics of Common banded awl *Hasora chromus* Cramer in *Pongamia pinnata* under normal temperature of 27±2 ºC and photoperiod conditions (day: night 12:12 hrs). In the Post Graduate Laboratory of College of Forestry, OUAT, Bhubaneswar. Results revealed that egg period was 1.58±0.45 days. There were five larval instars and it took 16.25±0.45 days to enter into the pupal stage. Pupation took place inside the webbed leaves and pupal period was lasted for about 5.85 and 6.65 days respectively. Adult longevity of male and female moths were 5.25 and 5.65 days respectively. The pre ovipositional, oviposition and post-oviposition periods were found as 3.00, 4.25 and 1.50 days respectively. The duration of total life cycle of adult male and female was 24.25 and 25.50 days respectively. Nutritional indices like growth rate (GR), consumption index (CI) and approximate digestibility (AD) decreased along with the growth of larvae. Efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) were decreased.

Keywords: Biology, *Hasora chromus* Cramer, *Pongamia pinnata*, nutrition indices

1. Introduction
Pongamia pinnata (L.) Pierre belongs to the family Fabaceae is a medium sized evergreen tree commonly called as Karanj or Pungam that generally attains a height of about 15-20 m with a diameter of around 50 cm Troup (1921) [11]. It is grown easily by seeds and has long tap root system which is well developed for absorbing nutrients from soil (Ahmedin *et al*., 2013) [1]. The forest cover of India is 7,08,273 km^2 which is 21.54% of total geographical area and Odisha has a vast forest canopy of about 51,354 km$^{2.}$ (India State of Forest Report, 2017 [4].
Its oil is a source of biodiesel. Yadav *et al.* (2011) [12] and Kesari *et al.* (2010) [5] its seed oil is known to contain active metabolites such as Karanjin, pongamol, glabrin and pinnatin etc. Karanjin is effective against large number of insects. Mathur *et al*. (1990) [6].
There are about 30 species of insect pests recorded to cause damage to *Pongamia pinnata* (L.) Pierre which is raised usually as avenue and strip plantations on marginal lands. (Orwa *et al*., 2009) [7]. Sundararaj *et al.* (2005) [9] reported a checklist of insects infesting *Pongamia pinnata* (L.) Pierre in India. This includes about 64 species of insects representing 21 families under six orders and one species of mite belonging to the family Eriophyid of the Order Acarina. *Hasora chromus* Cramer is found as the major defoliator infesting *Pongamia pinnata*. Suryanarayana *et al*. (2015) [10]. Effective management strategies have to be developed to reduce the losses caused by the pests. Understanding the biology of the pests in the crop will yield valuable information for strategizing the management options of the particular pests. Hence, the present investigation is carried out to study the biology and population dynamics of Common banded awl *Hasora chromus* Cramer a major defoliator infesting this plant at Bhubaneswar.

2. Materials and Methods
Studies based on biology of *H. chromus* Cramer were undertaken in the Post Graduate Research Laboratory of College of Forestry, OUAT. The pest was collected from Plantation sites as well as from College of Forestry campus.
The eggs of *Hasora chromus* Cramer were collected from the unsprayed *Pongamia pinnata* trees. The field collected eggs along with the leaves were brought to the laboratory and placed in blotting paper containing petridishes. The neonate larvae were placed in the plastic jars

(10cm x 10cm) and fed with fresh leaves of *Pongamia* early in the morning replacing the old leaves till the pupation of larvae. The exuviae and head capsule left on the leaves of *Pongamia pinnata* or inside the specimen box was considered as indication for change in instar. Pupae thus formed were examined under the binocular microscope and male and female pupae were kept in plastic jars (15cm x 15cm). Newly emerged male and female were kept in plastic jars for mating and egg laying. Honey 10% solution was provided as adult food. The rearing was carried out under normal temperature of 27±2ºC and normal photoperiod conditions (day: night 12:12 hrs). Light of the laboratory was switched off during night time. The number of egg laid on the leaves were registered daily so as to monitor egg laying rate. Weight of faecal matter excreted and weight of leaves consumed and larval weight each day was taken by contact precision balance. The biological parameters assessed were: duration of different stages of growth, weight, length and breadth of larva, pupa and adult, fecundity and longevity of adult, durations of pre-oviposition, oviposition and post-oviposition periods were also assessed.

The relation between food consumption and growth of larvae was analyzed statistically by using larval performance in term of food utilization indices which were calculated as-

$$\text{CI (Consumption index)} = \frac{\text{Weight of food consumed}}{\text{Weight of instar} \times \text{number of feeding days}} \times 100$$

$$\text{GR (Growth rate)} = \frac{\text{Weight gain of instar}}{\text{Mean weight of instar} \times \text{number of feeding days}} \times 100$$

AD (Approximate digestibility)

$$\text{AD} = \frac{\text{Weight of food consumed} - \text{Weight of faeces}}{\text{Weight of food consumed}} \times 100$$

ECD (Efficiency of conversion of digested food)

$$\text{ECD} = \frac{\text{Weight gain by instar}}{\text{Weight of food consumed} - \text{Weight of faeces}} \times 100$$

ECI (Efficiency of conversion of ingested food)

$$\text{ECI} = \frac{\text{Weight gain of instar}}{\text{Weight of food consumed}} \times 100$$

3. Results and Discussion

Biology of *Hasora chromus* Cramer was extensively studied on *Pongamia pinnata* host plant under laboratory condition as shown in Table 1. The mean egg period was 1.58 days and durations of different instars were 2.30, 2.59, 2.68.2.98 and 3.68 days for 1st, 2nd, 3rd, 4th and 5th instars respectively. The total larval period was 16.25 day where as duration of male and female pupa was about 5.85 and 6.65 days respectively. Mean larval weight for 3rd, 4th and 5 th instar was 64.65, 195.62 and 288.38 days respectively whereas mean weight of male and female pupa was 320.25 and 350.55 mg respctively. Mean length of male and female pupa was about 14.57 and 16.85 mm respectively and mean lengths of 1st, 2nd, 3rd, 4th and 5th instars were 3.00, 5.30, 8.78, 14.68, 24.68 mm respectively. Highest value of body diameter (4.28mm) and head capsule size (1.54 mm) were recorded in the 5th instar larvae.

Adult female laid eggs singly or in groups of 2-3 on soft tender leaves. Eggs were whitish in colour and have flattened base and prominent ridges from pole to base. Initially during the time of laying colour of egg was whitish but colour changes to pinkish at the time of hatching of eggs. Incubation period of eggs was 1.58 days. Our findings are strongly favored by the findings of other workers like Sahu *et al*. (2014) [8] and Suryanarayana *et al*. (2015) [10]. 1st instar larvae was brownish in colour and cyclindrical body was covered with setae. Head was black bilobed and profusely hairy. Mean duration of 1st larval instar was about 2.30 days. Measurement of larval length, diameter and head capsule was 3.00, 0.84 and 0.35 mm respectively. 2nd instar larvae were with have narrow body covered with hairs and four whitish narrow lateral bands were present along with and one dorsal band. Duration of 2nd instar larvae was 2.59 days and measurements of larval length, diameter and head capsule were 5.30, 1.27 and 0.45 mm respectively.3rd instar larvae were with more prominent dorsal and lateral bands. Larvae had numerous light colour patches on the dark colour body surface, narrow anal plate which was dark brown to black coloured and can be easily seen on the posterior end of larvae. Duration of 3rd instar larvae was about 2.68 days with an average weight of 856mg. days and larval length ,diameter and head capsule diameter were 8.78, 1.98 and 0.98 mm respectively.4th instar larvae Whitish in colour, setae on the head was much longer than earlier instar. Duration of 4th instar larvae was about 2.98 days with an average weight of 245mg and larval length, diameter and head capsule were 14.68, 3.08 and 1.08 mm respectively. These findings are in partial agreement with findings of both the earlier workers like Sahu *et al*. (2014) [8] and Suryanarayana *et al*. (2015) [10]. 5th instar larvae Colour changed to lightish green with several dorso-lateral spots present on the body of larvae. At this time their was reduction insize of larvae and discolouration of larvae. Duration of 5th instar larvae was about 3.68 days days and larval length, diameter and head capsule were 24.68, 4.28 and 1.54 mm respectively. Result was incontradict with findigs of Suryanarayana *et al*. (2015). [10] Total larval duration is 16.25 days which is in accordance with findings of same two earlier workers.Figure.1 Biology of *Hasora chromus* Cramer Pupais a chrysalis type and pupation took place inside the folded leaves. It was naked and attached itself to the leaf surface by a silk thread and remained inside the rolled leaf. It became greenish in colour and have white powder over the body surface being blunt at the posterior end and broad anteriorly. Mean pupal duration of male and female pupa was 5.85 and 6.65 days, whereas Sahu *et al.* (2014) [8] reported the pupal period of 9-10 days, temperature conditions prevalent at the time of rearing may be the cause of this. Male were unmarked, dark brown in the upper side, while females had two small semi transparent yellowish white spots in discal area in space 2 and 3. Underneath have purple gloss over brown. Ventral sides of the wings were bluish white outwardly diffused discal band across the hind wing and also has black tornal patch. (Figure 1)

The sex ratio of male: female is 0.9:1.06 , mean longivity of male and female is about 5.25 and 5.65 days respectively, which is in close agreement with findings of Suryanarayana *et al*. (2015) [10] but contrasting to the finding of Sahu *et al.* (2014) [8]. An average life span of male and female was 24.25 and 25.50 days respectively. (Table: 2) which is in contrast with findings of Sahu *et al.* (2014) [8]. The mean pre oviposition, oviposition and post oviposition period was

recorded as 3.00, 4.25 and 1.50 days respectively. Mean number of egg laid per female was 312.00. Mean length of wing expanse of adult male and female was 42.50mm 45.05mm respectively as given in Table 6.

Larval weight of *Hasora chromus* Cramer at different days of rearing in *Pongamia pinnata* leaves, weight of leaves consumed and faecal weight (mg) per day is presented in Table 3, 4, 5 respectively. Mean larval weight from 1st to 3rd instar was less than 2.00 mg whereas 4th to 6th instar larvae have average weight of 20 mg per day. Percentage weight gain was highest during 8th day of larval feeding. Heighest larval weight was recorded in the 14th day old lavae (710 mg) after which there a decrease in percentage larval weight gain till 16th day of larval feeding. Highest leaf consumption was recorded on 4th to 6th days old larvae (70.41%) followed by (38.28%) 10th day of feeding. Highest mean consumption of leaves was recorded on 15 day old larvae. However, there was a reduction in consumption of leaves after the larvae entered into pupal stage. Faecal weight recorded during 1st to 3rd instar was less than 0.40 mg and during 4th to 6th day, faecal weight was less than <0.60 mg/day. Increase in faecal weight per day was substantial in 10th day old larvae. Highest faecal weight was recorded in 15th day of rearing (420 mg/day) which was 9.52% more than that recorded during previous day. (Table.5) Highest food consumption of 2700.48 mg was reported in the final instar stage with maximum weight gain of 402.00 mg The mean larval weight recorded 300 times more in final instar stage than in 1st instar stage. (Table.7, 8) Both growth rate (G.R.) and consumption index (C.I.) was found to be decreased with the age of larvae, the former decreased from 0.25 to 0.15 and the C.I. varied from a high of 4.00 to 1.05. AD value decreased from instar I to V (97-82.34). The value of ECD% was found to increased from I instar to V instar. (6.41% to 18.08%). ECI value decreases from I to V instar (6.25 to 14.88). Similar tends in GR, CI, AD, ECD and ECI were also reported by Harinath *et al*. (2011) [3]. The AD value decreased from instar I to V. The highest being associated with first instar such high values also are expected when food item was rich in water tree foliage.

Table 1: Biology of *Hasora chromus* Cramer reared in *Pongamia pinnata* (L.) Pierre leaves at room temperature in the laboratory at Bhubaneswar (2018-2019)

Life stages	Duration (days)	Weight (mg)	Length (mm)	Diameter (mm)	Head capsule diameter (mm)
Egg stage	1.58±0.45 (2.00-3.00)	-	-	-	-
1st instar	2.30±0.51 (2.00-3.00)	2.00±0.45 (1.00-3.000)	3.00±.025 (2.00- 4.00)	0.84±0.05 (0.78-0.86)	0.35±0.01 (0.30-0.40)
2 nd instar	2.59±0.59 (2.00-4.00)	20±0.45 (10.00-25.00)	5.30±0.003 (3.00-6.50)	1.27±0.05 (1.20-1.32)	0.45±0.01 (0.42-0.48)
3 rd instar	2.68±0.25 (2.00-3.00)	85±0.45 (60.00-92.00)	8.78±0.88 (6.00-10.00)	1.98±0.06 (1.85-2.05)	0.98±0.01 (0.92-1.02)
4 th instar	2.98±0.40 (2.00-3.00)	245±0.42 (140.00-280.00)	14.68±0.005 (12.00-16.00)	3.08±0.04 (3.00-3.15)	1.08±0.01 (1.06-1.10)
5 th instar	3.68±0.85 (2.00-4.00)	645±0.65 (540.00-760.00	24.68±0.48 (22.00-26.00)	4.28±0.06 (4.16-4.35)	1.54±0.01 (1.52-1.58)
Total larval period	16.25±0.45 (14.0-18.00)	-	-	-	-
Male pupa	5.85±0.25 (5.00-6.00)	320.25±0.58 (210.00-350.00)	14.57±0.25 (12.00-16.00)	4.25±0.25 (3.50-4.50)	-
Female pupa	6.65±0.45 (6.00-7.00)	350.55±0.25 (245.00-400.00)	16.85±0.45 (15.00-18.00)	5.25±0.50 (4.00-5.60)	-

Each figure represents mean of 30 samples±S.D.
*Figure in parenthesis are range values

Table 2: Adult parameters of *Hasora chromus* Cramer reared in *Pongamia pinnata* leaves at room temperature in laboratory reared during *Kharif* (2018-2019)

Parameters		Maximum	Minimum	Mean* ±S.D.
Sex ratio (male: Female)		0.9	1.06	-
Adult longevity (days)	Male	6.00	4.00	5.25±0.05
	Female	6.00	5.00	5.65±0.28
Pre oviposition period		6.00	3.00	3.00±0.05
Oviposition period		6.00	3.00	4.25±0.05
No. of eggs laid per day	1 st	30.00	15.00	20.05±0.05
	2nd	90.00	40.00	64.00±0.25
	3 rd	120.00	60.00	72.24±0.15
	4 th	100.00	55.00	63.58±0.08
	5th	110.00	58.00	65.25±0.15
	6 th	40.00	20.00	28.05±0.34
Total no. of eggs		-	-	312.00±0.85
Post oviposition period		1.00	2.00	1.50±0.00
Total life cycle	Male	30.00	23.00	24.25±0.05
	Female	30.00	24.00	25.50±0.05

*Each figure represents mean of 30 samples±S.D.

Table 3: Larval weight of *Hasora chromus* Cramer at different days of rearing in *Pongamia pinnata* leaves at Bhubaneswar (2018-2019)

Observation period (day) from 1st day of 1st instar to 5th instar	Weight of larvae (mg) per day			Percentage increase or decrease per day
	Mean ±S.D.	Max.	Min.	
1st to 3rd	<2.00	-	-	-
4th to 6th	<20.00	-	-	-
7th	45.25±0.65	55.00	30.00	-
8th	95.05±0.65	105.00	90.00	52.26
9th	115.25±0.25	170.00	100.00	17.39
10th	150.05±0.65	210.00	120.00	23.33
11th	277.35±0.65	320.00	250.00	45.84
12th	310.05±0.05	350.00	265.00	10.64
13th	650.05±0.35	690.00	580.00	52.30
14th	710.25±0.65	720.00	680.00	8.45
15th	650.15±0.65	680.00	630.00	9.23
16th	595.05±0.05	650.00	575.00	-9.25

*Each figure represents mean of 30 samples ± S.D.

Table 4: Consumption of *Pongamia pinnata* leaves (mg) by *Hasora chromus* Cramer larvae reared in laboratory conditions in Bhubaneswar (2018-2019)

Observation period (day) from 1st day of 1st instar to 5th instar	Weight of leaves consumed (mg) per day			Percentage increase or decrease of weight per day per day
	Mean ±S.D.	Max.	Min.	
1st to 3rd	<16.00±0.05	<16.00	-	-
4th to 6th	142.0±0.40	180.00	110.00	70.41
7th	480.12±0.05	520.22	350.08	7.62
8th	520.25±0.15	5500.30	480.12	10.34
9th	580.28±0.25	610.31	510.14	10.34
10th	940.34±0.05	1000.36	850.15	38.29
11th	1080.37±0.45	1200.39	900.18	12.96
12th	1220.42±0.35	1250.46	980.20	11.10
13th	1800.46±0.22	2000.48	1600.28	37.77
14th	2800.49±0.62	3000.52	2600.32	35.71
15th	3200.52±0.24	3400.54	3000.36	12.50
16th	3000.46±0.36	3200.50	2800.40	- 6.66

*Each figure represents mean of 30 samples ± S.D.

Table 5: Faecal weight (mg) *Hasora chromus* Cramer larvae reared in *Pongamia pinnata* leaves in laboratory conditions Bhubaneswar (2018-2019)

Observation period (day) from 1st day of 1st instar to 5th instar	Faecal weight (mg) per day			Percentage increase or decrease per day
	Mean ±S.D.	Max.	Min.	
1st to 3rd	<0.40	-	-	-
4th to 6th	<0.60	-	-	-
7th	16.98±0.53	20.00	12.00	-
8th	18.24±0.65	22.00	16.00	11.11
9th	20.64±0.54	40.00	20.00	10.00
10th	120.32±2.85	185.00	108.00	83.33
11th	175.12±3.15	240.00	150.00	31.42
12th	180.32±2.58	260.00	150.00	2.77
13th	250.42±2.15	300.00	200.00	28.00
14th	380.39±3.15	425.00	350.00	34.21
15th	420.42±2.16	430.00	380.00	9.52
16th	380.66±2.78	415.00	360.00	-10.52

*Each figure represents mean of 30 samples±S.D.

Table 6: Adult morphometry of male and female *Hasora chromus* Cramer reared from field collected eggs in the laboratory at Bhubaneswar (2018-2019)

Sex	Length at the wing expanse (mm)			Abdomen length (mm)		
	Max.	Min.	Mean±S.D.	Max.	Min.	Mean±S.D.
Male	43.00	41.00	42.50±0.25	13.00	11.00	12.00±0.55
Female	46.00	44.00	45.05±0.50	14.00	12.00	13.00±0.25

Table 7: Food consumption of *Hasora chromus* Cramer larvae on *Pongamia pinnata* leaves

Instar	Weight of food ingested (mg)	Weight of faeces(mg)	Weight gain by larvae(mg)	Mean larval weight(mg)
I	16.00±0.05	0.4±0.05	1.00±0.01	2.00±0.01
II	142.00±0.15	0.6±0.02	15.00±0.25	20.00±0.04
III	526.60±0.05	18.29±0.08	65.00±1.25	85.18±0.06
IV	1080.38±0.35	158.83±0.15	158.00±0.85	245.00±0.07
V	2700.48±0.05	476.66±0.35	402.00±0.09	645.02±0.04

Table 8: Food utilization efficiency of *Hasora chromus* Cramer larvae on *Pongamia pinnata* leaves at Bhubaneswar (2018-2019)

Instar	GR (mg/day/mg)	CI (mg/day/mg)	AD%	ECD%	ECI%
I	0.25	4.00	97.5	6.41	6.25
II	0.25	2.36	99.5	10.61	10.56
III	0.25	2.06	96.5	14.08	12.34
IV	0.15	1.48	85.29	17.15	14.62
V	0.15	1.05	82.34	18.08	14.88

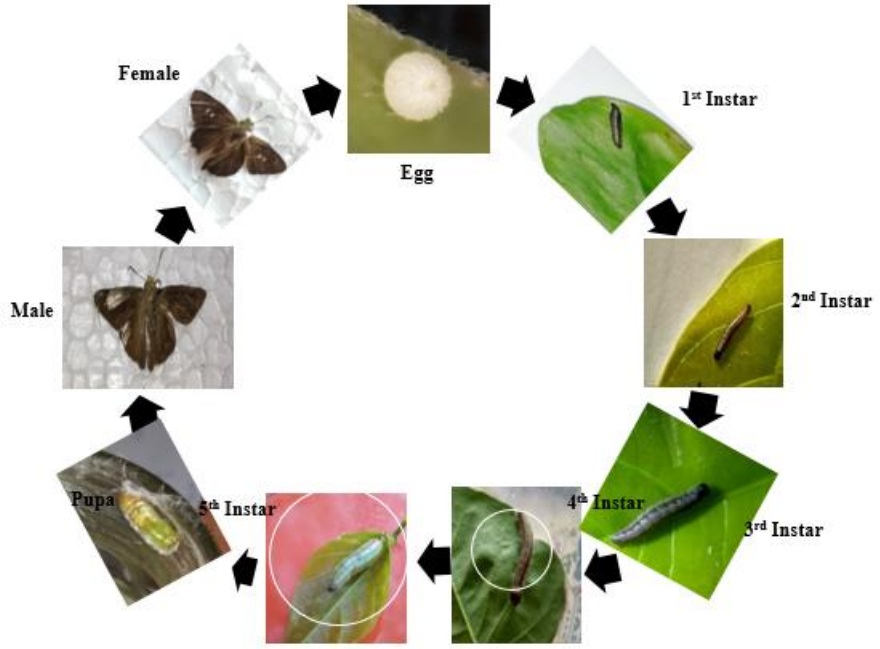

Fig 1: Biology of *Hasora chromus* Cramer on *Pongamia pinnata* (L.) Pierre at Bhubaneswar (2018-2019)

4. Conclusion

Close monitoring of the reproductive behaviour of *Hasora chromus* Cramer suggested that adult laid eggs singly or in groups of 2-3 on the upper side of the leaves. The incubation, larval, and pupal period is 1.58, 16.25, and 5.00-6.00 days respectively. There are five larval instars. The longevity of the adult male and female was about 5.25 and 5.65 days respectively. The pre oviposition, oviposition and post oviposition periods were found as 3.00, 4.25 and 1.50 days respectively. The duration of total life cycle of adult male and female was 24.25 and 25.50 days respectively.

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