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Assessing the developmental parameters from egg to adult stage of hide beetle, *Dermestes frischii* Kugelann 1792, (Coleoptera: Dermestidae) on three popular dried fishes of Bangladesh

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Abstract
With a view to establish a proper control program for the pest of dried fish, an investigation was taken under laboratory condition on life cycle parameters of *Dermestes frischii* on three most consumable and popular dried fishes (*Harpadon nehereus* Hamilton 1822; *Sicamugil cascasia* Hamilton 1822 and *Macrobrachium lamarrei* Edwards 1823). The parameters that have been taken under investigation on the above mentioned dried fish substrates were developmental period, size and weight of larvae and pupae, adult longevity, fecundity and fertility of *Dermestes frischii*. Incubation and pupation period were estimated as insignificant (p>0.01) among all dried fishes whereas the highest larval period was revealed from *M. lamarrei*. The result obtained from this experiment expressed a short developmental period for *H. nehereus* and *S. cascasia* against that of the *M. lamarrei*. The mean fertility screened from *H. nehereus*, *S. cascasia* and *M. lamarrei* was ranged between 81.2 ± 0.80 to 86.2 ± 1.77. There was a sharp peak for mean fecundity from dried *H. nehereus* and also a sharp decline in mean fecundity for dried *M. lamarrei*. In case of pupal weight, the heavier pupae were recovered from *S. cascasia* whereas the lightest pupae were collected from *M. lamarre*. A significant (p<0.01) result was obtained from all three dried fishes for adult male female longevity of *D. frischii*. The present experiment specifies a good indication for host preference of *Dermestes fischii* and also initiates a proper control program for this pest of dried fish.

Keywords: hide beetle, *Dermestes frischii*, developmental period, fecundity, fertility, adult longevity, infestation, dried fishes

Introduction
Smoked or dried fish form a traditional part of the diet for a large protein of the world population [1]. In Bangladesh dried fish are important source of low-cost dietary protein [2]. But unfortunately, from processing throughout storage shelf life, fish is vulnerable to insect pests belonging to three families, namely, Calliphoridae and Sarcophagidae (Blowflies) and Dermestidae (Beetles) [3]. Members of the genus *Dermestes* species are major pests of smoked dried fish in Africa, Asia and some part of Europe [4, 5]. FAO (2002) reported that dried fish can suffer considerable loss of weight due to feeding damage caused by insect pest [6]. *Dermestes* sp and *Necrobia rufipes* constitute the major pests on cured fish [7]. Other reports indicated that about 71.5% of dried fish infestation in most of the producing areas was caused by *Dermestes* sp [8]. Lale and Sastawa (1996) and Odeyemi *et al.* (2000) recorded about 50% losses during the storage in go downs, the pests consume the muscles leaving the skeletons behind. Invasion of hide beetles, specially by *Dermestes maculatus* and *Dermestes frischii*, on cured fish can cause overwhelming fragmentation which can lead to quantitative loss of the smaller remains and loss of assessment for quality reduction [9, 10]. According to Banglapedia, currently, *Harpadon* sp, *Macrobrachium* sp and *Sicamugil* sp dried fishes have been recognized as most prevalent and consumable dried fishes of Bangladesh [11]. Hence, we have selected three of these dried fishes for evaluating the details of *Dermestes frischii* life cycle. The hypothesis of this experiment was to inspect the developmental process of *Dermestes frischii* on *Harpadon nehereus*, *Sicamugil cascasia* and *Macrobrachium lamarrei* dried fishes with a view to understand their biology and host preference for an appropriate control measure.

Materials and Methods

Rearing of *Dermestes frischii*

The most common and consumable popular dried fishes (*Harpadon nehereus*; *Sicamugil cascasia* and *Macrobrachium lamarrei*) were purchased from local fish markets of Savar region, Bangladesh and sterilized at 1 kGy to avoid other pest infestation (Figure 1). Adult *Dermestes frischii* was reared on dried *Harpadon nehereus*; *Sicamugil cascasia*; and *Macrobrachium lamarrei* at Radiation Entomology and Acarology Division of Institute of Food and Radiation Biology, Savar, Dhaka. Water was abounding in a vial as supplementary intake. The experimentation was maintained at 28 ± 2 °C of temperature and at 65± 2% of relative humidity.

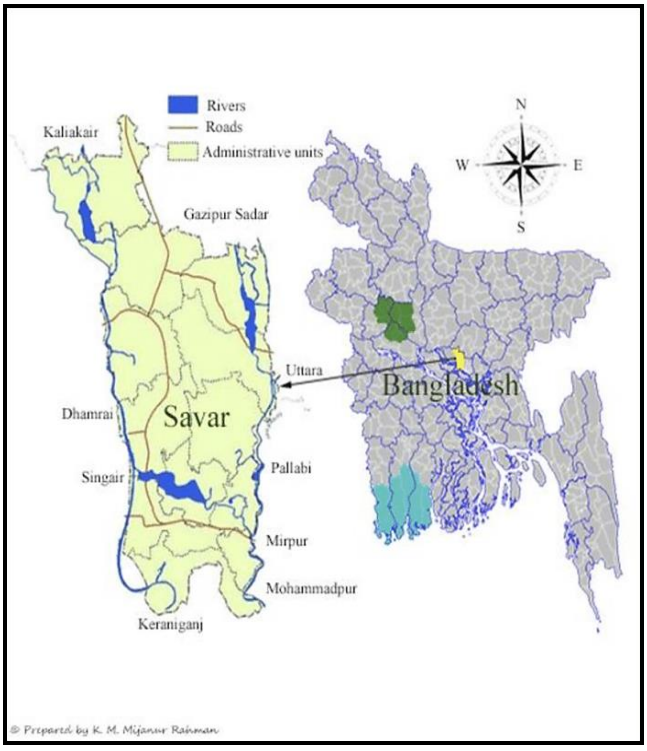

Fig 1: Site of local dried fish market in Savar Region, Bangladesh

Pairing of *Dermestes frischii*

60 newly emerged adult from three different diets was collected from the laboratory colonies and sexed separately by the presence of a shallow pit and brush of hairs on their 4th abdominal sternite in male (Osuji, 1985) within four days before they mature. 10 freshly emerged males and 10 females from each three different diets were paired (10 replications each with one male and one female from three diets) in Petridish (125mm X 0.5mm). Each pair (one male X one female) was provided with 0.5041 gm of dried fish and water in vial (16 X 24 mm). The hide beetle was allowed to drink water from the vial through soaking the cotton.

Egg Laying Bioassays

A folded black cotton cloth was placed in petri dish for *Dermestes frischii* for egg laying device. The petrtidishes were monitored once daily for the presence of eggs using hand lens (MG- 89077). Food and oviposition substrate were rechecked every second day to avoid mite infestation. Egg was counted and removed to a new petri dish (filled with dried fish as rearing media) by a soft brush where they started to hatch and larval development remain continued there. Fecundity by *Dermestes* were recorded daily till the death of female. Incubation period and hatching percentage was recorded just after hatching.

Larval development

The larval development was examined by rearing larvae in a petri dish containing 10 gm of fish substrates. On hatching, the larvae were separated into petri dish and each larvae was inspected every day. Duration of each larval instar was determined by the presence of exuviae after each molt. Larval period was counted from the day of emergence of first instar to the day on which the larvae goes on pupation. 50 larvae reared from each dried fish substrate were measured in mm with the help of a digital slide calipers (FstDgte, 0-150 mm) and weighted in gm by using an electronic balance (ABJ 220-4M).

Pupation

When the last instar larvae become almost C-shaped and non-motile the prepupal stage occurred. Pupal period was calculated from the changes occurred in larval to pupal morphology to the adult emergence. 50 pupae reared from each dried fish substrate were measured in mm to determine their length with the help of a digital slide calipers (FstDgte, 0-150 mm) and weighted in gm by using an electronic balance (ABJ 220-4M).

Adult longevity

Newly emerged *D. frischii* from three different fish substrates were maintained in a petri dish. Each petri dish was provided with dried fish and water. The longevity was counted from adult emergence till the death of the adult beetle.

Data analysis

Data collected on fecundity, fertility, larval and pupal size and weight, developmental period and adult longevity were analyzed by one way ANOVA by Microsoft Excel (XLSTAT by addinsoft) and detected as significant through P value and F value estimation at $p<0.01$ level.

Results

Developmental periods: From egg to adult emergence (in days)

From Table 1, the total developmental periods for *Dermestes frischii* was counted as 32.0 ± 2.54, 32.6 ± 2.47 and 36.0 ± 1.21 days from *H. nehereus*, *S. cascasia* and *M. lamarrei* dried fish respectively. The incubation periods and pupal periods for *D. frischii* from all three diets were quite similar (2 to 2.6 ± 0.24 and 6.6 to 7.6 days correspondingly). Maximum (25.8 ± 0.73, Mean ± SE) larval period was recorded from dried *M. lamarrei* while in case of dried *H. nehereus*, it took only 23.4 ± 1.18 days.

Fecundity and Fertility (Mean ± SE)

In Figure 2, B, a linear position for mean fertility was screened from dried *H. nehereus*, *S. cascasia* and *M. lamarrei* and it was ranged between 81.2 ± 0.80 to 86.2 ± 1.77 respectively. In case of mean fecundity, there was a sharp peak (96.25 ± 1.25) for mean fecundity from *H. nehereus* and also a sharp decline (58.25 ± 1.49) for *M. lamarrei*.

Size (in mm) and weight (in gm) of mature larvae and Pupae

The highest pupal weight (0.0409 ± 0.0004 gm) was revealed from *S. cascasia* whereas the lightest pupae (0.0319 ± 0.0004 gm) were recovered from *M. lamarrei*. In case of pupal size,

the larger pupae (4.22 ± 0.0399 mm) were recorded from *S. cascasia* and shorter (3.17± 0.0160 mm) was found from *M. lamarrei*. The heaviest larvae were attained from *S. cascasia* and rest of the larvae was 0.0413± 0.0008 gm and 0.0316±0.0006 gm from *H. nehereus* and *M. lamarrei* respectively. Larval size was significantly varied at $p>0.01$ level among three different dried fishes (Table 2).

Adult longevity (in days)

Adult female longevity for *D. frischii* on *H. nehereus* and *S. cascasia* dried fish showed a similar range (from 41- 42 days) while from *M. lamarrei*, the female *Dermestes* lasted only for 38.6 ± 1.07 days. In case of adult male longevity, 38.9 ± 0.99, 36.4 ± 0.96 and 33.8 ± 1.75 days were noted from dried *H. nehereus*, *S. cascasia* and *M. lamarrei* correspondingly (Figure 2, A).

Table 1: Incubation period, larval and pupal period including total developmental duration (in days) of *Dermestes frischii* on three popular dried fishes (*Harpadon nehereus*; *Sicamugil cascasia* and *Macrobrachium lamarrei*)

Dried fish substrate	Incubation Period (Mean ± SE) (days)	Larval Period (Mean ± SE) (days)	Pupal Period (Mean ± SE) (days)	Total developmental periods (in days) from egg to adult emergence
Harpadon nehereus	2 ± 0.00	23.4 ± 1.18	6.6 ± 0.24	32.0 ± 2.54
Sicamugil cascasia	2 ± 0.00	24 ± 1.34	6.6 ± 0.24	32.6 ± 2.47
Macrobrachium lamarrei	2.6 ± 0.24	25.8 ± 0.73	7.6 ± 0.24	36.0 ± 1.21

(Mean ± SE of 10 pairs from each dried fish)

Table 2: Mean size (mm) and weight (gm) of mature larvae and pupae of *Dermestes frischii* recovered from dried *Harpadon nehereus*, *Sicamugil cascasia* and *Macrobrachium lamarrei*

Parameters	Different dried fishes		
	Harpadon nehereus	***Sicamugil cascasia***	***Macrobrachium lamarrei***
Larval Size (mm)	7.38 ± 0.074	8.64 ± 0.053	6.93 ± 0.039
Larval weight (in gm)	0.0413 ± 0.0008	0.0532 ± 0.0012	0.0316 ± 0.0006
Pupal weight (in gm)	0.0388 ± 0.0002	0.0409 ± 0.0004	0.0319 ± 0.0004
Pupal Size (mm)	3.50 ± 0.0337	4.22 ± 0.0399	3.17 ± 0.0160

(Mean ± SE of 50 larvae and 50 pupae from each dried fish)

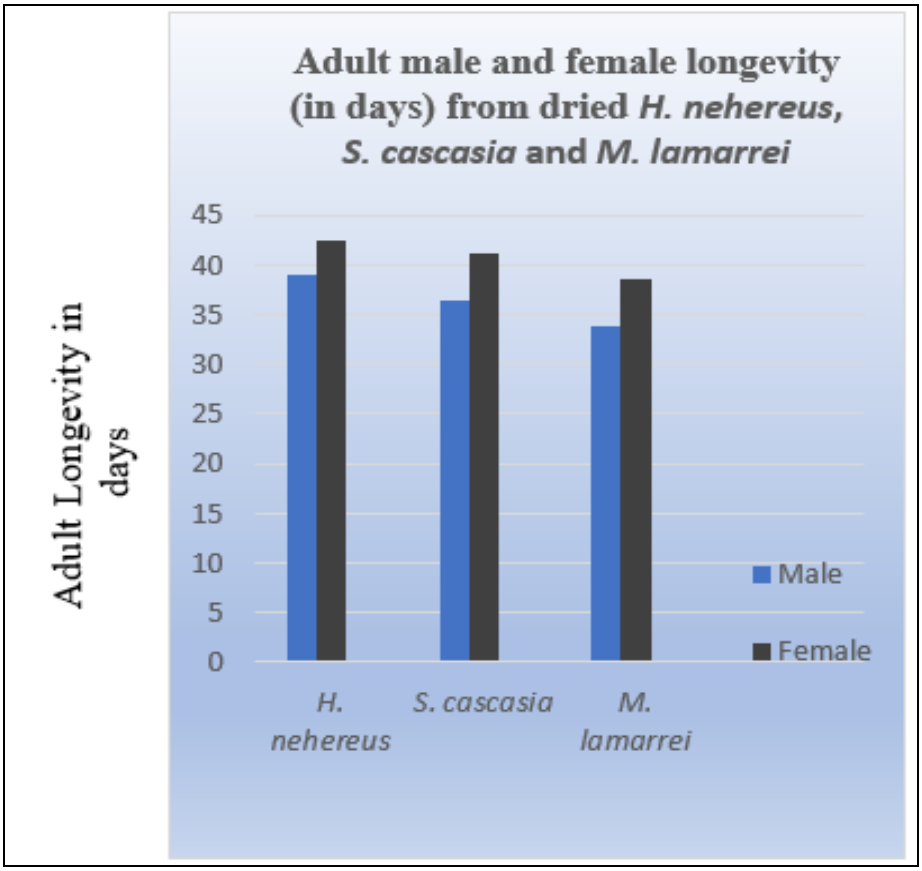

Fig 2A: Adult male and female longevity (in days) of *Dermestes frischii* from dried *Harpadon nehereus*, *Sicamugil cascasia* and *Macrobrachium lamarrei*;

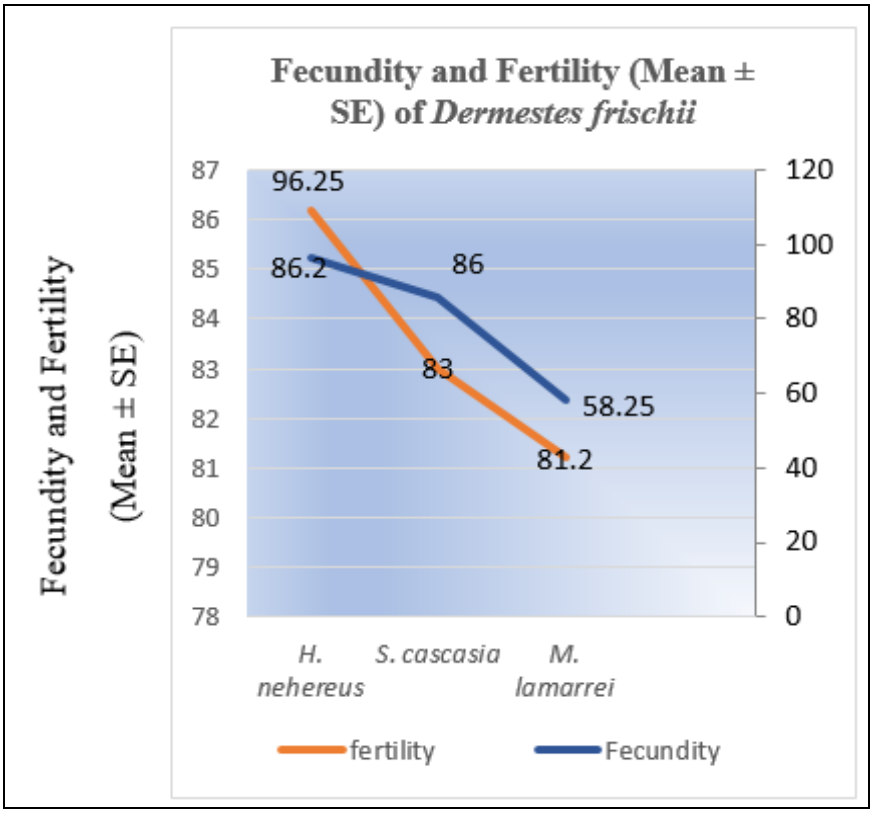

Fig 2 B: Fecundity and Fertility of *Dermestes fristchii* on different dried fish substrates

Discussion

The result of total developmental period of *D. frischii* from the present experiment varied from the findings of Ezenwaji and Obayi (2004) [12]. Again, Andres (1925) and Von Dobkeiwicz (1928) recorded the egg period as 2- 3 days at 28- 30 °C [13, 14]. According to Zakka *et al*. (2009) these differences recorded may be due to evolutionary trend, physical form of the dried fish or its nutritional composition [15]. The findings obtained from this trial expressed a short developmental period for *H. nehereus* and *S. cascasia* against that of the *M. lamarrei*. It is an indication of good host preference by *D. frischii*. Howe's (1953) figure of 54 days for 25 °C would appear to be somewhat low since at 75% relative humidity the life cycle was found to require 71.3 days [16]. Usman Zakka *et al*. (2013) reported 37.35 days (Mean ± SE) for larval development in case of *Dermestes maculatus* on *B. capriscus* fish and also reported a significant difference (P<0.05, F Prob.= 0.083) in pupal period with *B. capricus* from other fish species [17]. Osuji (1974) recorded a mean of 82 individual insects reared on *Clarias* sp [18]. A number of research works have been described the fecundity in insects on a specific host that is regulated by different factors that may determine its suitability or otherwise as a breeding medium, like nutritional quality, host abundance, morphology, environmental conditions, age and size of individual and competition [19, 20, 21, 22, 23]. TG Amos (1968) reported 90% fertility and 234 number of eggs per female at 30 °C of temperature including 60% of relative humidity for *Dermestes frischii* [24]. Osuji (1975) measured the *D. maculatus* pupae as between 6.34-8.87 mm on *Balistes* sp. and *Synodentis* sp. respectively [25]. U. Zakka *et al*. reported the shortest length of *Dermestes* sp. on *Tilapia* sp. in the third instar larva with 5.20 mm and longest on mixed substrates 7.93 mm, while on fourth larval instars *Clarias* sp. had the longest measurements of 12.58 mm and the shortest of 8.15 mm on *Balistes* sp [26]. These results did not covenant towards the observation of Samish *et al.* (1992) who recorded *Dermestes* larvae 16 mm as the highest measurement [27]. These variances may be accredited to different protein content in the fish species since it plays a vital role in larval growth and development. But Siddaiah and Kujur (2015) noted the longevity of *D. atar* as 11.33 ± 1.76 days in general [28]. This findings contrast the present data for adult longevity and the reason behind this dissimilarities is probably the species variation.

Conclusion

As dried fishes are good basis of protein intake and at the same time a striking source of foreign currency here in Bangladesh, we should concern regarding the proper management method and infestation rate of these insect pests (specially the hide beetle). The present research will be a countenance towards the insect pests control program for an appropriate management of dried fish and fisheries of Bangladesh.

Significance Statement

This study discovered the host preferences of insect pests specially the *Dermestes* sp. of most popular dried fishes here in Bangladesh. The present research work will surely guide the field worker towards a better control program for *Dermestes* pests and thereby lift up the export of dried fish throughout the world.

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