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LIFE HISTORY STATISTICS OF THE COMMON HOUSE CRICKET, ACHETA DOMESTICUS (GRYLLIDAE) UNDER NATURAL AND LABORATORY CONDITIONS

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Abstract

Acheta domesticus, the common house cricket, is the cosmopolitan species. Based on 100 crickets, a mean time spent in each stage (egg, nymph and adult) for the cricket was calculated. Female crickets produced an average of 2,195±225 eggs per life, but there was variation due to food availability and temperature. Females laid 125±15 eggs/day during the reproductive life period which averaged 3 weeks ±3 days. In the confinement of 25°C, the duration of the egg phase was on average 13±2 days. The cricket nymphs required 56±5 days to mature with 8 molts for becoming adults. Adult stage duration averaged 53±7 days but typically ranged between 45 and 60 days and mostly depended on temperature and moisture.

Key words: Life history, Cricket, *Acheta domesticus,* Gryllidae, Egg phase.

Introduction

Family Gryllidae belongs to the order Orthoptera and suborder Ensifera also called long horned grasshoppers due to their long antennae. Family Gryllidae, referred to as crickets, includes over 2026 valid species living in different regions of the world, in forests, meadows, and urban environments (Cigliano *et al.,* 2025). Crickets are well known not only for their special vocalizations, but also for its ecological values including decomposition, nutrient cycling, and being food for many insectivores (Alexander, 1962, Walker & Masaki, 1989,). Most specimens of family Gryllidae are dark brownish to blackish in colour and are nocturnal in habitat. Crickets are characterized by the big globular head, the tarsi compressed, posterior tibiae with sharp spines, ovipositors are needle shaped and cerci thick at base and pointed at its apex. The assessment of life history traits in the Gryllidae family is significant when considering the ways in which diverse types of crickets have evolved in response to various selective pressures. They are factors like growth rates, quantity and quality of offspring produced and other aspects that mold the survival and reproduction of a species in the evolutionary process (Stearns, 1992). A renowned group of scientists has conducted extensive research on the Orthoptera of Pakistan, highlighting various aspects such as morphology, biology, systematics, and DNA barcoding (Sultana and Wagan 2010a,b, Sultana *et al.,* 2013, Channa *et al.,* 2011, Ashfaq *et al.,* 2022; Bozdar *et al.,* 2024; Kumar *et al.,* 2022; Shah & Sultana, 2024; Sultana & Song, 2024). However, Afghan et al. (2022) and Bhanger *et al.,* (2024) have specifically focused on the systematics and control of Gryllidae.

Acheta domesticus is well known in many parts of the world, hence referred to as cosmopolitan; its successful bursting of many different areas of the world is due to its flexibility towards different environmental factors which make it favor temperate regions

(Mulkern, 1967). Males are characterized by large body size, comparatively great extremities for leaping, and vocalization that are chirpy known for attracting mates (Walker, 1975). A. domesticus has a short developmental period and it takes it from the egg to adulthood in about 45-60 days depending on environmental conditions (Dingle *et al.,*1990). This short life cycle is beneficial in the temperate regions where the seasonal changes require quick development as well as reproduction. Also, the implication that it has a versatile diet that consists of organic matters enables it to inhabit many regions including the forest, urban area and many more (Alexander & Meral, 1967).

Material and Methods

Study site

The study regarding the life history and reproductive strategies of gryllidae-crickets was carried out in Lower Sindh-Pakistan during 2024. A survey has been conducted in four different districts of lower sindh *i.e.,* Badin, Mirpurkhas, Tharparkar and Umerkot (Table 13 & figure12, 13) during the research work. Specimens were collected from trees, shrubs, herbs grasses, bakeries, holes in the houses, on lights at night, leaf litter, soil cracks, crops, vegetable fields and around human habitats. This study uses data from a literature review and field observations to compare life history traits of Acheta domesticus.

Collection of Specimen

The four different districts of lower Sindh province were used to collect Gryllidae, and specimens were collected from different habitats *i.e.,* agricultural lands, deserts, semi-desert, trees, shrubs, herbs grasses, bakeries, holes in the houses, on lights at night, leaf litter, soil cracks, crops, vegetable fields and around human habitats. Samples were taken with the help of insects and hand-picking methods.

Identification of samples

The collected specimens were brought to EBCRL lab for identification. The morphology and genitalia of the obtained material were used to identify them. Standard Entomological technique and instruments were used to correctly identify cricket species. For taxonomic work specimens were mounted, labeled and sorted properly.

Results

***Acheta domesticus* (Linnaeus, 1758)**

Table 1 & Figure 1-2.
This species has been synonomized by the following names:
Gryllus (Acheta) domesticus Linnaeus, 1758,
Acheta domesticus Fabricius, 1775,
Gryllulusdomesticus, Uvarov, 1935.

Material examined:

Pakistan, Sindh prov. 72♂, 65 ♀; Shamshad, Riffat; 24 Aug. 2024; Badin 24º39`20.59″N, 68º 50’14.07″E; 109♂, 136 ♀; Riffat, Shamshad;18 Aug. 2024; Mirpurkhas25°31′39.3″N,

69°00′50.6″E; 102♂, 87 ♀; Shamshad, Riffat; 31 Aug. 2024; Tharparkar24.8777°N, 70.2408°E; 83♂, 69 ♀; Riffat, Shamshad; 01 Sept. 2024; Umerkot; 25.3549°N, 69.7376°E

Distinguish characters

♂: Have medium, pubescent orgeous and convex bodies with a peculiar testaceous and bright fulvous color. Head with two broad transverse testaceous bands, not affecting the general brown colour. Pronotum having two big visible brown spots. The elytra project beyond the apex of the abdomen. Some brown markings are occasionally found on the yellowish legs. The femur has a few lines on the upper side and the tibia is provided with 6-7 spines. Cerci, positioned at the rear, remain diminutive in size.

♀: Exhibit a larger physique compared to males. The back of the head is slightly falling, and the bulging eyes add to the look. Interior portion of pronotum scringed in medially. Elytral veins in females are rather oblique. The tibia has five to six spines and the hind femur appears slenderer. Cerci are narrower, seen from the front. The ovipositor is long, acute, and of a normal form (Figure 2).

Phenology

The house cricket, *Acheta domesticus*, is abundant in fields. Its life-cycle lasts about 2-3 months, with no clear winter stage. Plants affected by this species include *Tritium aestivum*, *Oryza sativa*, *Sacharumofficinarium*, *Dactylocteniumaegyptium*. This species has been recorded in various environments.

Remarks

The global range of this species is cosmopolitan. Its presence is reported from various places, ranging from the Himalayas, Srinagar and even Kashmir where it has been collected at an elevation of 6000 ft. (Chopard, 1969). During study recorded that this species is distributed up to Sindh. In a previous literature review, the authors reported that *Acheta domesticus* and its related species represent rather important pests Sultana *et al.,* (2013, 2016 & 2021) having been reported in a number of crops in Pakistan (Shamshad, 2020) and (Ghouri, 1961).

Table 1: Measurement of various body parts of *Acheta domesticus*

Body Parameters	**Male (n=10) Mean ± SD (mm)**	**Female (n=10) Mean ± SD (mm)**
Length of head	4.7±0.62	4.3±0.25
Length of pronotum	5.3±0.62	5.0±0.40
Length of femur	11.7±0.47	12.1±1.03
Length of tibia	8.6±0.57	8.6±0.70
Length of cerci	8.2±0.85	8.3±1.50
Tegmina Thickness (mm)	0.35 ± 0.05	0.29 ± 0.01
Total body length	24.6±2.5	24.1±1.79

Note: Significant Sexual Dimorphism in *A. domesticus*.

(a) (b)

Figure 1: ***Acheta domesticus*** **(a) DV of** ***A. domesticus*** **(b) Femur and tibia with sharp spines.**

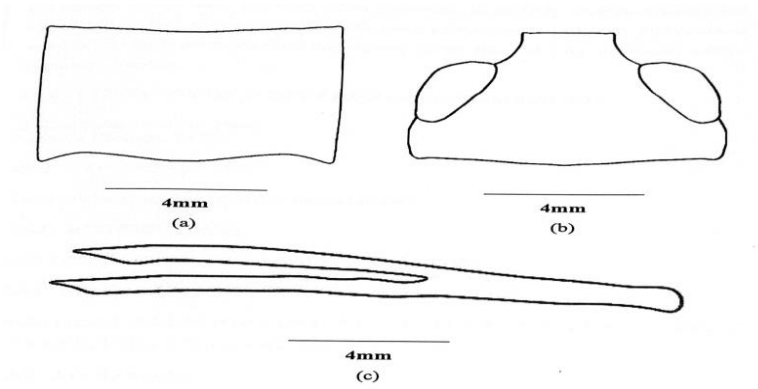

Figure 2: ***Acheta domesticus,*** **(a)Head - DV (b) Pronotum – DV (c) Ovipositor – LV (Bar-line 4 mm).**

Life history and breeding strategy

Mating call

Male crickets call for mates by singing loud, repetitive songs at night. As soon as a female is noticed by the male, it stridulates a courtship song after which the female is accepted by a specific male as mating partner. Probably that makes them better resource finders and/or users, and hence big guys' size is a faithful advertisement of their genes' being high-ish quality. Maybe it's based on size: Bigger males either make a deeper sound or a smaller sound. With females, they can hear and tell the size of a male. Females also employ this sound to determine which males are the most attractive.

Copulation

In crickets, copulation is finished when the male deposits a spermatophore, typically a minute sperm-containing ampulla, left parasitically hanging off the female once it has mated. The flap-like structure at the posterior extremity of female's body that covers the genital chamber opens during copulation. The male torts its body around so the female moves over him for a spermatophore. The inflorescence involves the capsules which bear sperms. About half an hour later the male deposits a large spermatophore which adheres to the female's genital opening.

Oviposition

Female crickets opted to oviposit in organic substrates which were damp. Females laid eggs 2–3 cm deep in the substrate at oviposition with their ovipositors. Under favorable conditions, the house cricket can lay eggs every other week throughout its life. An adult cricket female will lay around 125 eggs per day and around 2195 eggs in a lifetime.

Egg

Females lay eggs in damp soil, laying hundreds of eggs over their lifetime. Eggs of the house cricket, *Acheta domesticus*, are yellowish- white, elongated, translucent and slightly pointed at one end. Eggs are about 2.3±0.1mm in size and take about 13±2 days to hatch at optimal temperatures.

Nymph (Instars)

A nymph or larval form of cricket is more and more closely resembles the adult form. They are wingless and the female is not able to have an ovipositor. Cricket nymphs molt and lose their hard outer shell, or "skin." The interval between each molt stage is referred to as an instar. *Acheta domesticus* have about eight molts from egg to adult (Table 2 & Figure 3).

i. 1st Instar

Translucent, very small in size about 1.97±0.13 mm. Antennae are short in relation to body, Cerci are minimally developed.

ii. 2nd Instar

Slightly larger in size about 3.87±0.25 mm. Body segmentation become more visible. Antennae grow longer, cerci start to lengthen.

iii. 3rd Instar

Grow larger in size about 4.51±0.29 mm. Body and head become more proportional. Antennae grow longer, cerci start to lengthen slightly.

iv. 4th Instar

Larger in size about 6.52±0.50 mm. Legs grow thicker, Antennae grow longer and cerci become more prominent.

v. 5th Instar

Roughly large in size about 9.77±0.62 mm. Wing bud start to form but not easily visible. Antennae grow longer and cerci appear segmented.

vi. 6th Instar

About 11.03±0.59 mm in size, wing bud grows more evident, body begins to show adult like segmentation.

vii. 7th Instar

Medium in size, Wing buds are close to their final size. Cerci and legs resemble adult.

viii. 8th Instar

Approaches to adult size, Wings are fully developed, Cerci, legs and antennae reach to full length.

Adult

Male (♂): Medium-sized, pubescent, moderately convex, Elytra long, extending beyond apex of abdomen, tibia with 6-7 spines.

Females (♀): Usually larger in size than the males. Their color is rufous brown. The veins of the elytra are oblique. Tibia with 5-6 spines, ovipositor long, acute, regular.

Table 2. Measurement of various body parts to distinguish different instars of *Acheta domesticus*

Parameter (mm)	Instar (n=10)								Adult (n=10)	
	1st	2nd	3rd	4th	5th	6th	7th	8th	Male	Female
Length of head	0.58±0.07	0.67±0.09	0.71±0.03	0.94±0.12	1.17±0.06	1.56±0.20	2.15±0.12	3.35±0.31	4.7±0.62	4.3±0.25
Length of pronotum	0.66±0.07	0.75±0.05	0.83±0.06	1.06±0.08	1.25±0.10	1.76±0.13	2.50±0.31	3.65±0.23	5.3±0.62	5.0±0.40
Length of femur	1.46±0.58	1.67±0.06	2.01±0.17	3.42±0.20	4.02±0.25	5.90±0.56	7.15±0.42	9.05±0.35	11.7±0.47	12.1±1.03
Length of cerci	0.71±0.15	0.97±0.12	1.38±0.25	2.66±0.30	3.07±0.21	4.76±0.50	6.10±0.43	7.85±0.23	8.2±0.85	8.3±1.50
Total body length	1.97±0.13	3.87±0.25	4.51±0.29	6.52±0.50	9.77±0.62	11.03±0.59	17.55±0.89	21.55±0.89	24.6±2.5	24.1±1.79

(a). Egg

(b). Newborn/1st Instar

(c). 2nd Instar

(d). 3rd Instar

(e). 4th Instar

(f). 5th Instar

(g). 6th Instar

(h). 7th Instar

(i). 8th Instar

(j). Adult-Female

(k). Adult-Male

Figure 3: Egg, Instars and adults of *Acheta domesticus*

Life cycle duration of *Acheta domesticus*

Samples of 100 crickets were used to calculate average length of each stage (egg, nymph, and adult) of the cricket (Table 11. 3 & Figure 4). At a constant temperature of 25°C, the duration of the egg stage averaged 13±2 days. The cricket nymphs had a development time of 56±5 days with 8 moults before they reached adulthood. On the average, the adult period was 57±3 days but in general from 45 to 60 days, mainly depending on temperature and humidity.

Table 3: Life Cycle Duration across Multiple Generations in *Acheta domesticus*

Generation	***Acheta domesticus*** **Development Time (Days)**
1	55 ± 4
2	57 ± 3
3	58 ± 4
Average	56.7 ± 3.5

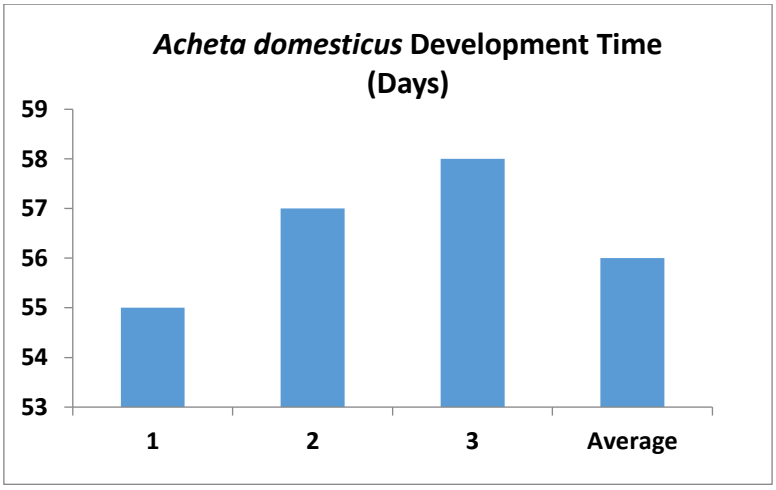

Figure 4: Life Cycle Duration across Multiple Generations in *Acheta domesticus*

Egg production

The sample of female crickets laid an average of 2,195±225 eggs each in their lifetimes, although variation in food availability and temperature conditions caused differences (Table 4 & Figure 5). During the reproductive phase, spanning 3 weeks, egg laying rate of 125±15 eggs/day were recorded. The number was very different among temperature, as crickets at 30°C laid around 25% more eggs than at 22°C.

Survival rates

Under optimal conditions (constant temperature 25°C + 60% humidity) the nymph survival from hatching to adulthood was 70%. Survival sharply decreased under extreme conditions (*e.g.* temperature variations, lack of food), and even under fluctuating conditions survival dropped to 40%. Environmental stress also affectedsurvival of adults. Adult survival was 80% under optimal conditions but only 50% in more extreme conditions.

Table 4: Reproductive Output and Egg Viability in *Acheta domesticus*

Characteristic	*Acheta domesticus*
Average Eggs Laid per Female	125 ± 15
Hatching Rate (%)	85 ± 5
Egg Size (mm)	2.3 ± 0.1
Average Incubation Time (Days)	13 ± 2
Larval Survival Rate (%)	78 ± 6

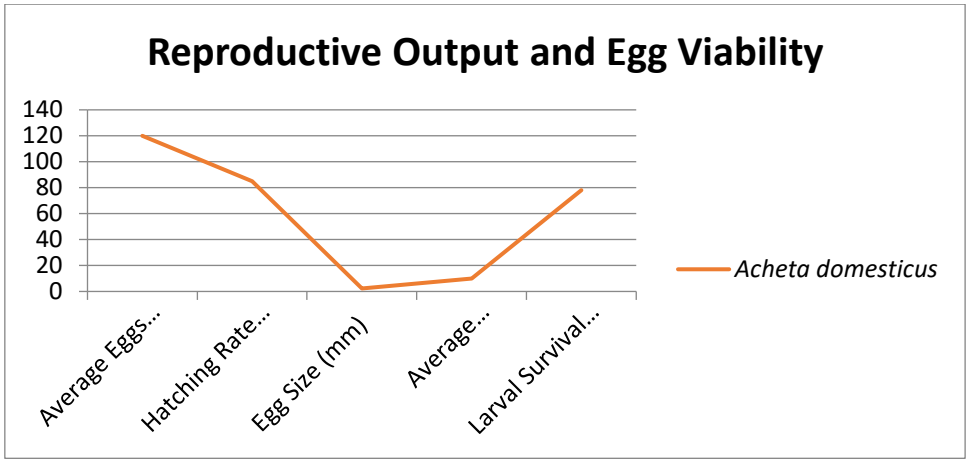

Figure 5: Reproductive Output and Egg Viability in *Acheta domesticus*

Behavioral observations

The number of observed calling males was recorded during mating periods. At night, 75% of adult males called on average, and maximum calling time was in the period between 8 p.m. and 10 p.m. corresponding to higher humidity levels.

Maintenance of adults for breeding

Collections of *Acheta domesticus* were made at monthly intervals from the selected study site to determine changes in the population structure. The crickets were then kept alive in insect rearing net (33×37cm) for group rearing with rolls of corrugated cardboard to provide hiding places. Petri dishes containing moist blotting paper or cotton wool were replaced daily and provided a source of water and a site for oviposition. The ambient temperature of the laboratory was about 25 to 30 ºC. The diet was cabbage, luffa, spinach or mixed diet. (Table 5-6 & Figure 6-7).

Table 5: Reproductive activities of *Acheta domesticus*adults on different host plants

Host plants	Duration of Maturation (Days) (Mean±Sd)	Duration of Pre-Copulatory period (Days) (Mean±Sd)	Duration of copulation (Hrs) (Mean±Sd)	Interval between each mating (Hrs) (Mean±Sd)	Total number of mating (Mean±Sd)
Brasicca oleracea	5.10±0.57	6.60±1.60	5.09±0.89	2.45±1.82	2.30±1.25
Luffa aegyptica	6.50±1.80	5.90±1.37	5.20±3.08	2.40±0.84	3.10±1.17
Oryza sativa	6.89±1.95	6.00±1.33	4.50±2.60	3.20±1.37	2.20±1.62
Spinacia oleracea	6.96±1.36	7.90±1.59	5.10±0.57	2.20±1.62	2.83±1.52
Mixed diet	7.90±1.59	6.96±1.36	9.93±6.25	3.60±1.50	3.50±1.26

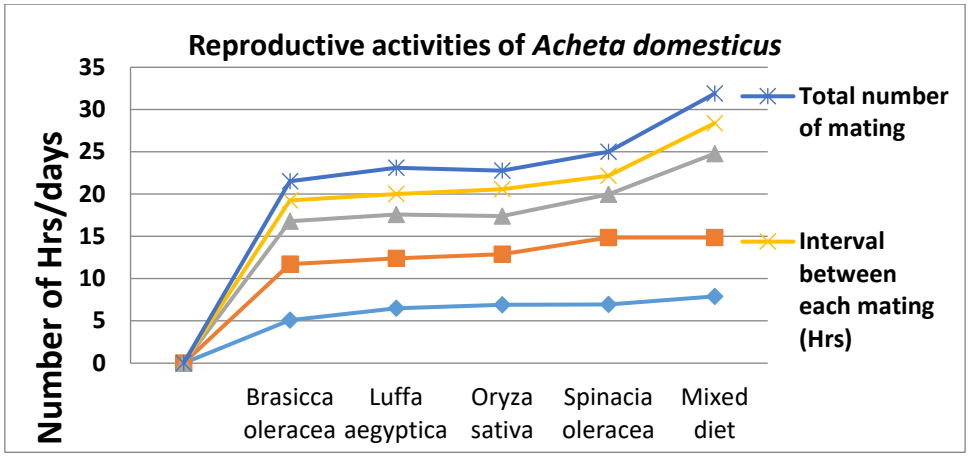

Figure 6: Reproductive activities of *Acheta domesticus*adults on different host plants

Table 6: Comparison between the survival-ship of adults (Male and Female) of *Acheta domesticus*on different host plants

Host plants	Male (Mean±Sd)	Female (Mean±Sd)
Brasicca oleracea	107.1±29.5	102.1±27.3
Luffa aegyptica	103.95±31.7	99.09±37.2
Oryza sativa	91.5±29.3	87.9±32.7
Spinacia oleracea	99.7±27.9	95.7±23.9
Mixed diet	97.1±25.3	92.1±21.87

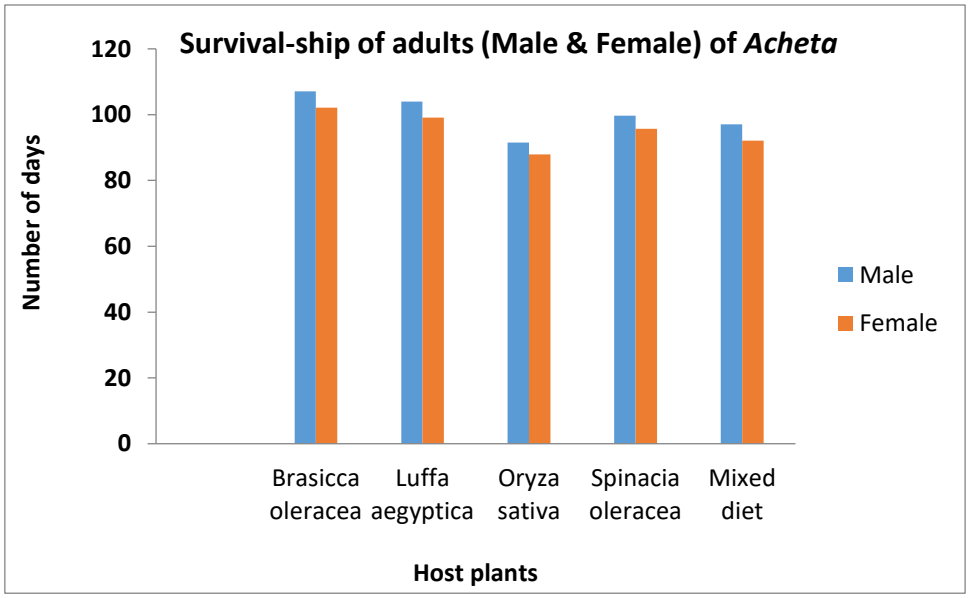

Figure 7: Survival-ship of adults (Male and Female) of *Acheta domesticus*on different host plants

Population density

A. domesticus grows more slowly but continuously, which indicates that this subspecies is adapted to temperate climates where population increases may be occasionally restrained by food scarcity (Table 8 & Figure 9).

Table 8: Population Density Changes Over Time in Simulated Environments

Time (Weeks)	*Acheta domesticus* Population Density (per 10 m²)
Week 1	10 ± 1
Week 4	40 ± 3
Week 8	70 ± 5
Week 12	110 ± 8

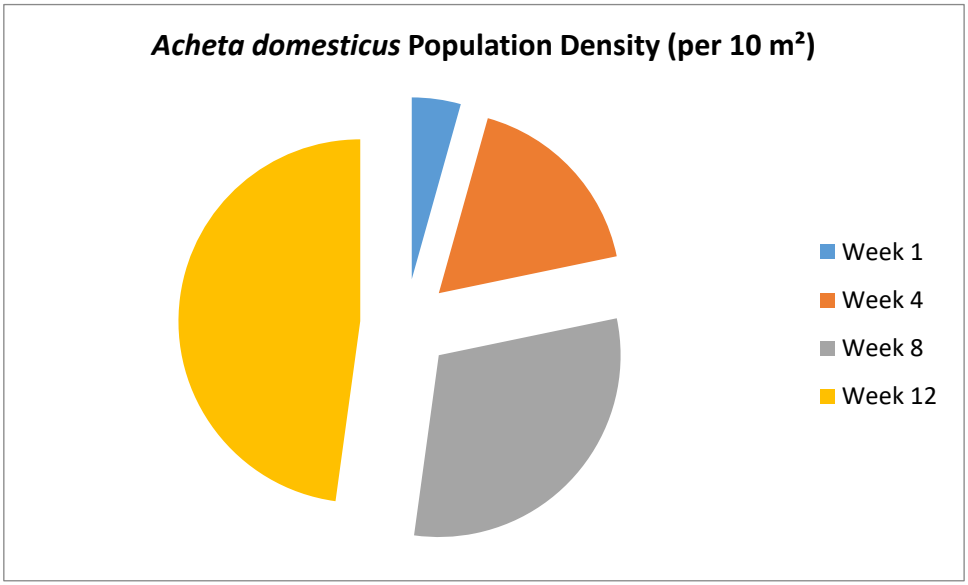

Figure 9: Population Density Changes Over Time in Simulated Environments

Survival period of nymphs and adults

Survival data is integrated across life stages in Table 9. Survival of nymphs at moderate temperatures (25-30°C) averaged 40 days. Survival was very drastically reduced by extreme temperatures (< 15°C or > 35°C), indicating the delicacy of environmental conditions necessary for growth. Mean survival under controlled conditions was 60 days for adult Gryllidae, females surviving approximately six days longer than males. This difference may be caused by reproductive energy demands in females.

Table 9: Survival Period of Nymphs and Adults

Life Stage	Condition	Survival Period (days)	Observation
Nymphs	25-30°C (optimal)	40 ± 5	Highest survival in moderate temperatures.
	< 15°C or > 35°C	< 20	Drastic decline in survival.
Adults	Controlled (30°C, 60%)	60 ± 10	Females outlived males by ~6 days.

Molting process

The key point of molting process in Gryllidae development is presented in Table 10. Under optimal conditions, the time interval between molts averaged 5 days and all observed generations underwent 8 molts. Molting success was almost 95% (60-70%) high humidity, but < 40% low humidity increased failure rates. In addition, these findings highlight the need to sustain vegetation physiologically appropriate to support successfully molting animals.

Table 10: Number of Molts

Parameter	Condition	Observation
Number of Molts	8	Observed across all generations.
Time Between Molts (days)	7 ± 1	Varies with temperature.
Molting Success (%)	95 (60-70% humidity)	Highest in optimal humidity.
	40 (<40% humidity)	Failure rate increases with low humidity.

Environmental tolerance range analysis

The adaptation of *A. domesticus* to a wider range of environment since it can survive in wider temperature range (15-30 ºC). This versatility makes *A. domesticus* have a competitive edge especially in a number of ecosystems across the globe. *G. supplicans* prefer high relative humidity 60-90% and narrow temperature which calls for its ecological niche occupying a tropical stable climate environment (Table 11 & Figure 12).

Table 11: Temperature and Humidity Tolerance in *Acheta domesticus*

Environmental Condition	*Acheta domesticus*(Tolerance)
Temperature (°C)	15 – 30
Humidity (%)	40 – 70
Optimal Light Hours	8 – 12
Activity Level at Peak Temp	Moderate

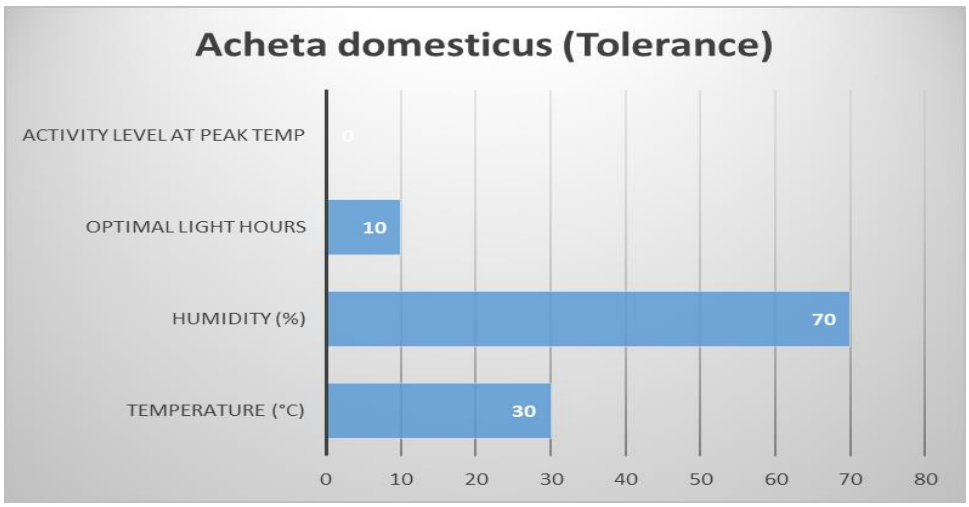

Figure 10: Temperature and Humidity Tolerance in *Acheta domesticus*

Table 12: Comparative data of the reproductive strategies of *Acheta domesticus*

Parameter	Measurement/Observation	Details
Life Cycle Duration	Egg stage duration	13 days (± 2 days)
	Nymph stage duration	56 days (± 5 days)
	Adult stage duration	57 days (± 3 days)
Egg Production	Total number of eggs produced per female	2,195 eggs (± 225) throughout the lifespan
	Average number of eggs laid per day	125 (± 15)eggs per day
	Egg-laying rate at 30°C	25% more eggs than those kept at 22°C
Survival Rates	Nymph survival rate (optimal conditions, 25°C, 60% humidity)	70% survival rate from egg to adult
	Nymph survival rate (stressful conditions)	40% survival rate under fluctuating conditions
	Adult survival rate (optimal conditions)	80% survival rate
	Adult survival rate (stressful conditions)	50% survival rate
Mating Behavior	Male calling frequency (observed during night)	75% of males call during mating period
	Peak calling activity time	8 p.m. - 10 p.m.
	Female preference for males (calling and aggressive behaviors)	Females prefer males with louder and more frequent calls
Oviposition Behavior	Preferred substrate for egg-laying	Moist organic material
	Depth of egg deposition	3 cm deep into substrate
	Environmental influence on oviposition behavior	Preference for moderate moisture, avoiding waterlogged areas
Nymph Behavior	Social behavior in early nymphs	Solitary behavior in early stages
	Social behavior in later nymphs	Small groups in areas with high food availability
	Instar stage solitary behavior	Older nymphs are solitary
Developmental Adaptations	Growth rate at 20°C	Slower growth rate, 1 extra week to reach maturity
	Growth rate at 30°C	Faster growth rate but higher mortality during molting
	Survival rate at 30°C	Lower survival rate during molting at high temperatures

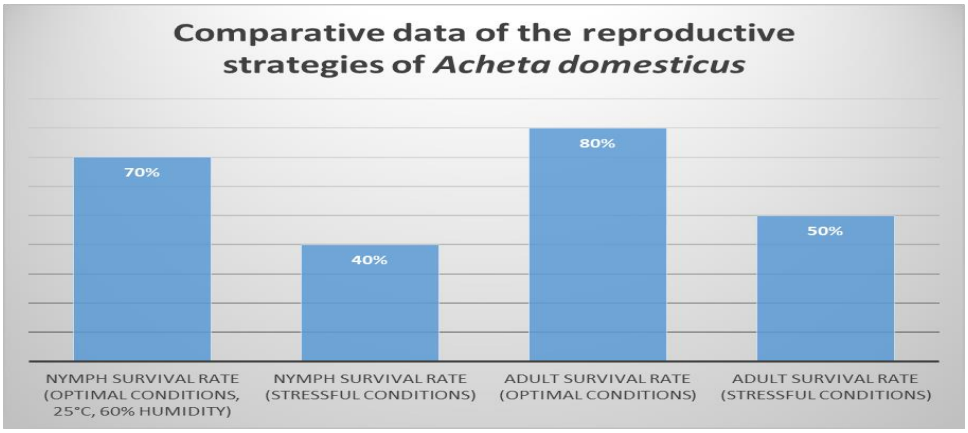

Figure 11: Comparative data of the reproductive strategies of *Acheta domesticus*

Table 13: Distribution of species in various localities of Sindh-Pakistan

LOCALITIES	SPECIES	
	Acheta domesticus **(n=723)**	
	Male	Female
Badin (n=137)	72	65
Mirpurkhas (n=245)	109	136
Tharparkar (n=189)	102	87
Umerkot (n=152)	83	69
Total (n=723)	**366**	**357**
Percentage %	**50.62%**	**49.38%**

Note: Species Distribution Across various localities in Sindh

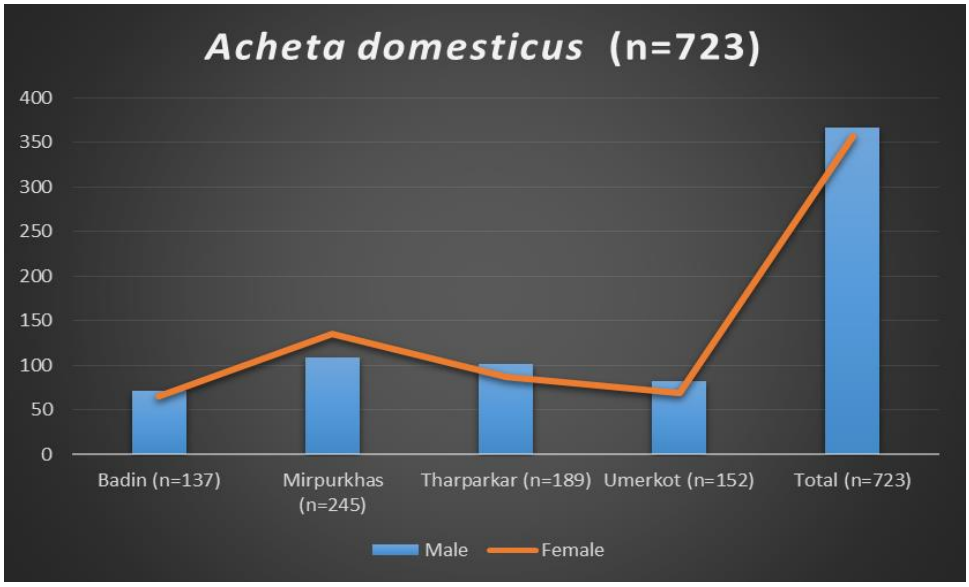

Figure 12: Species Distribution across various localities in Sindh

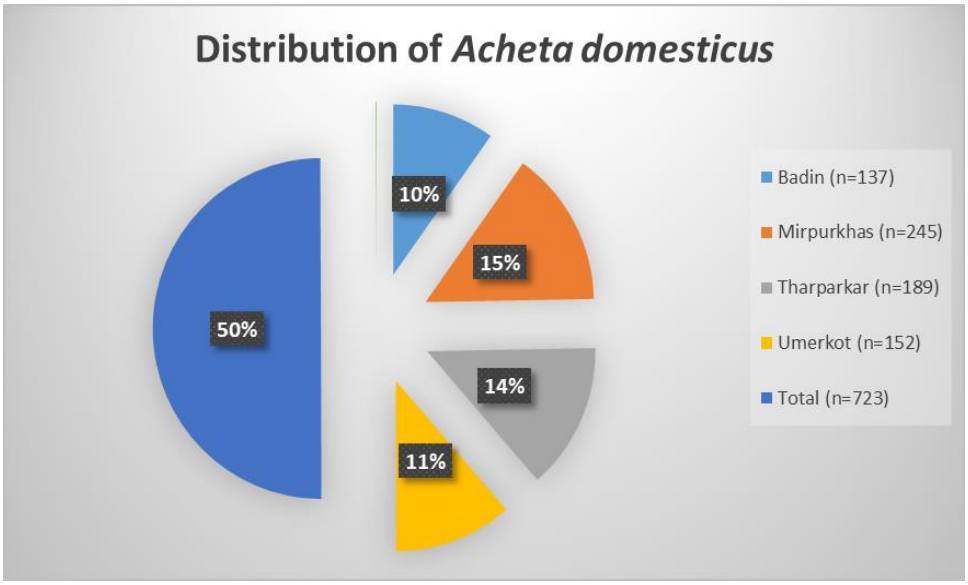

Figure 13: Species percentage across various localities in Sindh

Discussion

The reproductive analysis of cricket species, *Acheta domesticus* allows understanding how various life history characters are influenced by the environmental and functional needs (Tables 12-13 & Figures 11-12-13). This discussion interprets the findings within the physiology and life history of the distinctive species and discusses it with other studies conducted with Gryllidae. Primary distinctions are noticed in terms of ultimate structures, ontogenetic stages, sexual reproduction approaches, eating habits, and acceptability to certain ecological conditions because of the fact that pressures impact the courses of action within the family Gryllidae in different ways. Concerning the variations, it can be noted that *A. domesticus* tend to have a larger size together with longer antennae, which could imply greater range of sensitivity and buffer capacity in different environments (Walker, 1975). Speculates that larger body mass and greater developed sensory organs help in the struggle for existence within the temperate latitudes where the resources can be rather scarce. Moreover, tegmina thickness and structure in *A. domesticus* are favorable for intense acoustic communication. The generational cycles of *A. domesticus* shows the observable responses of the species to their surroundings. *A. domesticus* has a short generation or development time (56 days to maturity), which is advantageous since it enables organisms to mature in areas where seasons constrain food supply and climate. In *Acheta domesticus*, the focus on high fecundity, production of large numbers of eggs, and a relatively short developmental time are all adapted to a rapid growth of population in stable environments. This rapid development may be advantageous in that they may avoid exposure to environmental change Walker & Masaki, (1989) that species from temperate regions have shorter developmental periods. *A. domesticus* is assumed to be following the K-selected strategy where fewer oversized eggs are laid in comparison to eggs laid by r-selected species and these eggs have high rate of survival as the larval mortality rate was recorded to be 22%. This strategy accords with Stearns, (1992) who pointed out that opportunities to reproduce are normally few in such circumstances and so K-selected species major on producing few offspring, but provide each

with appreciable amounts of capital, as is witnessed here given the high resource-based investment made towards each horse.

Conclusion

A comparison of *Acheta domesticus* shows how life history traits have evolved in response to environment specific demands. *A. domesticus* possesses characteristics adapted to the temperate zones, such as accelerated ontogenetic development, high physiological plasticity, and highly plastic feeding behavior. These modifications allow it to persist in highly disturbed, often anthropogenic habitats. The present study highlights the ecological specialization in the evolution of Gryllidae. By considering how each of these species has evolved to maximize its survival and reproduction in each habitat, the results provide important information about the ecology of crickets. These studies provide a deeper understanding of Gryllidae ecology and highlight how life history strategies may help to preserve ecological networks in a wide array of habitats.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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