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ARTICLE

Evaluation of the population dynamics of blowfly *Lucilia purpurascens* using life tables conducted in the field and laboratory under various environmental conditions

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Abstract. The members of the Calliphoridae family (Insecta: Diptera) have a meaningful impact on human and animal health, and they also have forensic significance. The objective of this work was to provide information to the health system (medical-veterinary) about the life cycle of *Lucilia purpurascens* (Walker) (Diptera: Calliphoridae) by obtaining life tables that allow analysing its population fluctuations under various environmental conditions in the field and laboratory. For this aim, three replicates of each experience were generated, each consisting of full oviposition. Throughout all seasons of the year, the daily mortality of individuals, from eggs to adults, has been monitored in the field. This was contrasted with laboratory experiences using average seasonal climate data. Using the gathered information, life tables for both sexes were constructed. Most stages of development differed between the seasons investigated in the field and the laboratory, with Postfeeding Larvae and Pupa exhibiting a greater mortality. In all seasons, feeding larval mortality was extremely low. This study demonstrates that imago populations in nature are less abundant than those obtained by laboratory breeding. Despite this, the larvae are successful while eating, and this is the condition that has the biggest impact on the medical-veterinary environment.

Keywords. Myiasis; Fluctuating temperatures; Constant temperatures; Two sex; Sex ratio.

INTRODUCTION

The predominant insects of veterinary significance are ectoparasites that are connected with the skin, such as flies, lice, and fleas (Taylor *et al.,* 2016). The order Diptera, which includes flies and mosquitoes, has a more significant influence on the health of humans and animals compared to any other group of insects (Gerhardt & Hribar, 2019). At various stages of their life cycle, a wide variety of flies consume the blood, sweat, skin secretions, tears, saliva, urine, or excrement of homeothermic vertebrates, which serves as an attraction for them. These insects have particular veterinary importance for livestock and horses (Taylor *et al.,* 2016).

Myiasis refers to the invasion of the living tissues of vertebrates by the larvae of dipteran insects (Scholl *et al.,* 2019). Notable risk factors include the presence of newly formed open wounds in any part of the body (Forero-Becerra, 2011; Taylor *et al.,* 2016). Myiasis, which has a worldwide distribution (Bollea-Garlatti *et al.,* 2017), is a significant public health and veterinary health concern in developing countries with tropical climates. Its primary victims are impoverished individuals living in both urban and rural areas, as well as their companion animals (Forero-Becerra, 2011). Blowflies, present worldwide, are the primary factors contributing to myiasis. The majority of its larvae exhibit opportunistic feeding behaviour on both living and deceased tissue, leading to facultative myiasis (Taylor *et al.,* 2016; Scholl *et al.,* 2019). Animal production may be adversely affected by primary cutaneous myiasis, as heavy infestations of larvae often render the host more vulnerable to

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predation, disease, or mortality; the larvae may persist in feeding on the carcass (Gabre *et al.,* 2005; Scholl *et al.,* 2019). Calliphorid flies serve as both biological and mechanical vectors for numerous disease infections (Mariluis, 1999; Mariluis & Schnack, 2002; Taylor *et al.,* 2016); they pollinate numerous plants and crops (Scholl *et al.,* 2019); and they benefit humanity by facilitating the estimation of a corpse's time of death for forensic entomology purposes (Oliva, 2001; Centeno *et al.,* 2002; Alves *et al.,* 2014; Gerhardt & Hribar, 2019; Acosta *et al.,* 2022).

Understanding the ecology of populations of species of interest to humans will enable us to manage them successfully (Abou Zied *et al.,* 2003). Estimates of birth, mortality, and lifespan require the observation of population changes over time, even though population structure can be estimated through sampling (Graham *et al.,* 2021; Schowalter, 2006). Adult longevity is an important feature in the history of life that has applications in a variety of fields; for instance, it can provide better knowledge of the overall pattern of reproductive exhaustion among individuals of a certain target species (Graham *et al.,* 2021). The examination of life tables is the most trustworthy way to account for a population's most significant demographic characteristics (Schowalter, 2006). They have been identified as effective and essential tools for analysing and comprehending external influences, such as the impact of temperature on the growth, survival, reproduction, and intrinsic rate of increase of insect populations (Chi & Su, 2006; Chi *et al.,* 2020). Consequently, basic demographic analysis is necessary and indispensable for effective ecological management (Abou Zied *et al.,* 2003; Gabre *et al.,* 2005). Generally, age-specific life tables have been used for insects (Schowalter, 2006). However, this type of life table disregards male insects, varied development rates among individuals, and the several stages of an insect's life cycle (Abou Zied *et al.,* 2003; Gabre *et al.,* 2005; Byrd & Castner, 2010; Chi *et al.,* 2020). The age-stage, two-sex life table provides a comprehensive view of the population dynamics of the species, thereby resolving these issues (Chi *et al.,* 2020). There are few studies on the population dynamics of myiasis-causing organisms (Scholl *et al.,* 2019), such as in Argentina, where there are no regional studies, despite this knowledge being useful for the development of prevention strategies for this disease (Beider *et al.,* 2017). Hence, in order to examine and compare them, it is necessary to obtain data from multiple cohorts that represent distinct birth times, population densities, and environmental circumstances. This enables a comprehensive perspective on the occurrence of birth and mortality across a range of conditions (Schowalter, 2006). There is an observed correlation between geographical latitude and the life cycles of various fly species, with seasonal variations in myiasis. Temperate regions observe their highest incidence during the summer, whereas the tropics and subtropics of Africa and the Americas maintain a year-round high incidence. Their occurrence is greater in the tropical and forested northern regions of Argentina (Bollea-Garlatti *et al.,* 2017).

Lucilia purpurascens, a fly species native to the American continent, is observed ranging in distribution from Costa Rica to Argentina (Whitworth, 2014). Its habitats include both rural and natural areas in Argentina (Acosta *et al.,* 2020). Material from various farms in northern Argentina was submitted to the laboratory of the Instituto para el Estudio de la Biodiversidad de Invertebrados (IEBI) (National University of Salta, Salta, Argentina) for analysis during the summer. The specimens comprised larvae found in the wounds of poultry, cattle, and domestic animals. They were reared in a breeding chamber and identified as larvae of the *L. purpurascens* fly, indicating that this species may be a source of myiasis. A thorough revision of the *Lucilia* genus was undertaken by Whitworth (2014), which revealed that this specific species had been previously classified as part of a complex of species that were masked under the name *Lucilia cluvia* (Walker) (Acosta *et al.,* 2020). Therefore, studies that were carried out on *L. purpurascens* prior to 2014 (Mariluis, 1982; Mariluis, 1989; Mariluis *et al.,* 1994; Amat *et al.,* 2008) referred to it as *Phaenicia purpurescens, Phaenicia peruviana,* and *Lucilia peruviana,* respectively, are questionable and probably based on misidentification, as acknowledged by the authors (Mariluis & Schnack, 2002). Prior to the specified date in question, academic debate had already started regarding this genus (Mariluis *et al.,* 1994; Oliva, 2001). An analysis of the collection sites linked to those works offers additional evidence in favour of this idea, as the vast majority of them do not correspond to the current distribution of this species, which is comparable to the Yungas ecoregion as determined by more recent research (Acosta *et al.,* 2020). The existing literature (Acosta *et al.,* 2020; Acosta *et al.,* 2021a; Acosta *et al.,* 2021b; Acosta *et al.,* 2022) is insufficient to comprehensively evaluate the range and activity capacity of this specific species in that region. The aim of this work was therefore to obtain life tables that enable the analysis of the population fluctuations in *L. purpurascens* under different environmental conditions in the field and laboratory, therefore supplying information on the life cycle of this species to the medical-veterinary system. Native populations of *L. purpurascens* are thought to have adapted to the variable environmental and climatic conditions of rainforests, such as those found in northern Argentina. Based on this, we could hypothesise that the hatchling survival of these species would differ between controlled and stable laboratory environments and their natural habitat. Laboratory-reared populations ought to exhibit a greater ratio of survival to wild populations throughout all phases of development.

MATERIAL AND METHODS

Obtaining stocks

In La Caldera, Salta province, Argentina (24°35′57″S, 65°22′22″W), female specimens of *L. purpurascens* were collected in their natural habitat. Active captures were achieved by employing an entomological network and

fresh bovine liver. Female metallic body flies were visually identified in the field by transferring them into transparent containers. Following this, each female was positioned in an aluminium foil package that contained fresh liver, which was put in polyethylene cups that were secured with elastic bands and fine mesh cloth. To promote oviposition, the cups were positioned at a temperature of 22°C within a breeding chamber (INGELAB-I-501PF, Buenos Aires, Argentina). Following freezing to death at −18°C, the mothers were identified using the keys proposed by Buck *et al.* (2009), Vargas & Wood (2010), and Whitworth (2014) under a binocular microscope (Motic-SMZ-171, Hong Kong, China).

In each experiment, three repetitions were employed, and each replicate consisted of a single female depositing eggs ranging from 50 to 143 within an hour of bait exposure. The eggs were submerged in 0.1 M NaOH for a duration of 10 minutes in order to separate them and perform the initial cohort count (Fig. 1A). The eggs were not subjected to the temperature of each experiment since they are extremely sensitive to manipulation in the laboratory, causing many of their layings to be inviable and making it impossible to discriminate between the effects of the treatment and those induced by stress.

Establishment of progeny and data collection

Every culture grew in a plastic container measuring 21 × 13 × 8 cm, fitted with a fine mesh textile cover to enhance air circulation. A rectangular bovine liver fillet, encased in aluminium and with a thickness of approximately 2 cm, had been placed within the container (Fig. 1B). A 3 cm stratum of sterilised soil, which had been heated to 180°C, was introduced into the container as soon as the larvae commenced to wander. After the pupation process had begun, the pupae were transferred to a new container measuring 28 × 17 × 6 cm, which featured 12 concavities and was covered with a thin mesh fabric (Fig. 1C). Every concavity was filled with three centimetres of soil. Consequently, every recently formed pupa was inserted into a concavity bearing the push date. After reaching maturity, the adults were relocated to entomological cages measuring 40 × 30 × 30 cm and featuring mosquito-net walls. They were provided with a 50:50 mixture of sugar and milk powder, in addition to cotton wool that had been soaked in water. For the purpose of assessing fertility, once per week following one week of adult births, they were administered fresh bovine liver to induce oviposition.

Observations were made of the development of the larvae every hour following lay. Daily morning inspections were performed to document the quantity of viable and non-viable individuals from the moment the initial larva emerged until the final adult fly perished. Pupas were deemed deceased following the completion of the maximum period (in days) for adult emergence among the three replicates, as it is unfeasible to ascertain their demise solely through observation.

Experimental design

Under field environmental conditions (fluctuating temperatures) and laboratory environmental conditions (constant temperatures), cultures were subjected to experiments. Thus, an experiment was conducted for each season under each of the two environmental conditions so that comparisons could be made.

Field cultures: These were conducted on the National Universidad Nacional de Salta property in the autumn (Autumn Field), spring (Spring Field), and summer (Summer Field) of 2018. Since *L. purpurascens* does not reproduce throughout the winter, so it is impossible to cultivate field cultures during this season (Acosta *et al.,* 2020). To prevent the attack of scavenging animals, the cultures were conducted in entomological cages placed within a barbed and protected perimeter. This enclosure has a clear plastic roof and a black half-shade fabric underneath to protect against intense sunlight and precipitation. The entire frame was exposed directly to the external environment, and the climatic variables of temperature, humidity, and light were measured *in situ* for the duration of each experiment. Temperature and humidity were recorded every 30 minutes using a data logger (CEM-DT-171, Shenzhen, China), and light was measured every 60 seconds with a luxometer equipped

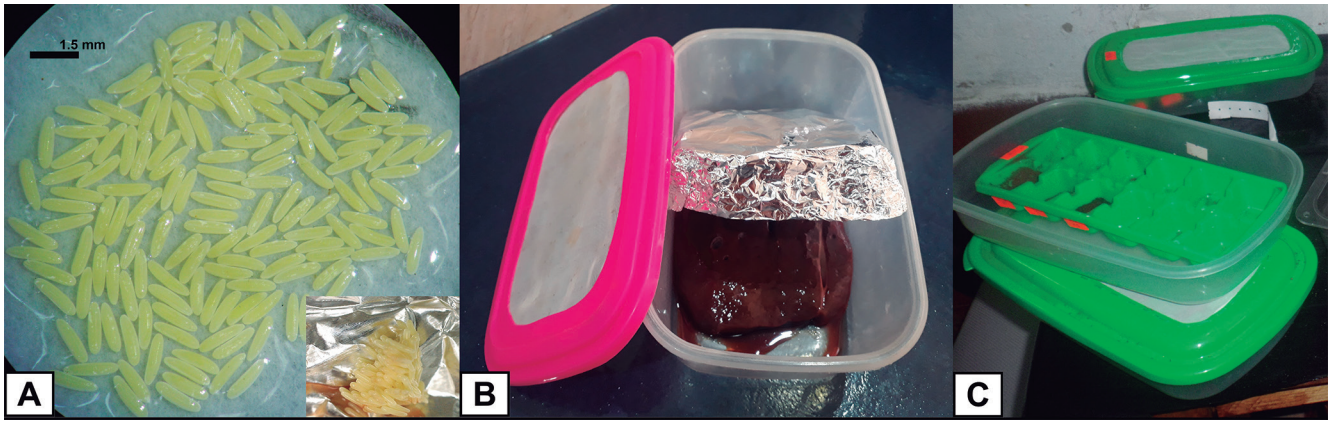

Figure 1. Various phases of the life cycle: (A) determining the number of eggs produced by a single oviposition. (B) Individual cultivation during the feeding larval stage. (C) Culture in the pupal stage.

with a data logger (CEM-DT-8809-A, Shenzhen, China). To have a parameter of the extreme environmental circumstances that could be restricting the activity of this species throughout the winter and to organise the laboratory experiment, data on these variables were collected for this season.

Laboratory cultures: During each season, specimens were collected to obtain ovipositions, and cultures were conducted in the breeding chamber in 2018 and 2019. This was calibrated using the average daily values of the variables recorded in the field, utilising the temperature, humidity, photoperiod, and lux data that characterise and depict the many phenological seasons throughout the year: Autumn (Autumn Laboratory): 13.4°C, 74.9%, 1035:1325 h (L:O) and 1916 lux; Winter (Winter Laboratory): 15.1°C, 63.4%, 1052:1308 h (L:O) and 2292 lux; Spring (Spring Laboratory): 23.6°C, 69.9%, 1315:1045 h (L:O) and 2276 lux; and Summer (Summer Laboratory): 22.3°C, 76.0%, 1225:1135 h (L:O) and 1985 lux.

Data Analysis

Based on the age-stage, two-sex life table theory (Chi & Liu, 1985) and the approach given by Chi (1988), the data were analysed using the TWO-SEX-MSChart programme (Chi, 2012). For each replicate, a comprehensive life table analysis was obtained. Due to the vast quantity of data acquired, a suitable selection was made; hence, graphs for age-stage survival rate (S matrix), development transition probability (D matrix), and age-stage distribution of death (P matrix) are given for each season. Since an average of the graphs of the three replicates cannot be calculated and the TWO-SEX-MSChart programme only examines a single population, each graph displayed relates to a randomly chosen replication. Alternatively, Multivariate Analysis of Variance (MANOVA) was performed on days with life, specific survival rate, and distribution of mortality by instar/stage to determine if there were any differences between conditions (field and laboratory) based on the rest of the previously collected data. Using SPSS version 25 (IBM, 2017) and a significance level of $P < 0.05$, these MANOVAs were conducted. When a MANOVA revealed a significant combination effect, Tukey's honestly significant difference (HSD) was employed to examine pairwise differences. Given that the adult survival rate is zero, as this is the final stage of development, this value is displayed while transitioning from pupa to female and from pupa to male. Similarly, the proportion of sexes for each season studied was evaluated, and to conduct a more in-depth analysis, the frac-

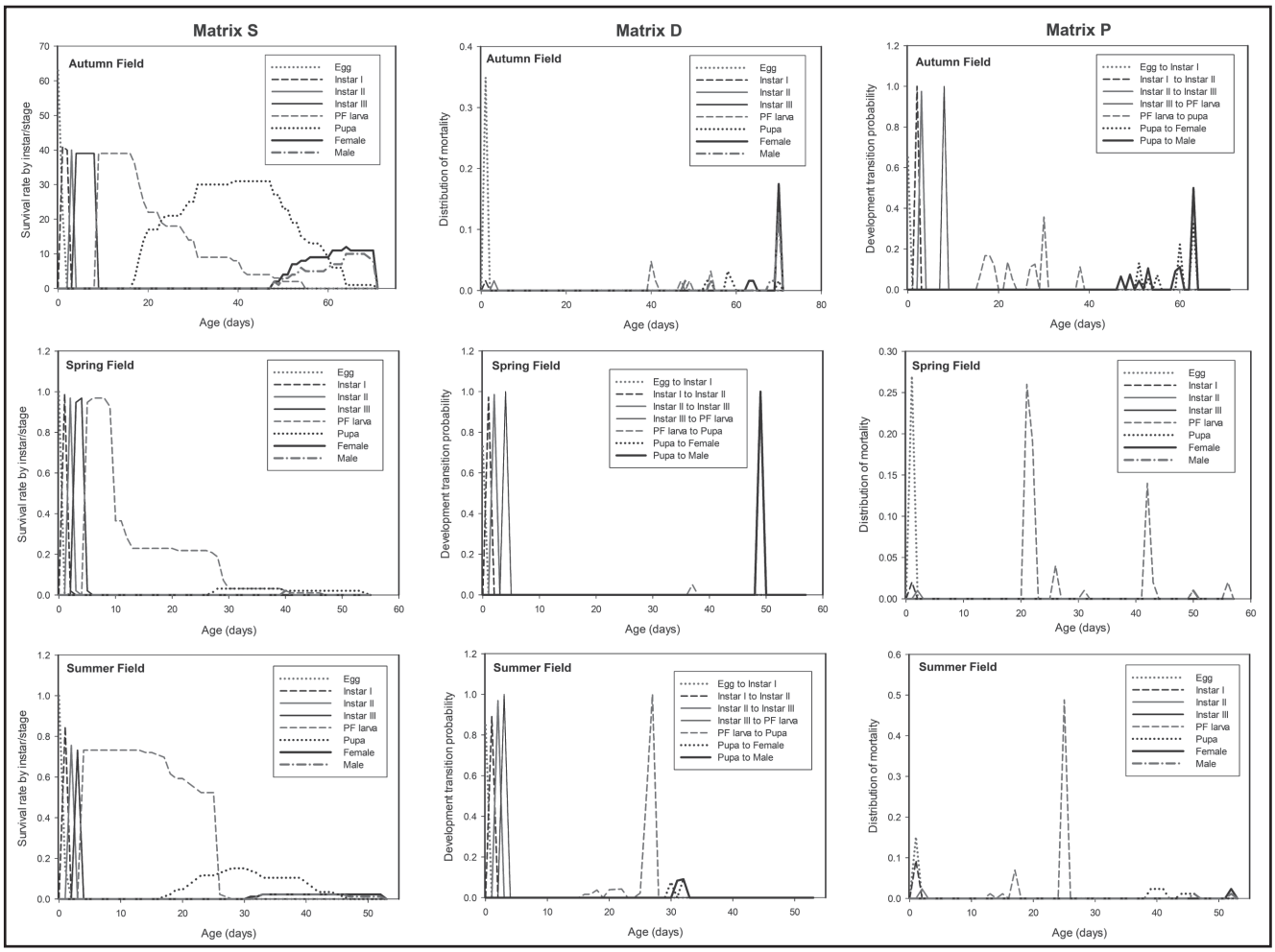

Figure 2. Graphs for all field seasons studied depict the age-stage survival rate (matrix S), development transition probability (matrix D), and age-stage mortality distribution (matrix P).

Table 1. Days alive of each instar/stage of development, also considering each sex and the total cycle for *Lucilia purpurascens* in each season analyzed. Different letters within the same column indicate statistically significant differences (P < 0.05, Tukey's test). n = 3 for all depicted means.

Seasons	Days Alive																			
	Egg		I Instar		II Instar		III Instar		PF Larva		Pupa		Adult		Female Adult		Male Adult		Egg to Adult	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Autumn field	1.00a	0	2.00a	0	1.00a	0	5.00a	0	18.08abc	4.07	33.21a	0.64	7.62a	5.60	6.74a	5.41	8.41a	6.24	66.24a	4.11
Spring field	1.00a	0	1.05b	0.06	1.00a	0	2.00b	0	28.68b	3.85	11.53b	0.81	5.97a	8.60	4.81a	6.60	24.00a	0	51.00bd	10.00
Summer field	1.00a	0	1.00b	0	1.00a	0	1.00c	0	21.27abc	3.83	15.33c	1.26	8.66a	9.17	7.06a	9.08	9.60a	9.89	50.88bd	2.39
Autumn laboratory	1.00a	0	2.00a	0	1.00a	0	3.00d	0	25.09abc	11.23	26.23d	1.25	11.24a	3.83	12.04a	3.50	10.75a	3.73	66.53a	0.63
Winter laboratory	1.00a	0	1.50a	0.71	1.50b	0.71	2.00b	0	23.15bc	2.11	15.63c	0.64	12.22a	0.58	11.52a	0.18	12.85a	1.25	57.12ad	0.77
Spring laboratory	1.00a	0	1.00b	0	0.50a	0	1.00c	0	11.18ab	1.67	9.11b	0.34	15.28a	1.49	14.51a	1.25	16.26a	2.25	39.12bc	0.92
Summer laboratory	1.00a	0	1.00b	0	1.00a	0	1.00c	0	9.83a	1.90	9.29b	0.17	11.93a	1.61	10.9a	0.77	12.92a	2.59	34.33c	2.37

Table 2. Specific survival rate for each instar/stage of development and from pupa to male or female for *Lucilia purpurascens* for each season evaluated. Different letters within the same column indicate statistically significant differences (P < 0.05, Tukey's test). n = 3 for all depicted means.

Seasons	Specific Survival Rate															
	Egg		I Instar		II Instar		III Instar		PF Larva		Pupa		Pupa to Female		Pupa to Male	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Autumn field	0.66a	0.25	0.91a	0.06	0.95a	0.05	0.97a	0.03	0.54a	0.24	0.60a	0.18	0.33a	0.12	0.28a	0.13
Spring field	0.91a	0.15	0.99a	0.02	0.98a	0.01	0.99a	0.01	0.09b	0.12	0.64a	0.32	0.05b	0.09	0.59a	0.36
Summer field	0.93a	0.76	0.95a	0.06	0.99a	0.02	1.00a	0	0.16b	0.06	0.46a	0.19	0.31ab	0.18	0.15a	0.03
Autumn laboratory	0.95a	0.02	0.96a	0.05	0.98a	0.02	1.00a	0	1.00c	0	0.83a	0.27	0.47a	0.09	0.35a	0.18
Winter laboratory	0.67a	0.13	1.00a	0	0.98a	0.01	1.00a	0	0.98c	0.01	0.98a	0.02	0.51a	0.25	0.47a	0.02
Spring laboratory	0.88a	0.19	0.99a	0.01	0.99a	0.01	1.00a	0	0.87c	0.11	0.73a	0.20	0.36a	0.04	0.38a	0.19
Summer laboratory	0.98a	0.03	0.98a	0.01	0.99a	0.01	0.99a	0.01	0.97c	0.13	0.85a	0.07	0.42a	0.04	0.44a	0.04

tion of "Unknown", which refers to individuals that died before reaching the adult stage, was taken into account.

RESULTS

As was previously documented, the absence of ovipositions prevented the acquisition of fertility results in all laboratory and field investigations. This indicates that the precise laboratory conditions that facilitate the reproduction of this native fly species remain undetermined.

The MANOVAs showed that there were statistically significant differences in the number of days with life (developmental time) (F = 59.76, d.f. = 78, P = 0), the specific survival rate (F = 2.04, d.f. = 48, P = 0.003), the distribution of mortality (F = 2.34, d.f. = 48, P = 0.003), and the proportion of sex (F = 34.97, d.f. = 12, P = 0.028).

Days with life (Development Time)

Table 1 shows the differences between the I Instar (F = 14.47, d.f. = 6, P = 0), the II Instar (F = 7.25, d.f. = 6, P = 0.001), the III Instar (F = 7.94, d.f. = 6, P = 0), the post-feeding larva (PF larva) (F = 5.73, d.f. = 6, P = 0.003), the Pupa (F = 306.97, d.f. = 6, P = 0), and the Egg to Adult (complete cycle; F = 24.79, d.f. = 6, P = 0). In general, the development time increases as the temperature of the culture rises. The development time from egg to adult was longer in the autumn under natural conditions and shorter in the summer and spring in the laboratory. However, the PF larva exhibits a unique dynamic, exhibiting a shorter development time at lower temperatures (Autumn Field) compared to high temperatures (Spring Field). Experiments in the laboratory, on the other hand, have demonstrated that the development time invariably lowers as the temperature rises.

Specific Survival Rate

Concerning the specific survival rate by instar/stage between seasons, only the PF larva (F = 306.97, d.f. = 6, P = 0) and the transition from Pupa to Female (F = 7.12, d.f. = 6, P = 0.001) differed (Table 2). Survival of PF larva was reduced in field studies, particularly in Spring Field and Summer Field, and the probability of developing into a female was extremely low in Spring Field. Analysing the graphs of the field survival rate (Matrix S, Fig. 2) and laboratory survival rate (Matrix S, Fig. 3) together reveals that the feeding stages (I Instar, II Instar, and III Instar) had the greatest survival and the quickest development during the *L. purpurascens* life cycle. Similarly, examining the graph of the probability of transitioning from one stage/state to another under field conditions (Matrix D, Fig. 2) and laboratory conditions (Matrix D, Fig. 3) reveals a very low value during the transition from PF larva to Pupa or from Pupa to Adult (female or male), with this likelihood of transition significantly lower in the warm seasons compared to the cold seasons. During these stages of the species' life cycle, we observed a population decline, particularly among adults at the end of the cycle, which was more noticeable in natural environmental conditions.

Table 3. Mortality distribution by instar/stage of development for adult female and male *Lucilia purpurascens* during each season studied. Different letters within the same column indicate statistically significant differences (P < 0.05, Tukey's test). n = 3 for all depicted means.

Distribution of Mortality																
Seasons	Egg		I Instar		II Instar		III Instar		PF Larva		Pupa		Adult Female		Adult Male	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Autumn field	0.34a	0.25	0.06a	0.04	0.02a	0.14	0.01a	0.01	0.27a	0.22	0.09a	0.03	0.10ac	0.09	0.09ab	0.09
Spring field	0.09a	0.02	0.007a	0.01	0.02a	0.01	0.003a	0.006	0.78b	0.12	0.04a	0.05	0.01a	0.02	0.04a	0.04
Summer field	0.07a	0.08	0.05a	0.05	0.07a	0.01	0a	0	0.73b	0.14	0.08a	0.04	0.04a	0.02	0.02a	0
Autumn laboratory	0.05a	0.02	0.04a	0.05	0.02a	0.02	0a	0	0a	0	0.16a	0.24	0.42b	0.07	0.31bc	0.16
Winter laboratory	0.33a	0.13	0a	0	0.01a	0.01	0a	0	0.01a	0.01	0.01a	0.02	0.33b	0.06	0.30bc	0.05
Spring laboratory	0.12a	0.19	0.003a	0.006	0.003a	0.006	0a	0	0.10a	0.09	0.21a	0.17	0.28bc	0.11	0.28abc	0.15
Summer laboratory	0.02a	0.03	0.007a	0.01	0.003a	0.005	0.006a	0.005	0.02a	0.03	0.14a	0.56	0.39b	0.05	0.39c	0.04

Table 4. Sex ratio incorporating unknown individuals at each season analysed for *Lucilia purpurascens.* Different letters in the same column indicate differences of statistical significance (Tukey's test, P < 0.05). n = 3 for all depicted means.

Sex Ratio														
Sex	Autumn field		Spring field		Summer field		Autumn laboratory		Winter laboratory		Spring laboratory		Summer laboratory	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Hembra	6.33a	5.77	1.00a	1.73	4.00a	2.64	36.67a	4.04	25.67a	0.58	23.67a	16.74	42.33a	14.15
Macho	6.00a	5.57	3.33a	3.21	2.00a	1.00	25.67a	8.39	23.33a	2.52	24.67a	19.14	18.67a	15.01
Unknown	48.33b	9.61	89.67b	12.10	90.67b	35.80	28.00a	30.41	29.33a	11.72	31.33a	12.01	35.11a	6.11

Distribution of Mortality

Statistically significant differences were identified in the seasonal distribution of mortality by instar/stage for PF larva (F = 26.23, d.f. = 6, P = 0), adult Female (F = 19.57, d.f. = 6, P = 0), and adult Male (F = 7.99, d.f. = 6, P = 0.001) (Table 3). Post-feeding larva mortality was extremely high in spring and summer under natural conditions; under laboratory conditions, mortality was higher for females during the cold seasons (autumn and winter), whilst males were more susceptible to death during the warm seasons (spring and summer) (Matrix P, Fig. 3).

Sexual ratio

There is no variation between the proportions of males and females in any season. By including the unknown individuals, the proportions across seasons remain equal under laboratory conditions. However, field cultures exhibited statistically significant variations in the autumn (F = 34.05, d.f. = 2, P = 0.001), spring (F = 143.93, d.f. = 2, P = 0), and summer (F = 17.89, d.f. = 2, P = 0.003), with a clear distinction with unknown individuals (Table 4).

DISCUSSION

This is the first study to use life tables to examine the population parameters of *L. purpurascens.* As insects progress through several stages of development, the duration of each stage varies depending on the species and environmental conditions encountered by the insect. It is probable that additional population parameters, including survival and life expectancy, will also experience an influence (Chen *et al.,* 2017; Byrd & Castner, 2010). Regarding the days with life, a discernible pattern emerges wherein the warm seasons (spring and summer field-laboratory) are distinguished from the cold seasons (autumn and winter field-laboratory), wherein the duration of development for each instar/stage diminishes with increasing temperatures and vice versa. This finding is consistent with the conclusions drawn by prior researchers (Acosta *et al.,* 2021; Acosta *et al.,* 2022; Byrd & Castner, 2010; Chen *et al.,* 2017). Following the observations of Gabre *et al.* (2005) and Graham *et al.* (2021), the full cycle (from egg to adult) of *L. purpurascens* varies seasonally, but the lifespan of adults, regardless of sex, does not alter appreciably. However, they differ from other *Lucilia* species, such as *Lucilia cuprina* (Wiedemann) (Abou Zied *et al.,* 2003; Hasan, 2017) and *Lucilia sericata* (Meigen) (Abou Zied *et al.,* 2003; Rueda *et al.,* 2010), in that the females live longer. The most important agents of primary myiasis are the last two species (Taylor *et al.,* 2016; Mariluis, 1999), which inhabit predominantly human-altered ecosystems (Mariluis, 1999; Mariluis & Schnack, 2002). Even within the same genus, these findings support the notion of a high degree of adaptability in the population dynamics of different species.

In conjunction with the mortality distribution, the specific survival rate is examined. In this way, it is apparent that one of the greatest threats to the survival of this species mostly affects the post-feeding larva and the pupa; that is, when the larva leaves the substrate and must find a new refuge to continue its development. The majority of previous studies (Alvarez-Garcia *et al.,* 2017; Arias-Di Donato & Liria, 2016; Gabre *et al.,* 2005; Hadura *et al.,* 2018; Pérez *et al.,* 2016) do not regard the PF larva as a stage, and analyses of the pupa are limited. However, these studies depict a continuous decline in survival from egg to adult, irrespective of the temperature at which they were raised, a pattern that the current investigation did not detect.

During the spring field experiment, the survival rate of PF larvae was extremely low, which would explain why the greater number of *L. purpurascens* in nature is concentrated at the end of summer, even though the two seasons do not experience large temperature fluctuations. This could be due to the fact that the region's highest temperatures occur in the spring and not the summer, causing a significant population decline during that season (Acosta *et al.,* 2020). This suggestion would be based on the idea that desiccation is deleterious to the survival of larvae (Scholl *et al.,* 2019).

In terms of the sex ratio, equality between males and females remains constant throughout the year. However, under laboratory conditions, the proportions remain equitable despite the inclusion of unknown individuals in the analysis, in contrast to field experiments in which these individuals display a significantly greater proportion. Even in extreme circumstances (such as Autumn Field), where the number of recovered adults is low (8 individuals) and the number of unidentified individuals is considerable (57 individuals), this equality between males and females is maintained. Several laboratory studies on calliphorid flies have reported an identical proportion of sexes (Gabre *et al.,* 2005; Graham *et al.,* 2021; Hadura *et al.,* 2018; Hasan, 2017; Pérez *et al.,* 2016), but this study validates it for natural conditions.

Having correct climate data is of the utmost relevance for applied branches that study insects (Byrd &

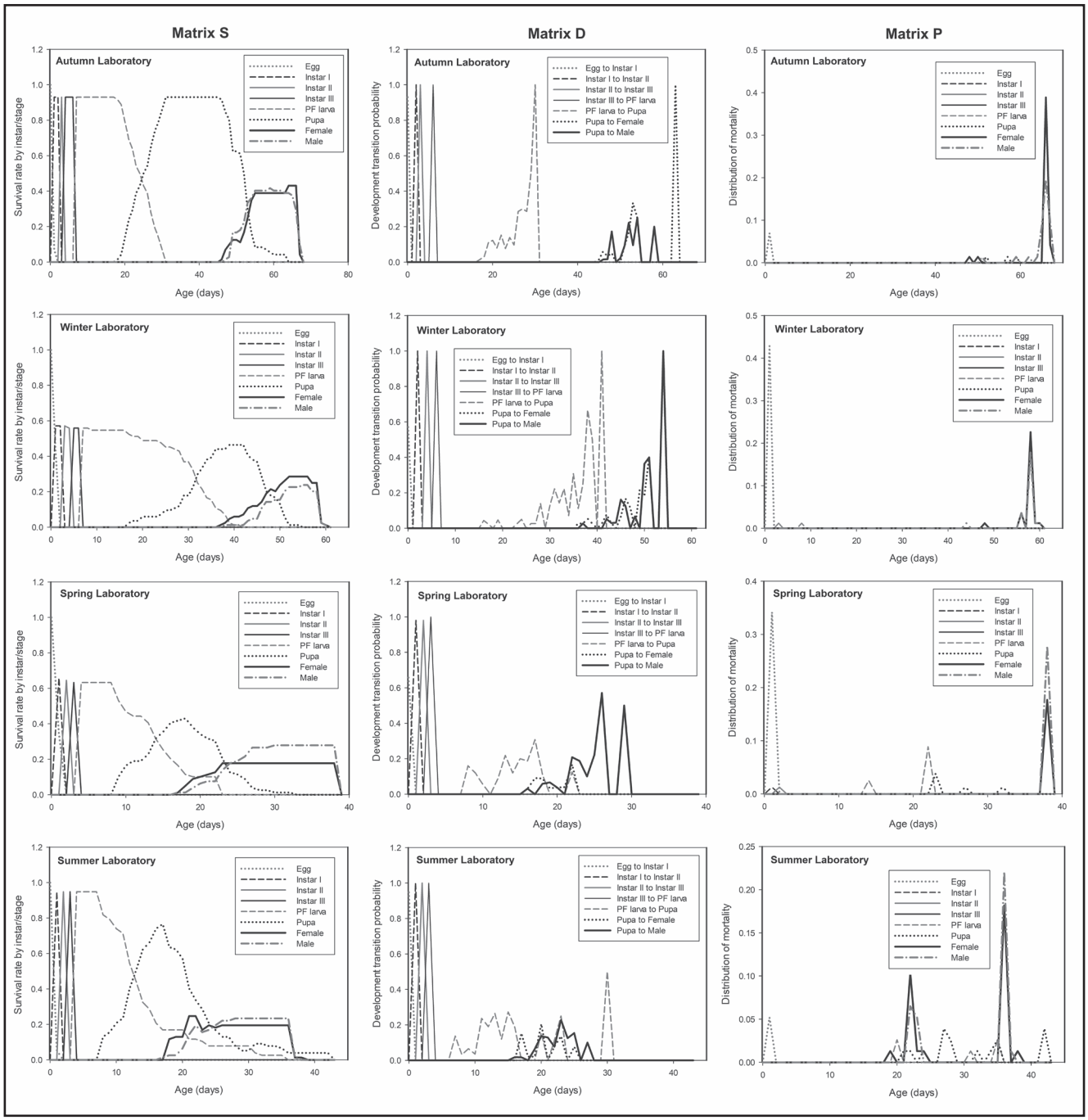

Figure 3. Graphs illustrating the age-stage survival rate (matrix S), development transition probability (matrix D), and age-stage mortality distribution (matrix P) for all seasons tested in the laboratory.

Castner, 2010), as it enables researchers to comprehend the effects of climatic fluctuation on their populations and hence forecast the activity and population density of insects that are crop pests, disease vectors, and myiasis drivers (Chen *et al.,* 2017; Speight *et al.,* 2008). The work by Acosta *et al.* (2022) already demonstrates that the development of *L. purpurascens* differs when grown in different environmental conditions (field vs. laboratory). Nonetheless, in agreement with Gabre *et al.* (2005), life-to-field table studies are more challenging to undertake than laboratory experiments. This study confirms the existence of a distinct dynamic in the development of *L. purpurascens* under fluctuating natural conditions relative to laboratory constants by addressing both analyses concurrently.

In this approach, the high mortality of the post-food states demonstrates that population abundances in nature are significantly suboptimal, particularly if the imago is emphasized. This leads one to believe that the three feeding larval stages pose the greatest problem in the formation of myiasis by *L. purpurascens,* not the adult, whose survival rate is not significantly different from the ideal. Regardless of species, the larvae of these stages of flies are the true medical-veterinary concern, as they are the ones that feed most efficiently on animals' living tissues (Forero-Becerra, 2011). During this parasitic phase of the life cycle, food, humidity, and temperature restrictions are mostly irrelevant, as the host provides the necessary circumstances for survival (Scholl *et al.,* 2019).

An Argentine study reveals that 80 percent of agricultural producers consider myiasis a serious health concern, and more than 90 percent of their establishments have documented cases of the disease, most of which resulted in fatal outcomes. Despite the use of doramectin and ivermectin for prevention and control, the larvae exhibit a high and growing resistance to these drugs. Therefore, the costs associated with this disease exceed six billion Argentine pesos, making the development of strategies to mitigate the effects of this parasitosis a priority for Argentina (INTA, 2022). Lack of awareness of the native species that cause myiasis leads to misdiagnosis and improper treatment. Most nations lack sufficient information on the occurrence and effects of myiasis, making it a potentially neglected disease (Forero-Becerra, 2011). The impact on wild animals is also severe, and they could serve as the primary source of *L. purpurascens* infection. They are of particular concern because they serve as key reservoirs that are not under human control (Forero-Becerra, 2011). Myiasis primarily affects the underprivileged population, neglected domestic animals, and undernourished wild animals, making research into this illness crucial and necessary.

CONCLUSION

The viability of adult *L. purpurascens* is considerably diminished in the wild compared to laboratory conditions where the environment is more stable. Despite encountering various climatic conditions, it is notable that the feeding larval stage of *L. purpurascens* maintains an exceptionally high survival rate. This implies that myiasis could happen unimpeded at this stage. Myiasis is categorised as a neglected disease on account of the paucity of knowledge regarding its preventative and therapeutic strategies. At present, information used for control purposes has been in use for centuries; this information is neither secure nor effective. Our findings would be beneficial in facilitating the implementation of more precise measures to regulate this infection.

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