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Bioecological aspects of *Sepedon maculifemur* (Diptera: Sciomyzidae), a predator of mollusc vectors of distomatosis in the Zou department of Benin (West Africa)

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Abstract

Sciomyzidae dipterans are attracting growing interest in the context of alternative strategies for controlling mollusc vectors of parasites. In Benin, *Sepedon maculifemur*, a poorly documented species whose biology and predatory efficiency remain largely unknown, could play a role in mollusc population regulation. The general aim of this study is to characterize the development cycle of *S. maculifemur* under laboratory conditions and to evaluate its predatory performance on various mollusc prey. To achieve this adults were captured in the field and reared in the laboratory to obtain eggs, larvae and pupae. Morphological observations are made at each developmental stage. Five mollusc species were used as experimental prey to measure larval predatory performance. Data were analyzed using advanced statistical models, including penalized logistic regression (Firth) and LASSO models, with graphical representation in R (version 4.3.2).

The results show that *S. maculifemur* completes its development cycle in laboratory, with a high hatching rate (75.65%) and larval survival dependent on mollusc species. *Bulinus globosus* is identified as the most favorable prey, serving as a comparative basis in the analyses. Larval survival probabilities were significantly reduced (25 times less) with other species such as *Subulina octona* (OR = 0.04). Analysis of combined effects of larval stage, species and prey size reveal a significant interaction, highlighting a progressive trophic adaptation during larval development.

This study provides new data on the biology of *S. maculifemur* and confirms its malacophagous potential with regard to molluscs of medical interest. These results lay the foundations for the future development of this species as a biological control agent in bilharzia-endemic areas. Further investigations are required to confirm its ecological significance.

Keywords: Predaroty fly, Malacophagy, Biocontrol, Bilharzia, Gastropod, Benin

Introduction

Sciomyzidae, also known as "snail-killing flies", are a family of Diptera mainly associated with wetlands, where they play a crucial ecological role in the natural regulation of mollusc populations. Widely distributed throughout the world, these insects are particularly present in habitats rich in low vegetation, in the immediate vicinity of water bodies, where their prey - mainly aquatic or terrestrial molluscs - is abundant [1, 2]. Adults, with their generally limited flight, are found mainly in microhabitats that are favorable for egg-laying and larval survival. Sciomyzidae larvae display a remarkable diversity of trophic strategies, ranging from active predation to parasitism, with developmental transitions sometimes observed between these feeding modes [3, 4, 5]. This behavioral plasticity is at the heart of research into their ecological interactions, their adaptability to environmental gradients, as well as their potential as biocontrol agents in agricultural and aquatic systems [6, 7]. As bioindicators, their presence and diversity are particularly sensitive to variations in temperature, humidity, water quality and vegetation structure [8].

In Afrotropical region, several works have documented the biology and ecology of various species, including *Sepedon ruficeps*, *Sepedon knutsoni*, and *Sepedonella nana*, all known for their specialized feeding on aquatic oligochaetes and mollusks [9, 10]. However, the true diversity of Sciomyzidae remains partially explored in many parts of West Africa, due to a lack of targeted inventories and in-depth ecological studies [11, 12]. In Benin, several research work [13, 9, 14, 15], on the entomofauna of this insect family, reveals the existence of three genera such as Sepedon, Sepedoninus and Sepedonella, divided into eleven (11) species, namely *Sepedon knutsoni*, *Sepedon ruficeps*, *Sepedon ornatifrons*, *Sepedon trichrooscelis*, *Sepedon umbrosa*, *Sepedon maculifemur*, *Sepedon lippensi*, *Sepedon straeleni*, *Sepedon nasuta*, *Sepedoninus curvisetis* and *Sepedonella nana*.

However, during our surveys, *Sepedon maculifemur* was captured for the first time in the ZOU department of Benin. This represents a significant advance in our knowledge of this family, extending the known distribution of the species and raising new questions about its bioecological characteristics.

In this context, the present study aims to characterize some bioecological aspects of *Sepedon maculifemur*, including its habitat, trophic behavior and interactions with freshwater molluscs in the region. By deepening our knowledge of this species, this work aims to contribute to the valorization of Sciomyzidae as potential biological control agents against harmful molluscs, while enriching our understanding of the ecological dynamics of this family in West Africa.

Material and methods

Study area's location

Benin is a west african country located in the intertropical zone between the equator and the Tropic of Cancer, more precisely between parallels 6°30' and 12°30' north latitude and meridians 1°00' and 3°40' east longitude [16]. It is subdivided into twelve departments, including Zou, located in the south-central part of the country. This department, made up of plateaus whose altitude generally varies between 200 and 300 meters, comprises nine communes: Abomey, Agbangnizoun, Bohicon, Covè,, Ouinhi, Zangnanado, Djidja, Za-Kpota and Zogbodomey [17]. These last three make up our study area. Zou department is characterized by a sub-equatorial climate, marked by four seasons: a long rainy season from April to July, a short dry season from July to September, a short rainy season from September to October, and a long dry season from November to March [18, 16]. Average temperatures range from 24°C to 32°C, with mean annual rainfall fluctuating between 900 and 1, 200 mm, depending on locality [19].

However, the region is experiencing significant changes in the spatio-temporal distribution of rainfall, as a direct consequence of climate change [20]. Zou represents a climatic transition zone between the sub-equatorial climate of southern Benin and the humid tropical Sudano-Guinean climate characteristic of the north-central part of the country [21, 22]. These climatic dynamics strongly influence the availability of water resources, plant phenology, associated fauna and agricultural and pastoral activities in the area [22].

Living material

The biological material used consisted in adults of *Sepedon maculifemur* (Diptera, Sciomyzidae) and aquatic, semi-aquatic and terrestrial molluscs belonging to the following species: *Bulinus globosus*, *B. forskalii*, *B. truncatus*, *Physa acuta* and *Subulina octona*. These species were selected for their local availability and ecological relevance as potential prey for *S. maculifemur* larvae**.**

Technical equipment

Field and laboratory work required the use of a range of equipment: weeps nets, sorting cages, rearing boxes specific to Sciomyzidae, manual vacuum cleaners, gloves, boots, dissection kit, pillboxes, binocular magnifiers, Petri dishes, Eppendorf tubes, plastic packaging, as well as laboratory products for disinfecting and preserving specimens.

Methods

Collection and rearing of adults

Adults of *S. maculifemur* were captured using sweep nets manoeuvred over the vegetation between 6 and 10 AM. or from 4 to 7 PM., over an area of around 50 m², or over the entire biotope for smaller sites. Collections were made twice a month from January to December, and daily for seven days in July to study daily rhythms.

In the laboratory, five pairs of *S. maculifemur* adults were kept individually in transparent cylindrical boxes (9 cm diameter × 11 cm height), with a side opening covered with netting for ventilation. Each box contained a moistened slice of filter paper, a drinking trough consisting of a perforated container with a wick, and a capsule containing a mixture of cassava flour and honey. The boxes were changed every three days. Under these conditions, mating and egg-laying were regularly observed.

Morphological characterization and eggs incubation

Fifty eggs (ten per pair) were collected with a fine wet brush. Twenty of them were observed under a binocular magnifying glass for morphological description, while the remaining thirty were incubated in Petri dishes lined with filter paper kept moist. Hatching larvae were observed for morphological description and ecological classification.

Rearing prey molluscs

Collected molluscs were identified using the [23] key, grouped by environment of origin, then placed in plastic containers (60 × 40 × 30 cm), fitted with mesh lids for aeration. The water in their environment was regularly renewed. They were fed with disinfected fresh lettuce leaves. Egg-laying was monitored until juveniles were obtained and used as experimental prey.

Larval rearing and development cycle monitoring

Larvae were placed individually in Petri dishes containing molluscs of various sizes and species. The dishes were cleaned daily, and dead prey replaced. Stage changes were identified by the presence of exuviae which were collected and preserved in 70% ethanol. The pupae obtained were followed until adult emergence**.**

Evaluation of malacophagic performance

Larval predatory performance was assessed using a method adapted from [9, 24], by exposing larvae of three stages (L1, L2, L3) to five mollusc species divided into three groups according to shell size: G1: < 3 mm; G2: 3 to 7 mm; G3: > 7 mm.

Forty L1 larvae were isolated individually in Petri dishes each containing a mollusc from each group. Each larva was monitored four times a day (8 a.m.-7 p.m.). Any dead or consumed prey was immediately replaced. Larvae were observed until their transformation into pupae and then into adults. Each experiment was repeated ten times under the same experimental conditions.

The data collected enabled morphological description of the developmental stages of *S. maculifemur*, identification of preferred prey, estimation of hatching rate, average duration of larval stages, and trophic yield (number of molluscs consumed per developmental cycle).

Data processing

All data collected during the experiments were organized, cleaned and structured using Microsoft Excel 2016, then statistically analyzed with R version 4.3.2 [25]. Quantitative variables (duration of stages, morphometric sizes, yields, etc.) were described by their mean, standard deviation and range of variation.

For the analysis of temporal variations (e.g. hatching, stage durations), repeated-measures ANOVAs were performed when the assumptions of normality and homogeneity were met, supplemented by a Tukey HSD post-hoc test to identify statistically different groups.

The effects of prey mollusc species on larval developmental success were modeled using penalized Firth-type logistic regressions, via the logistf package in R, to correct for biases associated with small numbers and near-complete separation. Odds ratios (OR) were calculated to interpret the relative probability of success compared to a reference species (*Bulinus globosus*).

The analysis of predation capacity as a function of mollusc species and size involved a log-linear model, followed by a Tukey post-hoc analysis (emmeans), while the combined effect of three factors (larval stage, species and prey size) was explored by a LASSO logistic regression model (glmnet), with selection by cross-validation.

Finally, figures were generated using the ggplot2 and ggpubr packages, ensuring both visual clarity and rigorous graphical representations.

Results

Abundance and spatial distribution of *Sepedon maculifemur*

The study of *S. maculifemur* catches in the three communes investigated revealed marked spatio-temporal variations in both quantity and behavior (Table 1). A total of 136 adults were caught, distributed between Djidja (75 individuals), Za-Kpota (40) and Zogbodomey (21), representing 55.5%, 29.4% and 15.4% of total catches respectively. Djidja had the highest relative abundance (55.55% of catches), suggesting a specific ecological preference or more favorable conditions in this locality. Males were more abundant overall (86 males vs. 50 females), reflecting a significant unbalanced sex ratio (χ^2 = 10.65, $p<0.01$) and representing 69.3% in Djidja ; 55% in Za-Kpota and 57.1% in Zogbodomey. However, a Fisher's exact test did not reveal any statistically significant difference between gender proportions by commune ($p \approx 0.45$), suggesting a relatively homogeneous distribution of the sex ratio in the three localities.

Temporal analysis reveals a strong influence daily time on the average number of specimens caught. The morning slots (6am-10am) concentrate most of the activity, with capture rates reaching 73.5% in Djidja, 72.2% in Za-Kpota, and 100% in Zogbodomey. A Kruskal-Wallis test applied to the numbers per time slot confirmed the significance of this variation (H = 13.52; ddl = 5; $p \approx 0.019$), highlighting a marked nycthemeral rhythmicity of the species, strongly morning.

Furthermore, joint analysis of the effects of locality and time of capture, via a two-factor ANOVA, revealed significant main effects of the commune factor (F(2, 30) = 12.1; $p<0.001$) and the time factor (F(5, 30) = 18.3; $p<0.0001$), as well as a significant commune × time interaction (F(10, 30) = 2.42; $p=0.03$). This interaction reflects variability in the hourly profile of activity between communes: in Zogbodomey, the insect adulte activities is exclusively concentrated between 6 and 8A.M., while in Djidja, low activity persists at the end of the day (4 - 7 P.M.), reflecting possible local adaptation or a response to specific environmental factors (residual humidity, plant cover, prey activity, etc.).

Finally, the overall distribution of catches by commune was tested using a Pearson Chi² test, revealing a highly significant difference between localities (χ^2 = 27.29; ddl = 2; $p<0.001$). This inequality suggests that Djidja is a particularly favorable habitat for the species, probably due to optimal ecological conditions not detailed here (presence of wetlands, spawning substrates, abundance of prey gastropods, etc.).

Influence of environmental conditions on catches

Cross-analysis of monthly trends in *S. maculifemur* catches and climatic parameters in Zou department (**Fig 1)** reveals a marked seasonal dynamic, closely associated with variations in temperature and rainfall. The data show a total absence of catches during the dry period (January to April), followed by a gradual increase from May onwards, peaking in July and then declining until October. This pattern suggests a strong influence of the rainy season on the species' abundance, with a peak in captures recorded in July, a month characterized by maximum rainfall (233.9 mm). Multiple linear regression between the total number of specimens caught, mean monthly temperature and rainfall indicates that these two climatic variables together explain 58% of the observed variance (R^2 = 0.58; $p<0.05$). However, only temperature remained a significant predictor in the model, with a marked negative effect ($p=0.032$), while precipitation, although positively correlated with captures, failed to reach statistical significance ($p > 0.05$). Pearson's correlation coefficient confirms this trend, showing a negative relationship between temperature and catches (r = -0.65; $p=0.025$), and a non-significant positive relationship with precipitation (r = 0.47; $p=0.11$).

These results suggest that *S. maculifemur* shows increased activity under conditions of high humidity combined with moderate temperatures (around 25-26°C), conditions typical of the heart of the rainy season in Benin. The clear dominance of captures in the commune of Djidja compared to Za-Kpota and Zogbodomey could be attributed to local microecological factors, notably the availability of temporary or semi-permanent aquatic habitats favorable to larval development. Overall, these observations reinforce the hypothesis that *S. maculifemur* adopts a phenological strategy aligned with regional hydrometeorological dynamics, and underline the importance of considering climatic parameters as major regulating factors of its spatio-temporal ecology.

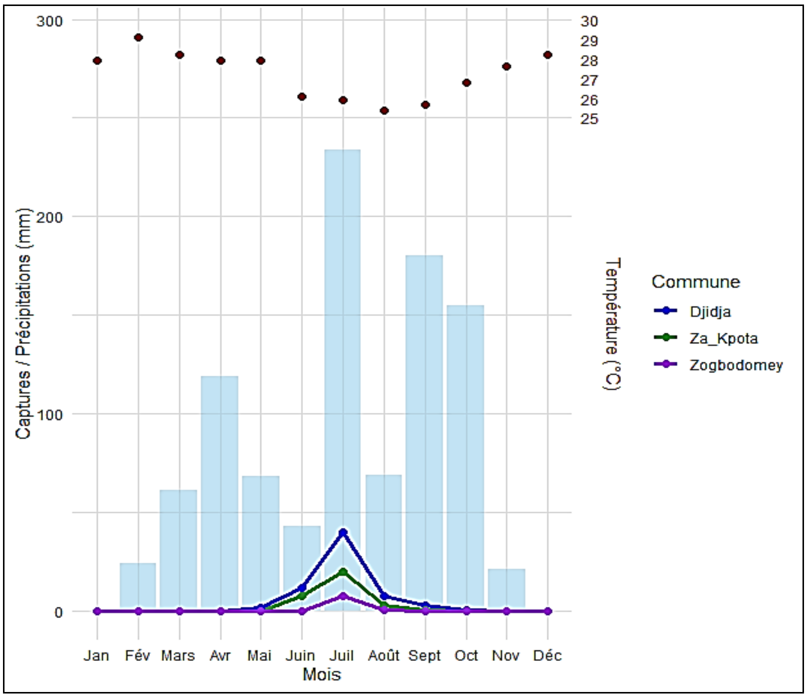

Fig 1: Monthly trends in *S. maculifemur* catches by zone and climatic parameters

Descriptive morphology and dynamics of the *S. maculifemur* development cycle under controlled conditions

For Sciomyzidae, sexual reproduction is the dominant mode of perpetuation, initiated by mating (Fig 2 A). In the case of *S. maculifemur*, both in the wild and under laboratory conditions, this preliminary phase can last from a few minutes to several hours, in the absence of exogenous disturbances. After mating, females oviposit in a dispersed manner, but within the same oviposition zone. The eggs give rise to larvae that successively go through three distinct stages (L_1, L_2, L_3), before entering pupation and giving birth to the imago (Fig 2).

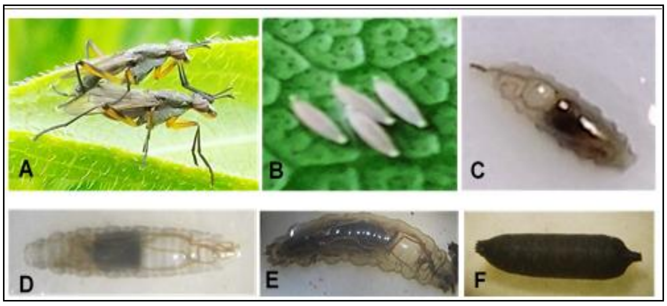

Fig 2: Stages in the development of *S. maculifemur*
(A: imago pair ; B: eggs; C: L_1 larva; D: L_2 larva; E: L_3 larva; F: pupae)

Fertility of mated females

Observation of post-mating egg laying shows an average fecundity of 183.1±29.20 eggs per female over a 30-day period. Under experimental conditions, eggs were deposited on various internal surfaces of the rearing box, including the shells of prey molluscs, the walls or any other available support.

Morphological characteristics of eggs

Twenty sampled eggs were examined under a binocular magnifying glass (Fig 2 B). They were spindle-shaped, tapering slightly at the ends, with an average length of 1.20±0.20 mm and a diameter of around 0.29 mm. The chorion, initially whitish and soft, tends towards a yellowish-grey hue by the third day. On the outer surface, hexagonal striations are visible. The egg has two distinct sides: a convex ventral side, generally in contact with the egg-laying surface, and a slightly concave dorsal side. The ends of the egg are beaded with aerophore orifices.

Larval morphology

Morphological analysis of ten individuals per larval stage (Fig 2 C D E) reveals a transparent integument and a relatively homogeneous overall morphology. Size varies according to stage: L_1 (1.74±0.17 mm), L_2 (3.71±0.19 mm) and L_3 (6.68±0.18 mm). Body coloration seems to correlate with the nature of the prey ingested (Fig 3). Each larva is segmented into twelve parts: 1 cephalic segment fitted ventrally with a mouth apparatus and a band of spines, 3 thoracic segments each bearing two tufts of three ventral sensory bristles, 8 abdominal segments with lateral and ventral tubercles. The last abdominal segment ends in a posterior disc bearing two pairs of lobes (one ventral and one latero-ventral) and two anal plates. These lobes are poorly developed and have short, water-repellent bristles.

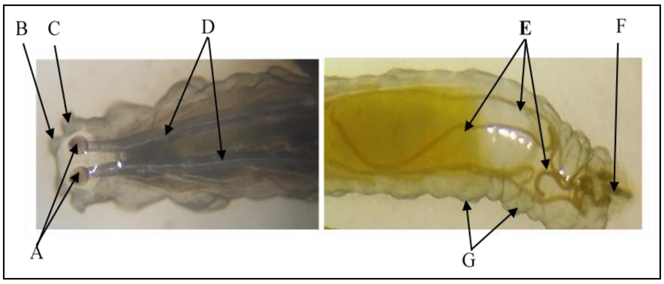

Fig 3: Morphological details of stage L_3 larva
Legend: A: Anal plates; B: Ventral lobe; C: Latero-ventral lobe; D: Tracheal trunk; E: Malpighian canal; F: Mouth and pharyngeal sclerite; G: Lateral tubercles.

Pupae

Morphometric measurements on twenty pupae (Fig 2 F) show an average length of 5.67±0.20 mm, a width of 1.74±0.37 mm, and a height of 1.63±0.16 mm. Their color ranges from dark brown to anthracite gray. Morphologically, they present a convex dorsal side, a straight ventral side and a dorsally curved posterior end. The anterior end is abruptly narrowed. The presence of subapical stigmata and an atrophied posterior disc, bearing sclerotized remnants of the L_3 lobes, was observed.

Duration and dynamics of the *S. maculifemur* development cycle under controlled conditions

The mean number of L_1 larvae collected (**Table 2)** varied significantly with incubation time (repeated measures ANOVA, F = 252.39, $p<0.001$). Peak hatching was observed at 72 hours, with a mean number of 39.14±1.98 larvae (Table 2), significantly higher than all other times ($p<0.001$). The 24 h and 120 h times showed very low and statistically similar numbers (group a), while the 48 h and 96 h times showed intermediate levels, not significantly different from each other but distinct from the 72 h peak.

In controlled experiments, a total of 419 *S. maculifemur* eggs were collected, of which 317 gave rise to first-stage larvae (L_1), giving a hatching rate of 75.65%.

Analysis of data from 15 rearing cycles of *S. maculifemur* under controlled conditions has enabled us to characterize precisely the duration of the different development phases. Table 3 shows the estimated means, standard deviations and ranges for each phase.

The different phases of the cycle from hatching to adult emergence revealed a characteristic temporal structuring, with an average total duration of 26.8±1.81 days. Statistical analysis (repeated measures ANOVA) revealed highly significant disparities between the durations of successive stages (F = 886.78, ddl = 5, $p<0.0001$), highlighting the temporal complexity inherent in the ontogeny of this species. The Tukey HSD post-hoc test indicates that all phases differ significantly from one another, with the exception of L_1-L_2 and Egg-L_1, whose mean durations are statistically close ($p > 0.05$). On the other hand, the L_2-L_3, L_3-Pupe and especially Pupe-Imago phases show significantly longer durations than the early stages ($p<0.001$). These results highlight a gradual but significant increase in phase duration as larval development progresses, culminating in the Pupe-Imago phase, the longest stage of the cycle (8.44±0.88 days). This trend probably reflects the increasing complexity of morphogenetic processes as the organism progresses towards adulthood.

Larval development and trophic spectrum of *Sepedon maculifemur* under experimental conditions

To assess the trophic preferences and developmental performance of *S. maculifemur* as a function of prey type, five species of pulmonate molluscs frequently found in freshwater ecosystems in Benin were tested in the laboratory as larval food resources. These were *Bulinus globosus*, *Bulinus forskalii*, *Bulinus truncatus*, *Subulina octona* and *Physa acuta*. Forty L_1-stage larvae were brought into contact with each species tested. The number of individuals reaching stages L_2, L_3, pupa and imago was recorded (**Table 4**).

Table 4 shows a marked variation in developmental success depending on the mollusc prey. *Bulinus globosus* ensures optimum yield (70%), with low losses at the various larval stages, testifying to high trophic suitability. By contrast, other molluscs show significantly lower yields, ranging from 25% to 10%, reflecting an unfavorable impact on survival and progression to imago. This disparity highlights a trophic specificity, which directly influences the life cycle, and suggests that *Bulinus globosus* should be favored in any approach aimed at maximizing larval development.

Effect of prey mollusc species on larval development success of Sepedon maculifemur

The influence of prey mollusc species on the probability of *Sepedon maculifemur* larval development was assessed using a penalized logistic regression model (Firth), to correct for biases associated with small numbers and near-complete data separation. The aggregated data concerned the number of L_1 larvae successfully developing to the pupa stage, based on five mollusc species tested in the laboratory.

The model revealed a highly significant effect of prey type on larval development performance (overall model test, $p<0.001$). The reference being *Bulinus globosus*, the only species to achieve a success rate of over 70%, the other species proved significantly less effective (Table 5). In particular, *Physa acuta* and *Bulinus truncatus* showed significantly reduced success probabilities, with logistic regression coefficients of -3.26 (SE = 1.05; $p=0.002$) and -2.85 (SE = 0.98; $p=0.004$) respectively. These results suggest a strong trophic selectivity in *S. maculifemur*, favoring certain malacological species for the completion of its larval cycle.

Predation capacity of *Sepedon maculifemur* larvae according to species and mollusc size

Fig 4 shows the average number of molluscs consumed by *S. maculifemur* larvae, as a function of species and prey size (G1: <3 mm, G2: 3-7 mm, G3: >7 mm). Predation varied significantly by larval stage ($\chi^2 = 114.7$; $p<0.0001$), mollusc species ($\chi^2 = 67.3$; $p<0.0001$), and prey size ($\chi^2 = 95.5$; $p<0.0001$), with a significant three-way interaction ($\chi^2 = 42.1$; $p=0.0006$).

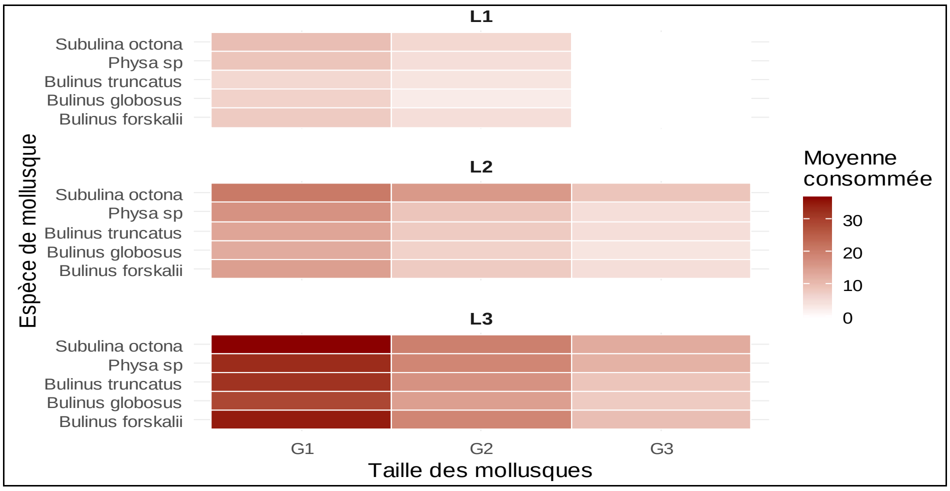

Fig 4: Predation capacity of *S. maculifemur* according to species, size and larval stage.

L_1 larvae show little predation, limited to small molluscs (G1 and G2), and no predation on G3. L_2 consume more, with a clear preference for G1. L_3 show high and widespread predation, irrespective of group. Post-hoc analysis (Tukey, $p<0.01$) confirms a marked difference between G1 and G3 sizes. Penalized logistic regression (LASSO) indicates a 3-fold higher probability of predation on G1 (OR > 3.2), particularly on *Subulina octona* and *Physa acuta*.

These results underline the potential efficacy of *S. maculifemur* as a biocontrol agent targeting juvenile molluscs in tropical aquatic environments.

Discussion

The data collected in the temporary aquatic ecosystems of southern Benin reveal a marked seasonal dynamic of *S. maculifemur*, characterized by maximum abundance in the rainy season and a total absence of catches in the dry season. This dependence on hydroclimatic conditions is consistent with the work of [1, 2, 26], who highlighted the structuring role of aquatic habitat and mollusc prey availability for tropical Sciomyzidae. The negative correlation between temperature and abundance indicates strong thermal sensitivity, confirming the observations of [27], that temperatures above 30°C can alter larval survival and reproductive behavior. The average length of the complete cycle of *S. maculifemur* in the laboratory is 26.8 days, comparable to that reported for *Sepedon spinipes* and *S. ruficeps* by [28], who observed similar life cycles in these species.

The longer durations of the L_3 and pupal stages reflect the intensity of morphogenetic transformations, as also reported by [28], who noted variations in the duration of immature stages as a function of environmental conditions. This developmental pattern, combined with reproduction synchronized with the wet season, suggests an adaptive strategy characteristic of predators specialized in temporary environments, as highlighted by [28], who observed reproduction synchronized with the wet season in these species. The species' potential sensitivity to increased climatic variations in the Sudano-Guinean zone was also highlighted by [28], who noted an adaptation of *S. ruficeps* to variable hydrological conditions.

Experiments under controlled conditions show that *Sepedon maculifemur* exhibits high fecundity (up to 230 eggs/female) and a hatching rate of over 75%. These results concur with those of [28] on the reproductive plasticity of tropical Sciomyzidae. Morphological traits of eggs (elongated shape, paracrystalline ends) and pupae (terminal sclerification) suggest adaptation to desiccation and unstable substrates, as documented by [3] for *Sepedonella nana* and [29] for *Sepedon trichrooscelis*. Compared with *S. ruficeps* and *S. spinipes* also studied by [28], *S. maculifemur* adopts a more quantitative reproductive strategy, which could reflect a high degree of adaptation to habitats with high variability. Experimental results highlight strong trophic selectivity: only Sciomyzidae larvae deployed on *Bulinus globosus* allow efficient development (>70%), unlike the other species tested (*Physa acuta, B. truncatus, B. forskalii, Subulina octona*). These observations are in line with the work of [30, 31], who demonstrated under experimental conditions the selectivity of tropical Sciomyzidae according to the species of origin of the mollusc hosts. *S. maculifemur* larvae are poly-malacophagous and develop predatory/parasitoid behavior, according to [32]. The rigorous statistical approach used shows a significant effect of mollusc species on developmental success: the probability of reaching the pupa stage is reduced by 6 to 25 times depending on the host species. This type of asymmetric trophic selection has been demonstrated experimentally [31].

Furthermore, logistic models applied to other Diptera [27] showed comparable reductions in survival probability as a function of key variables, illustrating the rigor of this statistical approach. Predation performance shows that L_3 larvae are more active and less selective, while L_1s target prey < 3 mm. This dynamic is consistent with the observations of [30] for *Sepedon scapularis* and [33] for *Tetanocera elata*. Statistical analysis (LASSO type) indicates a 3-fold increase in predation probability on small prey, notably *Physa acuta* and *Subulina octona*, suggesting targeted regulation of juvenile parasite vectors. This asymmetrical trophic specialization implies an integrated strategy to optimize ecological efficiency in biological control programs.

Conclusion

This study makes a significant contribution to our understanding of the bioecological aspects of *Sepedon maculifemur*, a key species of the Sepedon genus with promising potential for the biocontrol of freshwater molluscs. Analysis of the development cycle of *S. maculifemur* under controlled conditions reveals a well-structured ontogeny, high fecundity and stability of successive phases over time. *S. maculifemur* larvae are poly-malacophagous and develop predatory/parasitoid behavior. At the same time, investigations on *S. maculifemur* revealed a marked trophic selectivity, with a preferential affinity for *Bulinus globosus*, the only one to guarantee optimal larval yield. Penalized logistic regression confirmed the decisive influence of prey identity on larval development success. Furthermore, the predatory capacities of the larvae, modulated by development stage and prey size, confirm the functional adaptability of *S. maculifemur*.

These results, at the crossroads of developmental biology and functional ecology, reinforce the hypothesis of the integration of Sciomyzidae in sustainable approaches to regulating mollusc vector populations.

They thus pave the way for innovative biocontrol solutions that respect ecological balances in tropical wetlands, particularly in contexts with a high prevalence of distomatosis (bilharzia).

Table 1: Distribution of *Sepedon maculifemur* individuals according to commune, sex and time of capture.

City	Males	Females		Total	% Total	6h-8h	8h-10h	10h-12h	12h-14h	14h-16h	16h-19h
Djidja	52	23		75	55, 55%	36, 59	24, 39	9, 76	0, 00	0, 00	12, 20
Za-Kpota	22	18		40	29, 41%	22, 86	14, 29	5, 71	0, 00	0, 00	8, 57
Zogbodomey	12	9		21	15, 44%	16, 00	4, 00	0, 00	0, 00	0, 00	0, 00

Table 2: Mean±standard error of the number of L1 larvae collected according to incubation time, with statistical groups (different letters = significant differences at the 5% threshold).

Incubation time	Average number of larvae L1±ES
24 h	0, 57±0, 64a
48 h	2, 29±0, 80ab
72 h	39, 14±1, 98c
96 h	3, 57±0, 88b
120 h	0, 29±0, 29a

Table 3: Average duration of Sepedon maculifemur development phases (n = 10 complete cycles)

Development phase	Mean duration±Standard deviation (days)
Œuf → L1	3, 30±0, 48a
L1 → L2	3, 70±0, 48a
L2 → L3	5, 50±0, 53b
L3 → Pupe	5, 70±0, 67b
Pupe → Imago	8, 60±0, 97c
Cycle complet	26, 80±1, 81

Table 4: Average number of individuals reaching each stage of development by prey mollusc species and final yield (Imago / L1 in %)

Mollusc species	L1 initiales	L2	L3	Pupae	Imagos	Yield (%)
Bulinus globosus	40	30	28	28	28	70, 0
Subulina octona	40	10	10	10	10	25, 0
Bulinus forskalii	40	10	7	7	7	17, 5
Bulinus truncatus	40	19	10	6	6	15, 0
Physa acuta	40	5	5	4	4	10, 0

Table 5: Effect of prey molluscs on the probability of successful larval development of *S. maculifemur*

Prey mollusc	Coefficient β	Standard error	p-value	OR (e^{β})	Interpretation
Bulinus globosus	Reference	—	—	—	*Base comparative*
Subulina octona	-1, 92	0, 88	0, 032	0, 15	*Success≈6× less likely*
Bulinus forskalii	-2, 45	0, 91	0, 007	0, 086	*Success≈12× less likely*
Bulinus truncatus	-2, 85	0, 98	0, 004	0, 058	*Success ≈17× less likely*
Physa acuta	-3, 26	1, 05	0, 002	0, 039	*Success≈25× less likely*

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