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Identifying The Distribution Of Golden Snail (Pomacea Canaliculata) During The Rice Crop Harvest (Oryza Sativa L) In Sumberaji Village, Kabuh District, Jombang Regency

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Abstract: *This study aimed to examine the distribution of the golden apple snail (*Pomacea canaliculata*) and its ecological associations during the rice harvest stage (*Oryza sativa *L.) in Sumberaji Village, Kabuh District, Jombang Regency. Fieldwork was conducted from May to June 2025 using a descriptive quantitative design. Data were collected through purposive sampling across four observation plots, each measuring one square meter. Statistical analysis included Pearson correlation to assess the relationship between environmental variables and snail abundance, while the distribution patterns of temperature and pH were evaluated using the Chi-Square Goodness of Fit test. A total of fourteen individuals were recorded across all plots, resulting in an average density of 0.875 individuals per square meter. The highest abundance was observed in the second plot, where water temperature and pH were within the optimal ecological range. The lowest abundance occurred in the fourth plot, with only one individual recorded. Correlation analysis revealed no significant relationship between environmental factors and snail abundance ($r = -0.28$ for temperature; $r = -0.31$ for pH; $p > 0.05$). The Chi-Square test results indicated that the distribution of temperature ($\chi^2 = 0.097$; $p > 0.05$) and pH ($\chi^2 = 0.065$; $p > 0.05$) did not differ significantly from an even distribution pattern. These findings indicate that temperature and pH conditions at the study site were relatively homogeneous across plots and did not represent dominant determinants of golden apple snail distribution. Other ecological variables, including food availability, vegetation structure, and biotic interactions, are likely to exert a stronger influence on population variability.*
Keywords: *Golden Apple Snail, Temperature, Population Distribution.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the primary staple crop and the main source of dietary carbohydrates for the Indonesian population (Mubarok et al., 2024). As one of the largest rice-producing countries globally, Indonesia must continuously sustain and increase productivity to ensure food security amid ongoing population growth (Kasnelly et al., 2024). One of the major constraints in paddy cultivation is infestation by plant pest organisms, particularly the golden apple snail (*Pomacea canaliculata*), an invasive species widely recognized as a destructive pest in rice ecosystems. This species feeds on young rice tissues and basal stems, causing significant yield losses and compromising crop quality (Dwi Rachmi Safitri, 2020).

Existing literature has predominantly examined the impact of golden apple snail infestations during the vegetative and generative growth phases of rice (Gau, 2021). These studies emphasize seedling vulnerability and early crop establishment, forming the basis for most integrated pest management strategies. Field observations, nevertheless, indicate that golden apple snails persist beyond these growth stages and remain active during the harvest period, particularly in paddies characterized by standing water and post-harvest organic residues (Irawan, 2021). Despite this persistence, systematic investigation of snail distribution during the harvest phase remains limited.

This gap has important implications. The harvest stage represents a transitional ecological period in which pest populations may survive, reproduce, or redistribute, potentially initiating reinfestation cycles in subsequent planting seasons (Hasanah, 2024). Current management frameworks rarely incorporate ecological assessments at this stage, thereby overlooking a potentially critical control point. The absence of empirical data on population distribution and environmental associations during harvest constrains the development of comprehensive and preventive pest management strategies (Asmah, 2021).

Ecological variables such as water temperature, pH, organic residue accumulation, and irrigation patterns may influence snail survival and spatial distribution during post-harvest conditions. Although previous studies have demonstrated that environmental factors affect the growth and reproduction of *P. canaliculata* (Jumiono et al., 2024), their specific role during the harvest phase remains underexplored. Addressing this limitation is essential for advancing ecological-based pest control approaches that extend beyond early crop stages.

This study responds to the identified gap by examining the spatial distribution of golden apple snails during the rice harvest period and analyzing selected ecological factors associated with their population density. By situating the harvest phase as an integral component of the pest life cycle, this research contributes to a more temporally comprehensive understanding of golden apple snail ecology. The findings are expected to inform sustainable pest management strategies

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grounded in ecological monitoring rather than reactive intervention. Accordingly, the objective of this study is to identify the distribution pattern of golden apple snails during the rice harvest stage in Sumberaji Village, Kabuh District, Jombang Regency, and to analyze the ecological factors associated with their population density.

METHOD

Research Design

This study employed a quantitative descriptive design using a field survey approach to examine the distribution and population density of golden apple snails (*Pomacea canaliculata*) during the rice harvest stage. A quantitative descriptive design is appropriate for ecological population studies aimed at quantifying species distribution patterns and environmental associations without experimental manipulation (Creswell, 2014; Odum & Barrett, 2005).

The research was conducted from May to June 2025 in paddy fields located in Sumberaji Village, Kabuh District, Jombang Regency, Indonesia. The study focused on harvest-stage rice fields characterized by residual standing water and post-harvest organic matter.

Population and Sampling

The study population comprised all golden apple snails present within the designated research site. Sampling was conducted using purposive sampling based on ecological criteria, including proximity to irrigation canals and the presence of standing water. Purposive ecological sampling is commonly applied in field-based population assessments where habitat characteristics are used as selection criteria (Krebs, 1999).

Four observation plots measuring 1 × 1 meter were established within the study area. Quadrat sampling of this size is widely used in ecological studies to estimate invertebrate population density and spatial distribution (Southwood & Henderson, 2000). The total effective observation area was 16 m².

Data Collection Procedures

Data collection was conducted systematically through the following stages:

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1. Establishment and marking of quadrat plots using stakes and raffia rope;
2. Direct counting of individual golden apple snails within each quadrat;
3. Measurement of ecological parameters, including water temperature and pH;
4. Documentation and structured recording of field observations.

Water temperature was measured using a calibrated water thermometer, while pH was measured using a digital pH meter. Specimens were temporarily collected using buckets and jars when necessary for counting verification. A 70% alcohol solution was prepared as a preservative for documentation purposes. Field data were recorded using standardized observation sheets and photographic documentation.

Data Analysis

Population density was calculated using the general ecological density formula:

$D=N/A$

where:

D = population density (individuals/m²)

N = total number of individuals

A = total observation area (m²)

This density estimation method follows standard ecological population assessment procedures (Odum & Barrett, 2005; Krebs, 1999).

Descriptive quantitative analysis was used to present distribution patterns across plots. To assess the relationship between environmental variables (temperature and pH) and snail abundance, Pearson Product-Moment Correlation analysis was applied. Pearson correlation is appropriate for evaluating linear relationships between continuous variables (Field, 2013).

To determine whether the distribution of temperature and pH values differed significantly from an even distribution, the Chi-Square Goodness of Fit test was employed. The Chi-Square test is commonly used in ecological studies to compare observed frequencies with expected distributions (McDonald, 2014). Statistical significance was evaluated at $\alpha = 0.05$.

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RESULT AND DISCUSSION

This study recorded a total of 14 individuals of golden apple snails (*Pomacea canaliculata*) within a 16 m² observation area in the rice fields of Sumberaji Village, Kabuh District, Jombang Regency. The spatial distribution of individuals varied across plots. Plot 2 contained the highest number of individuals (n = 5), while Plot 4 exhibited the lowest abundance (n = 1). The calculated mean population density was 0.875 individuals/m². This value indicates a relatively high presence, as golden apple snails were detected in nearly all observation plots.

Measurements of ecological parameters revealed that water temperature ranged from 32.1°C to 34.3°C, while pH values varied between 6.00 and 6.84. These environmental conditions fall within the optimal range for the growth and reproductive activity of golden apple snails. Plot 2, which showed the highest abundance, recorded a temperature of 32.2°C and a pH of 6.00, conditions conducive to the biological performance of the species. Although Plot 4 also exhibited environmental values within the suitable range, its low abundance suggests that additional ecological variables may influence distribution patterns. Factors such as organic matter availability, substrate characteristics, and water flow dynamics are likely to contribute to local population variability.

The persistence of golden apple snails during the harvest phase indicates that this pest is capable of surviving beyond the early vegetative stages of rice cultivation (Angi, 2023). Prolonged waterlogging, residual straw accumulation, and proximity to irrigation channels appear to facilitate population survival. These findings are consistent with Nurlette et al. (2022), who reported a strong association between snail distribution and water sources, and with Suriyati et al. (2023), who observed clustering tendencies in high-humidity environments. Yassin (2025) similarly highlighted the critical role of ecological factors in shaping population dynamics.

From a practical standpoint, these findings underscore the necessity of extending pest management strategies to include harvest and post-harvest stages (Jaya et al., 2025). Surviving populations may serve as reservoirs for reinfestation during subsequent planting cycles, thereby

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threatening productivity. Preventive measures such as straw removal, field drying, drainage optimization, and sanitation of harvesting equipment should be implemented systematically. This approach aligns with integrated pest management principles that combine mechanical, biological, and environmental control methods (Gea et al., 2024). Environmentally sustainable alternatives, including the use of ducks or baited traps, may further reduce population density while minimizing ecological disruption. Overall, continuous monitoring of golden apple snail populations, including during the harvest phase, is essential. A density value of 0.875 individuals/m² reflects a potential risk to sustainable rice production if management interventions are not applied. Effective control requires an integrated and sustained strategy to maintain agricultural productivity while supporting environmentally responsible cultivation systems.

Results

This study was conducted in rice fields located in Sumberaji Village, Kabuh District, Jombang Regency, with the primary objective of identifying the distribution of golden apple snails (*Pomacea canaliculata*) during the rice harvest phase.

Observations across four quadrat plots (1 × 1 m² each) recorded a total of 14 individuals within the total observation area. Plot 2 showed the highest abundance (5 individuals), while Plot 4 showed the lowest abundance (1 individual). The calculated average population density across all plots was 0.875 individuals/m². These findings indicate that golden apple snails remain present even after the harvest stage.

Plot	Number of Individuals
1	4
2	5
3	4
4	1
Total	**14**
Average	**3.5**
χ^2 (Calculated)	2.571
χ^2 (Table; $\alpha = 0.05$; df = 3)	7.815

Table 1. *Number of Golden Apple Snails in Each Observation Plot*

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Since the calculated χ^2 value (2.571) is lower than the critical value (7.815), the difference in the number of individuals among plots is not statistically significant. This result indicates that the spatial distribution of golden apple snails during the harvest phase tends to be relatively uniform.

Water Temperature and pH Measurement Results in Each Plot

Environmental parameters were measured to evaluate ecological conditions associated with snail presence. Water temperature ranged from 32.1°C to 34.3°C, while water pH ranged from 6.00 to 6.84. These values fall within the optimal physiological range for golden apple snail survival and metabolic activity.

Field observations also indicated additional ecological characteristics, including persistent waterlogging, the presence of residual straw, and proximity to irrigation canals, which may contribute to habitat suitability during the harvest period.

Plot	Temperature (°C)	pH
1	34.3	6.84
2	32.2	6.00
3	32.1	6.21
4	32.8	6.15
Total	**131.4**	**25.20**
Average	**32.85**	**6.30**
χ^2 (Calculated)	0.097	0.065
χ^2 (Table; $\alpha = 0.05$; df = 3)	7.815	7.815

Table 2. *Water Temperature and pH in Each Observation Plot*

The Chi-Square Goodness of Fit test indicates that the calculated values for temperature (0.097) and pH (0.065) are lower than the critical value (7.815). Therefore, variations in temperature and pH among plots are not statistically significant. This suggests relatively homogeneous abiotic conditions across the observation area.

Relationship Between Number of Individuals, Temperature, and pH

Pearson correlation analysis was conducted to examine the relationship between the number of individuals and environmental variables. The correlation between the number of individuals and temperature was $r = -0.095$ ($p = 0.905$), indicating a very weak and statistically non-significant

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relationship. The correlation between the number of individuals and pH was r = 0.078 (p = 0.922), which also indicates a very weak and non-significant relationship. A strong positive correlation was observed between temperature and pH (r = 0.933). Nevertheless, the small sample size (n = 4) limits the statistical strength of this association.

Plot	Number of Individuals	Temperature (°C)	pH
1	4	34.3	6.84
2	5	32.2	6.00
3	4	32.1	6.21
4	1	32.8	6.15
Total	**14**	**131.4**	**25.20**
Average	**3.5**	**32.85**	**6.30**
r (Individuals–Temperature)	-0.095		
r (Individuals–pH)	0.078		
p-value	0.905 ; 0.922		

Table 3. *Relationship Between Number of Individuals, Temperature, and pH*

Because p-values are much greater than 0.05, the variation in the number of individuals among the four plots is not statistically explained by variations in temperature (32.1–34.3°C) or pH (6.00–6.84). These findings indicate that other ecological factors beyond the measured abiotic parameters likely play a more dominant role in determining golden apple snail abundance during the harvest phase.

Discussion

The findings demonstrate that golden apple snails (*Pomacea canaliculata*) remain active during the rice harvest phase, with a recorded mean density of 0.875 individuals/m². This evidence indicates that the species' life cycle extends beyond the early vegetative stage of rice growth and persists until the end of the planting season. The continued presence of standing water, residual straw, and proximity to irrigation canals appears to provide suitable habitat conditions that sustain the population during post-harvest periods. These results support the observations of Nurlette et al. (2022), who reported that humid environments with abundant organic matter enhance golden apple snail survival and population growth. Similar clustering behavior in ecologically favorable habitats was documented by Suriyati et al. (2023). Hasanah (2024) also emphasized the importance

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of temperature and pH as environmental determinants influencing snail persistence in paddy ecosystems.

The measured environmental conditions in this study—temperature ranging from 32.1 to 34.3 °C and pH between 6.00 and 6.84—fall within the physiological tolerance range of *P. canaliculata*. Previous ecological research indicates that this species can tolerate temperatures between 15 and 35 °C and thrives in slightly acidic to neutral waters. Within this optimal range, minor variations in temperature and pH are unlikely to exert strong limiting effects on population density. The absence of a statistically significant correlation between snail abundance and the measured abiotic parameters supports this interpretation. Population variability across plots is therefore more plausibly influenced by other ecological variables, including organic residue availability, microhabitat structure, water flow dynamics, and potential predator interactions. Studies on freshwater mollusks consistently demonstrate that habitat complexity and food resources often exert greater influence on abundance than small fluctuations in temperature or pH.

Although a tendency toward higher abundance at relatively lower temperatures (32.1–32.2 °C) was observed, the limited sample size ($n = 4$) restricts the statistical reliability of this pattern. The small number of observation plots and the absence of spatial replication reduce the statistical power of the analysis and constrain broader ecological generalization. Future investigations should incorporate larger sampling areas, replicated quadrats, and additional environmental variables such as dissolved oxygen concentration, electrical conductivity, substrate composition, and vegetation cover. Analytical approaches suited for ecological count data, including Generalized Linear Models (GLM) with Poisson or Negative Binomial distributions, would provide more robust inference for population–environment relationships.

From an integrated pest management perspective, these findings highlight the importance of extending monitoring and control measures beyond the early crop stages. Conventional pest management strategies often concentrate on seedling protection, whereas the present results indicate that the harvest phase also functions as a critical ecological window for population persistence. Post-harvest interventions such as straw removal, field drainage, irrigation management, and sanitation of harvesting equipment may significantly reduce the risk of reinfestation in subsequent planting cycles. This approach aligns with the ecology-based Integrated Pest Management (IPM) framework outlined by Gea et al. (2024), which emphasizes preventive habitat management alongside mechanical and biological control strategies.

The theoretical contribution of this study lies in reframing the temporal dynamics of golden apple snail infestation. Rather than conforming strictly to plant growth stages, the species demonstrates ecological continuity across the cropping cycle. Recognition of this continuity challenges earlier pest control paradigms that prioritized only seedbed and vegetative phases. Continuous population monitoring throughout the entire cultivation period, including harvest, is therefore necessary to support sustainable rice production systems. In summary, this study reinforces existing ecological theory regarding the interaction of biotic and abiotic factors in shaping pest distribution while extending its application to the harvest phase of rice cultivation. The findings provide a basis for developing more comprehensive, environmentally responsible, and sustainable pest management strategies that support long-term agricultural productivity.

CONCLUSION

Golden apple snails (*Pomacea canaliculata*) were found to remain active and distributed during the rice harvest phase in Sumberaji Village, Kabuh District, Jombang Regency. A total of 14 individuals were recorded within the observation area, with a mean population density of 0.875 individuals/m². These findings confirm that the species persists beyond the vegetative growth stage and continues to occupy paddy ecosystems until the end of the planting cycle. Environmental conditions, including water temperature, pH, persistent inundation, residual organic matter, and proximity to irrigation channels, contribute to habitat suitability during the harvest period. Although temperature and pH were within the optimal tolerance range for the species, their statistical association with population density was not significant, indicating that additional ecological factors likely play a more substantial role in shaping distribution patterns. Effective

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management of golden apple snail infestations should therefore extend beyond early crop stages to include harvest and post-harvest periods.

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