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Correlation between pest gastropod occurrence and selected environmental variables in agricultural lands in the Nuwara Eliya district, Sri Lanka

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Many of the exotic terrestrial pest gastropods introduced to Sri Lanka, either intentionally or accidentally, are well established as pests in agricultural lands, but hardly any studies have been carried out to determine the factors affecting their occurrence. Hence, this study was conducted to determine the correlation between selected environmental factors and density of gastropod pest species in some agricultural lands in the Nuwara Eliya district. A total of 80 agricultural lands were sampled from 2017 to 2019, where each land was surveyed for pest gastropods by establishing ten 1 m^2 sampling plots for a maximum of 15 minutes/plot. Species richness and abundance were recorded in the field and species were identified at the field using available guides. Unidentified species were brought to the laboratory for further identification. Elevation, atmospheric temperature, rainfall, relative humidity and soil pH were measured using a Magellan Explorist 310 portable GPS, a Kestrel 4000nv weather tracker and a HANNA-HI-99121 electronic digital pH meter at each sampling location. Canonical correspondence analysis (CCA), Pearson's correlation and generalized linear mixed model (GLMM) in R studio were used to analyze data. The first two axis of CCA explained 85% of the total variation. Species were ordered along the first axis in the CCA primarily affected by elevation while the second axis affected by rainfall and soil pH. CCA results indicated that the measured environmental factors influencing the occurrence of the gastropod species. For example, *Deroceras laeve* (Muller, 1774), *Deroceras reticulatum* (Miller, 1774), *Milax gagates* (Draparnaaud, 1801) and *Mariella dussumieri* (Gray, 1856) were influenced by the elevation and atmospheric temperature; *Cryptozona chenui* (Pfeiffer, 1847), *Macrochlamys indica* (Godwin and Austen, 1883), *Subulina octona* (Bruguiere, 1789) and *Euplecta emiliana* (Pfeiffer, 1854) were influenced by the rainfall and soil pH; while *Allopeas gracile* (Hutton, 1834), *Leavicaulis alte* (Ferussac, 1822), *Lissachatina fulica* (Bowdich, 1822), *Cryptozona bistrialis* (Beck, 1837) and *Ratnadvipia irradians* (Pfeiffer, 1853) were influenced by the relative humidity. According to the correlation analysis, the gastropod species richness was positively correlated to the daily rainfall ($r=0.34$, $p<0.05$); the total species abundance at all the sites were positively correlated to the elevation ($r=0.56$, $p<0.05$) and negatively correlated to the atmospheric temperature ($r=-0.42$, $p<0.05$). The results of this study indicate that gastropods could become invasive and pests due to changes in climatic and environmental factors whilst causing severe economic losses to agricultural crops in the Nuwara Eliya district. Therefore, the knowledge on the effects of environmental factors, as revealed by the results of this study, can be used to formulate management plans to control the occurrence and distribution of pest gastropods in the Nuwara Eliya district.

Key words: Agricultural lands, Environmental factors, Nuwara Eliya district, Pest gastropods, Sri Lanka

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