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QUANTIFICATION AND SHAPE DETECTION OF BUTTERFLY EGGS: AN IMAGE PROCESSING APPROACH

Bioinformatics

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ABSTRACT

The objective of the present study was to quantify the numbers and measure the size of butterfly eggs by using image processing tool. We captured the image of butterfly eggs and processed within the CP tool (version, 2.1.0). The image was incorporated and analyzed in this tool as per specified input and analysis modules. Total numbers of eggs were quantified as per appropriate input and data were found in .csv extension. The number and size of eggs for individual identified object was recorded. In the present study, a total 16 eggs were identified in the image. Different shapes (mean radius) of the eggs were also obtained The study was based on image analysis as per different automated steps, which performed within th CP tool. In conclusion, this tool could be easily determined the amount and shape (mean radius) of butterfly eggs, which might be a simple way to measure the diversity of butterflies in the terrestrial ecosystem. Because the eggs quantification is also well-known methods for the future diversity of butterflies, which are beneficial towards the ecosystem.

KEYWORDS

Automated screening, Butterfly, Eggs, CP tool, Image analysis

INTRODUCTION

With an increasing rate of decrease in terrestrial ecosystems, especially those that sustain insects,[1] global biodiversity has been experiencing the Sixth Mass Extinction since the Industrial Revolution (mainly caused by human actions). According to global biodiversity models and long-term monitoring, environmental changes are causing a continuous and systemic decline in insect taxa. This loss is predicted to increase in the 21st century.[2,3,4] With declines observed even among common species.[5] Moreover, butterflies that are known to be environmental indicator species, suffer a higher net species loss than plants and birds. Urbanized areas see additional exacerbation of these drops due to habitat destruction, changes in land usage,[6] fragmentation of green spaces[7] and agricultural intensification.[8]

The diversity study can be known easily qualitative and quantitative level of fauna in an ecosystem. But the presence of eggs onto leaf surface can easily detect the emerging butterflies in future. The minimum quantity of eggs may quantify manually but image processing was well-known technique for faster screening of huge numbers of egg.

In this context, CellProfiler (CP, version 2.1.0), is an image analysing, fast screening, non-commercial tool, can measure more than 100 numbers of images as objects within short period for different cell types, cell lines, mammalian cells, yeast colony, etc. that stained with DNA binding dyes as fluorescent nature [9-12] and non-fluorescent nature of nucleus as per DNA binding dye in the peripheral reb blood cells [13,14] as well as microbial colony count ability with this tool.[12]

The objective of the present study was to quantify the numbers and measure the size of butterfly eggs by using image processing tool.

MATERIALS AND METHODS

Image of butterfly egg (Fig 1) was processed by using CellProfiler (CP, version 2.1.0), as per studied protocol of Carpenter et al.[9] followed by previous studies.[13,14]

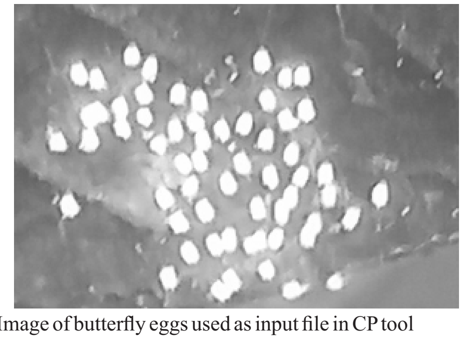

Fig 1: Image of butterfly eggs used as input file in CP tool

The image was incorporated and analyzed in this tool as per specified input and analysis modules. Total numbers of eggs were quantified as per appropriate input and data were found in .csv extension. The number and size of eggs for individual identified object was recorded as per earlier studies.[9,13,14] The input image is exhibited in Fig 1.

RESULTS

In the present study, a total 16 eggs were identified in the image. The study was based on image analysis as per different automated steps, which performed within th CP tool (Figs 2 – 10).

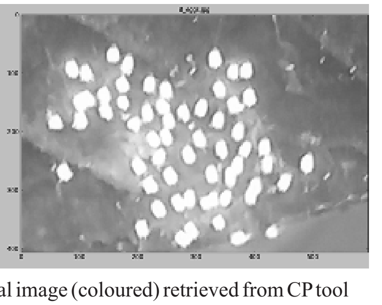

Fig 2: Original image (coloured) retrieved from CP tool

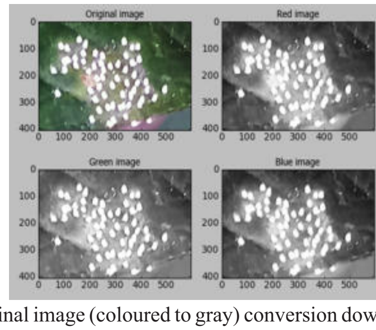

Fig 3: Original image (coloured to gray) conversion downloaded from CP tool

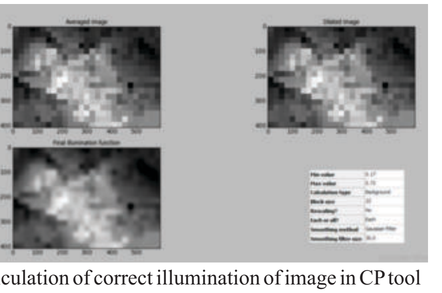

Fig 4: Calculation of correct illumination of image in CP tool

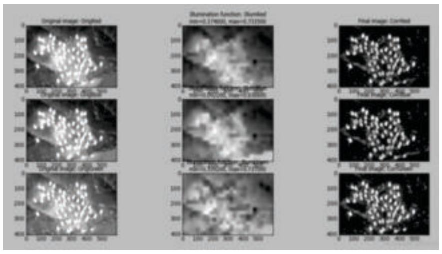

Fig 5: Correct Illumination Calculation Of Image In CP Tool

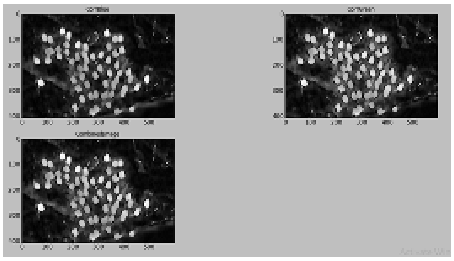

Fig 6: Mathematical Calculation Of Image In CP Tool

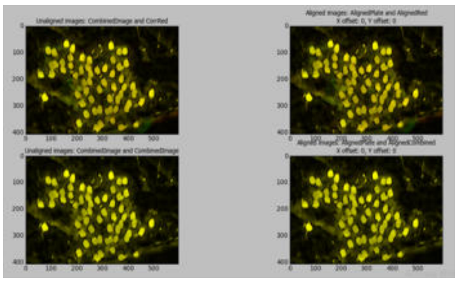

Fig 7: Alignment Of Image In CP Tool

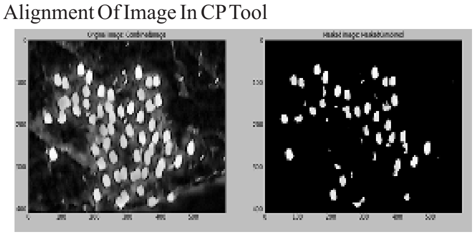

Fig 8: Masking Of Image In CP Tool

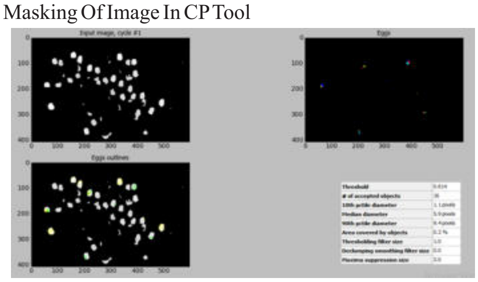

Fig 9: Identification Of Primary Object Of Image In CP Tool

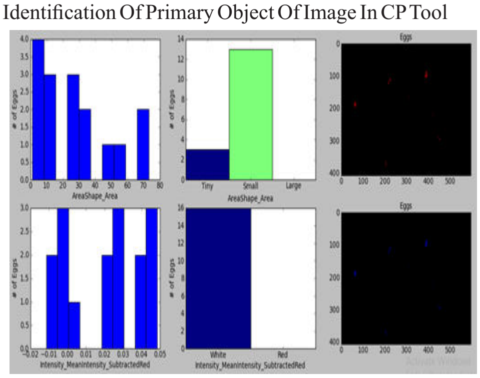

Fig 10: Area Shape Of Object Of Image In CP Tool

Different shapes (mean radius) of the eggs are graphically represented in Fig 11.

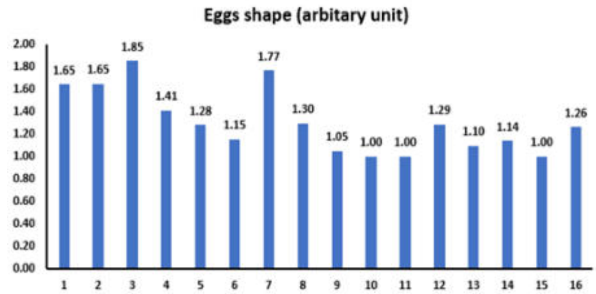

Fig 11: Measured Size And Numbers Of Eggs Obtained From CP Tool

DISCUSSION

Utilizing the CP tool, our research identified the amount and shape (mean radius) of butterfly eggs, which might be a simple way to measure the diversity of butterflies in the crops under investigation. The identification of butterflies using machine learning ML modelling has been the subject of several studies.

Almryad & Kutucu[15] used "Convolutional Neural Networks (CNNs)" for the identification of butterfly species in which 80% success was achieved for both test and training data compared to the experimental findings but Jagdish et al.[16] advocated for this novel effort, which highlighted the future diversity of butterflies after using image processing with a k-NN classifier for identification and categorization of the caterpillar. Another study by Efromson et al.[17] explored that species identification of caterpillar eggs could be performed by using ML modelling as CNN algorithm.

CONCLUSION

It is concluded that the CP tool used in the present study that could be easily used the amount and shape (mean radius) of butterfly eggs, which might be a simple way to measure the diversity of butterflies in the terrestrial ecosystem. Because the eggs quantification is also well-known methods for the future diversity of butterflies, which are beneficial towards the ecosystem.

Conflict Of Interest None

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