Conclusion

6. Conclusion

Digital morphometric method, shape analysis, Elliptic Fourier Analysis and Principal Component Analysis were employed to study the shape variation among Convolvulaceae members. The resulting data set was subjected to various cladistic methods for the generation of cladogram. I was able to analyse for the first time objectively and in detail the usefulness of the digital morphometric method as a viable option in species segregation. I was able to show.

(1) The digital morphometric method can successfully be employed in species delimitation and segregation based on various parameters.

(2) Only leaf shape cannot provide 100% accurate results regarding the species delimitation and segregation.

(3) From a phenetic standpoint, results clearly show the difficulty in detecting morphological grouping within the plants studied, which is not surprising in a group as persistently taxonomically problematic.

(4) From a cladistic perspective, the results show species segregation and grouping based on leaf shape which indicates that any possible speciation processes must be due to a particular combination of plesiomorphic features.

The variability in studied leaf shape does not show any remarkable pattern of association between species. According to the available literature and past studies we had expected a clearly defined pattern of association between species based on leaf shape. We did not detect non-overlapping or diagnostic morphological traits, nor did the PCA show distinctive grouping of species. Nevertheless, it would be desirable confirmation from procedures such as DNA barcode for two main reasons.

1. The frequent morphological homoplasy that affects the delimitation of infrageneric units within the genus.
2. The extremely low sampling size of the problematic species (known only from their type collections), thus perhaps no representative of the entire species variation.

We conclude that there is a statistically significant difference in mean leaf shape between Species of family Convolvulaceae, but the overlap is considerable and negates the use of leaf shape as a diagnostic character to distinguish the two taxa. Furthermore, inter-population differences are just as great as those between the taxa and the populations did not form consistent separate clusters corresponding to the taxa, neither was there any evidence of correlation of inter-population leaf shape variation and geographical distance. Our initial hypothesis is thus only partially upheld.

Further validation studies encompassing a broader spectrum of substances beyond leaves are necessary to ascertain this method's applicability for distinguishing other taxa. The selection and application of a specific morphometric technique for evaluating leaf shape are critical, as each method considers distinct facets of the leaf shape, which can introduce bias into the results. The present study demonstrates that elliptical Fourier descriptors are a straightforward method that can aid in the identification of plant species in the absence of reproductive and other diagnostic characteristics, as well as when molecular-level research is somehow unfeasible. Further investigations of taxonomic differences between and within the species of family Convolvulaceae are needed using a wider array of phenotypic and genetic characters and are justifiable in view of the socio-economic importance of both taxa. We see great potential in applying our approach to data obtained from species descriptions or large databases. In addition, this method can be used for fieldwork or on sensitive herbarium vouchers, especially when non-destructive in situ measurements are needed.

7. Future Prospects

Morphometrics, digital image analysis, and digital morphometric analysis in plant science research are promising, offering significant improvements in precision, efficiency, and scalability over traditional methods. Digital morphometrics, which involves the quantitative analysis of form using high-resolution imaging and advanced software, allows for more accurate and reproducible measurements of plant structures. This technique is particularly valuable in plant species segregation, providing objective and standardized data that can distinguish species with subtle morphological differences.

Digital image analysis enhances the ability to capture and analyze detailed images of plant specimens, facilitating the study of large collections and enabling quick as well as accurate species identification. Advances in imaging technology and processing algorithms will further enhance these capabilities. Machine learning algorithms, trained on extensive datasets of plant images and morphometric data, can recognize patterns and make accurate predictions about species identity, significantly expediting the identification process.

The combination of digital morphometric analysis and machine learning provides a powerful tool for plant species segregation. Digital morphometrics captures detailed morphological data, which machine learning models can analyse to classify species with high accuracy. This approach reduces human error and bias, enhances reproducibility, and allows for the efficient processing of large volumes of specimens. The integration of machine learning into this field offers even greater potential in future.

In conclusion, the integration of morphometrics, digital image analysis, and machine learning in plant science research holds immense potential for developmental biology, morpho-anatomy, molecular taxonomy, and phylogenetics. These technologies enable precise, efficient and crucial for biodiversity conservation and ecosystem management. As these fields develop, they will lead to new discoveries and innovations in plant science, enhancing our ability to study and protect the world's flora.