## ABSTRACT

A new classification of the Oliniaceae is presented. The monogeneric Oliniaceae is one of the smallest, but lesser known myrtalean families that has not been monographed since Cufodontis' (1960) revision, despite advances in analytical tools. In this thesis, a combination of morphometric phenetic (principal component analysis, principal coordinate analysis, and cluster analysis) and phylogenetic (cladistics) methods of analyses were used to critically evaluate the morphological variation; to determine the best taxonomic characters (quantitative and qualitative); and, based on these characters, to circumscribe species within *Olinia;* to propose and test hypotheses of phylogenetic relationships; and to provide a new classification of the Oliniaceae. Data were gathered from herbarium specimens and from populations in the field in order to gain an understanding of intra- and inter-specific and population level variation.

In this study, the basic assumptions often made by most plant systematists with regard to characters thought to be useful in the taxonomy of plant taxa, and the methods of character analysis often employed are tested. It is established that there are noteworthy exceptions to some of the commonly held indefensible views of *a priori* taxonomic knowledge of specific groups, especially in the Oliniaceae; instead the most objective means of assessing the relative merits of different data sets should be sought. It is also recognised in this study that one of biggest impediments to understanding species-level variation and diversity is not so much the lack of data and the sources (herbarium specimens or population level data), but rather the flawed methodology used to analyse data.

The classification presented in this study reflects remarkable morphological variation within *Olinia*, which is the basis for identification of species. The major delimiting characters between species were found to be the shapes of petals and leaves, presence or absence of indumentum and the degree of hairiness on floral parts, and the form of inflorescence units (i.e. being either compact or spreading). Insect infestations and their effect on the floral biology and morphology (size and length) in *Olinia* are discussed in the context of species circumscriptions. Different types of floral galls are associated with particular species groups, whereby flowers of some species twist and exhibit characteristic tubercles along elongated ridges of the hypanthium when infected by insects, completely different from flowers that expand and swell when infected.

The polymorphic or ochlo-species *O. rochetiana* complex was found to exhibit great morphological variation that does not correlate with geography, and hence not easily delimited using traditional methods. A scientific, systematic procedure and technique for analysing morphological variation in suspected ochlo-species is presented, and it involves numerical phenetic or morphometric methods of analysis through separate, yet sequential stages. The technique involves calibration of the character set, sub-sampling of the taxonomic operational units (OTU's), and a stepwise approach to analysing unresolved clusters or groups. These procedures are simple to perform and reduce the biases often involved in the delimitation of clusters in phenetic analyses. The standard taxon is identified and used to calibrate the character list in Cluster Analysis in order to inform the taxonomic decisions on where to delimit taxa on phenograms by using the level of phenetic dissimilarity at which members of the standard taxon join each other before they join other clusters as the criterion for delimitation of taxa. In order to avoid the calibration of the data set being influenced by

a single concept of a standard taxon, more than one standard taxon can be included in the analyses. The consistency of retrieving similar clusters in Cluster Analysis can be verified by analysing representative sub-samples of the data matrix. This provides the confidence with which to accept or reject the delineated clusters. Therefore, the consistent retrieval of the same groups in the different analyses of the sub-samples using different OTU's and numbers of OTU's of groups suggests that the groups are reliable based on the set of characters used, and that the groups obtained do not depend on the total number of OTU's or individual OTU's used in the analyses, but rather on the interpretation of variation among the studied taxa represented by the OTU's. The stepwise approach becomes useful when there is difficulty in the interpretation of phenetic similarities of clusters in ordination analysis. Accordingly, distinct clusters or groups of unquestionable distinctness in the ordination space are removed from the analysis, thereby increasing availability of ordination space to allow the remaining groups to spread beyond their original positions. During stepwise analysis, different suites of characters that correlated with other ordination axes often become dominant or active in separating the remaining clusters or groups of OTU's. This technique is recommended as a standard procedure in phenetic analyses since it improves the confidence that can be assigned to resultant clusters or groups, and also allows for finer resolution and clearer visualisation of phenetic similarities of unresolved clusters or groups.

The morphometric analysis of variation has established that *O. huillensis*, hitherto reported to occur only in Angola, is widespread in southern Africa and exhibits geographic segregates characterised as *O. huillensis* subsp. *huillensis* (largely the Angolan material with papery leaves), *O. huillensis* subsp. *burttdavii* (for plants with very short petioles; leaves that are broadly elliptic to obovate and leathery; inflorescences

that are compact with shorter internodes), and *O. huillensis* subsp. *discolor* (for plants with slender branches; longer petioles; thin, glossy leaves; inflorescences with longer internodes; and thin walls of floral tubes/hypanthia). The persistence of bracts and bracteoles through and after anthesis or their deciduousness before or at anthesis, including the reduction or not of axes of the inflorescence are critical distinguishing features among some sympatric species (*O. capensis* and *O. ventosa*, and between *O. micrantha* and *O. emarginata*) which are often confused. Two species (*O. radiata* and *O. micrantha* Decne.) are protected under the South African National Forests Act (Act No. 84 of 1998). The cladistic analyses corroborate and support the monophyly of *Olinia* as earlier demonstrated (Conti *et al.* 1996; Schönenberger & Conti 2003). Two major clades are recognisable at sectional levels: Section *Olinia* and Section *Rochetiana* with the latter representing all tropical and subtropical taxa (*O. rochetiana sensu stricto*, *O. ruandensis*, *O. usambarensis*, *O. huillensis* subsp. *huillensis*, *O. huillensis* subsp. *burttdavii*, and *O. huillensis* subsp. *discolor*) whereas the former section, which includes the type species *O. ventosa* (L.) Cufod. for the genus *Olinia* and bears the autonym, represents all the temperate taxa (*O. emarginata*, *O. radiata*, *O. capensis*, *O. micrantha*, *O. ventosa*, and *O. vanguerioides).* The recognition of these two sections leaves *Olinia* phylogenetically natural (i.e. monophyletic), and from a taxonomic point of view the two sections or species groups have unique morphological synapomorphies.

Accepting that plant taxa should be reproductively isolated and phenotypically distinct (Rieseberg *et al.* 2006), the discrete non-overlapping phenotypic clusters obtained in the phenetic analyses were considered to represent taxonomic entities. Therefore, the phenetic and ecological concepts of species are applied at the specific and subspecific

levels, respectively. Variation in the polymorphic *O. rochetiana* species complex is best explained using the ochlo-species concept (White 1962). Types (holotypes, isotypes, and iconotypes) were designated and cited for all species and their synonyms. A full taxonomic account of Oliniaceae worldwide is provided with an identification key, descriptions and distribution maps for all taxa recognised.