

## CHAPTER 10: GENERAL CONCLUSIONS

### 10.1 Genera

*Boerhavia* and *Commicarpus* are two distinct genera which can be distinguished by means of morphological and anatomical characters. They differ morphologically in growth form, inflorescence type, the shape and indumentum of the upper and lower parts of the flower, and in the shape and indumentum of the anthocarp. *Boerhavia* are upright or spreading herbs with compound cymes. The upper part of the flower is campanulate and lower part five-ribbed or 3–5-winged, glabrous or covered with trichomes. The anthocarp is clavate or elliptic-clavate, five-ribbed or 3–5-winged, glabrous or covered in trichomes. *Commicarpus* comprises subshrubs, spreading or scrambling herbs with an umbel. The upper part of the flower is infundibuliform and the lower part has ten ribs with 5 or 10 prominent glands around the apex and less prominent glands below the apex. The anthocarp is cylindrical, fusiform, clavate or elliptic-clavate and ten-ribbed with sessile or stalked glands.

Leaf and anthocarp anatomy can be used to distinguish between the two genera. The minor veins of the leaves of the *Boerhavia* species are surrounded by Kranz anatomy and the sclerenchyma in the anthocarps is present within the ribs and the area between the ribs. The minor veins of the leaves of the *Commicarpus* species are surrounded by parenchyma cells and the sclerenchyma in the anthocarps is only present in the rib area. The number of chlorenchyma rows in the stem might also be a diagnostic character to distinguish between *Boerhavia* and *Commicarpus*, but further investigation is required.

Pollen morphology can broadly distinguish between *Boerhavia* and *Commicarpus*, but the shapes and sizes show too much variation between species to justify the use as diagnostic characters. The pollen of *Boerhavia* and *Commicarpus* is uniform in shape and sculpturing. The pollen grains are spheroidal, pantoporate and the tectum is tubuliferous and spinulose, the collumellae are short, the foot layer is thick and the endexine is thin. Numerically, the pollen grains of the *Boerhavia* species are smaller than that of the *Commicarpus* species. The pore diameter of the *Commicarpus* species

is larger than that of the *Boerhavia* species and the exine of the *Commicarpus* species is thinner than that of the *Boerhavia* species.

Neighbor-joining and maximum likelihood analyses using sequences obtained from the ITS and *ndhF* genes divide *Boerhavia* and *Commicarpus* in two clades with high bootstrap support, thus supporting the morphological and anatomical results. The type specimen of *Commicarpus* (*C. scandens*) groups inside the *Commicarpus* clade, which supports the hypothesis that *Commicarpus* in southern Africa is indeed *Commicarpus* and not *Boerhavia*.

## 10.2 Species

Morphologically, seven species of *Boerhavia* and eight species of *Commicarpus* can be distinguished. The anthocarp and the lower, coriaceous part of the flower provide the most valuable taxonomic characters by which to distinguish the different species. The shape of the anthocarp, the ribs and the presence of the trichomes are species specific for *Boerhavia* and the shape of the anthocarp and the arrangement of the stalked glands around the apex, together with the arrangement of the wart-like glands below the apex, is species specific for *Commicarpus*. The arrangement of the glands, ribs and trichomes on the lower, coriaceous part of the flower is species specific, except for *B. coccinea* var. *coccinea*, *B. diffusa* var. *diffusa* and *B. repens* subsp. *repens* which are similar. *Commicarpus fruticosus* and *C. squarrosus* are morphologically similar except for flower colour, and cannot be distinguished by either their anthocarps or the lower, coriaceous part of the flowers. Growth form and foliage of the different species are similar, but does allow for the division of each genus into smaller groups which can make identification easier (e.g. the upright growth form and elongated, elliptic-lanceolate leaves of *B. deserticola* and *B. hereroensis* distinguish them from the prostrate, decumbent or procumbent growth form with roundish leaves of other *Boerhavia* species).

The anatomy of the stems, leaves and anthocarps of the different *Boerhavia* and *Commicarpus* species is uniform and uninformative and cannot be used to distinguish between the species. The shape of the sclerenchyma bundles in the anthocarp of the *Commicarpus* species can possibly be applied to divide *Commicarpus* into two groups

(that is, a group with rounded sclerenchyma bundles and a group with elongated sclerenchyma bundles), but further investigations are still needed.

The molecular analyses support the distinction of the different species as defined by the morphology and group the morphologically similar *C. fruticosus* and *C. squarrosus* in close relation. The *Boerhavia* species are divided into two subclades. *Boerhavia cordobensis*, *B. diffusa* var. *diffusa* and *B. erecta* are species alien to southern Africa and form a distinctive subclade. *Boerhavia deserticola*, *B. hereroensis* and *B. repens* subsp. *repens* are indigenous to southern Africa and group together in a second subclade. *Boerhavia coccinea* var. *coccinea* (whose origin is not known) groups with the indigenous *Boerhavia* species. The groupings of the *Commicarpus* species are varied and not ascribable to specific non-molecular trends. The extra-African *C. plumbagineus* and *C. helenae* var. *helenae*, and the African limited *C. pentandrus* and *C. decipiens* group together, but this is not supported by the morphology.

This investigation of the phylogeny was indeed preliminary, as more samples and genes still need to be incorporated and the results interpreted in combination with the morphological, anatomical, palynological and biogeographical data.