

What's up with the spirally twisted keel beaks in *Crotalaria* flowers?



Alexander Rockinger¹ and Susanne S. Renner¹
 Institute of Systematic Botany and Mycology, University of Munich, Germany

a.rockinger@gmail.com

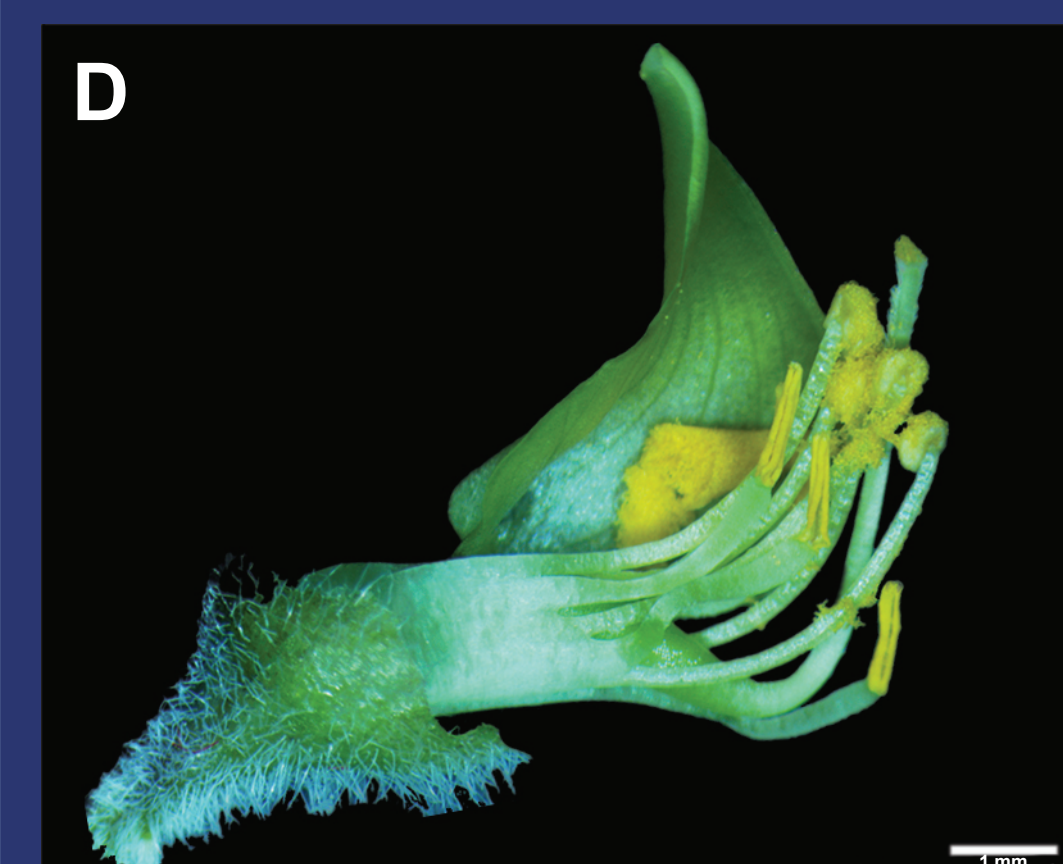
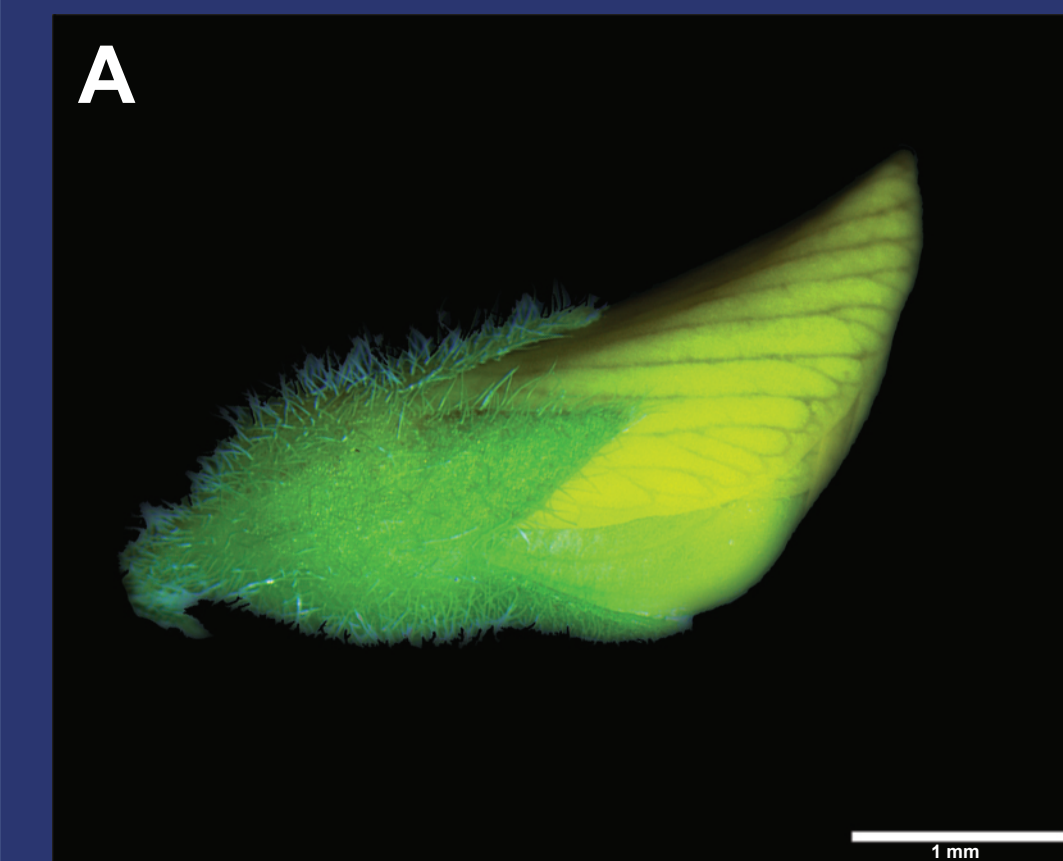
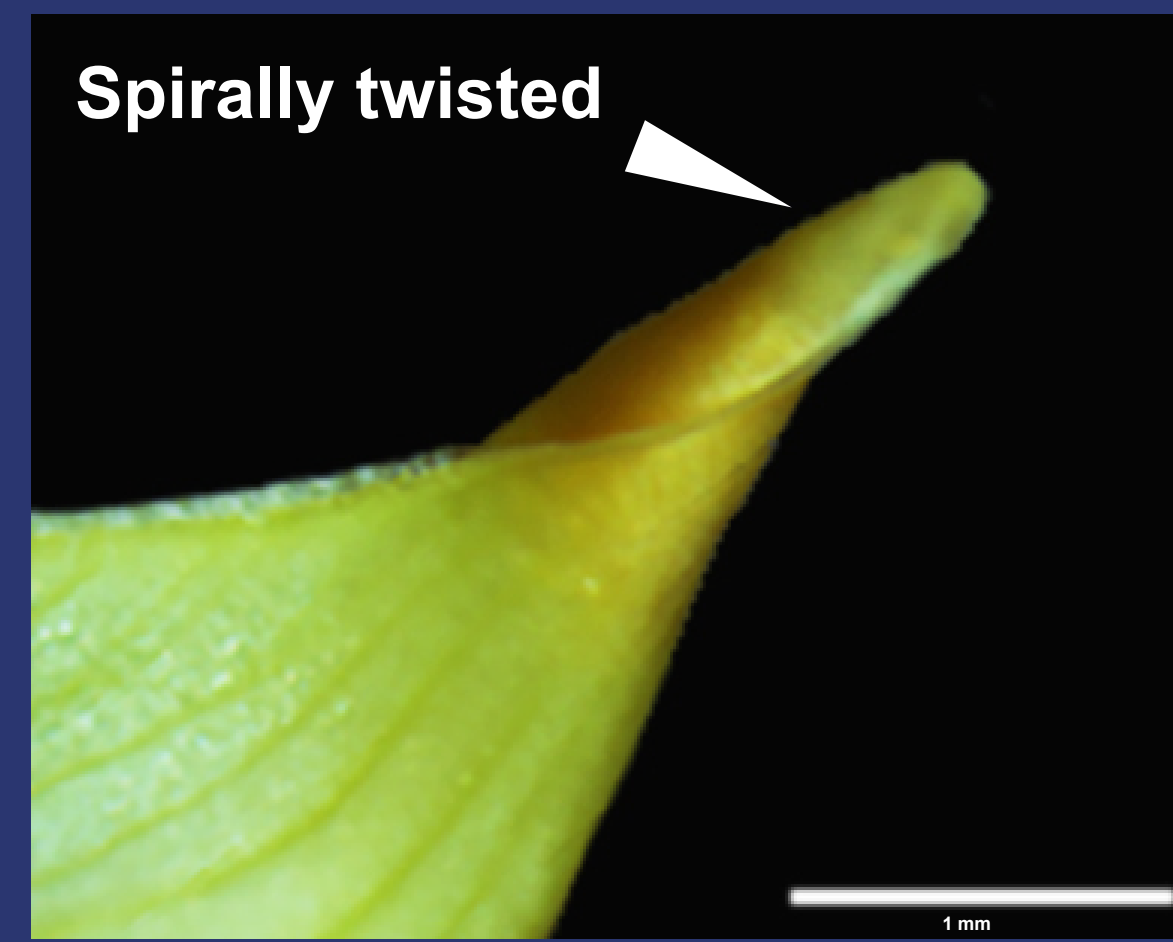
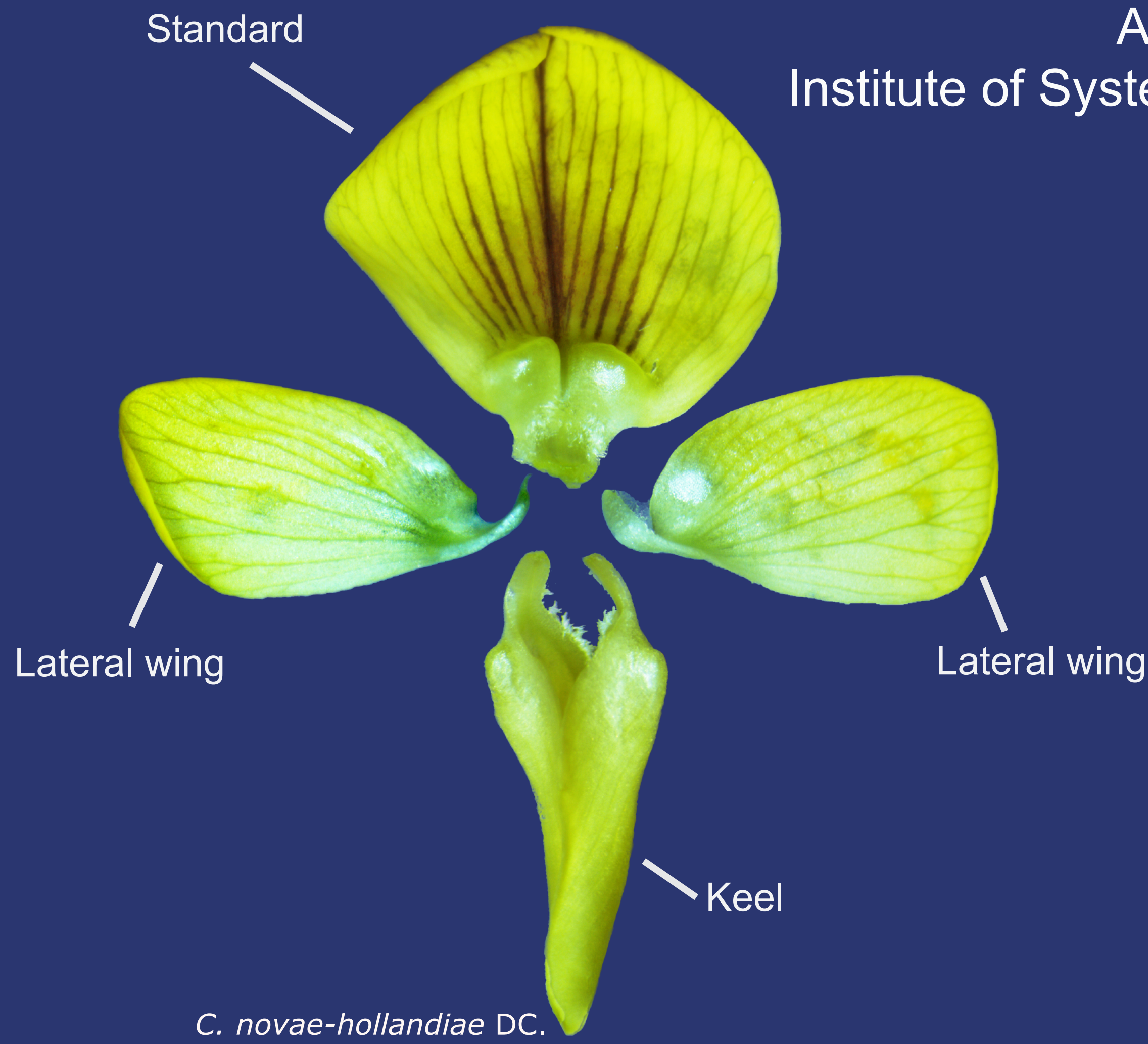
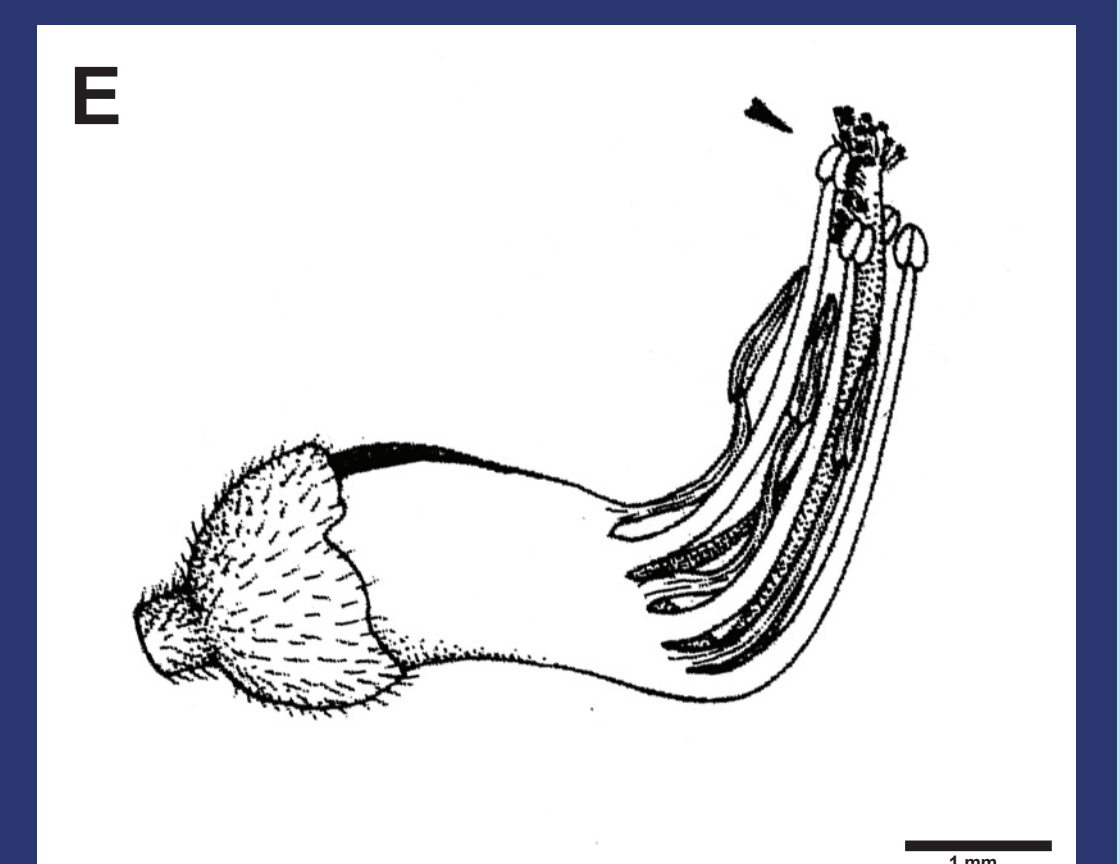
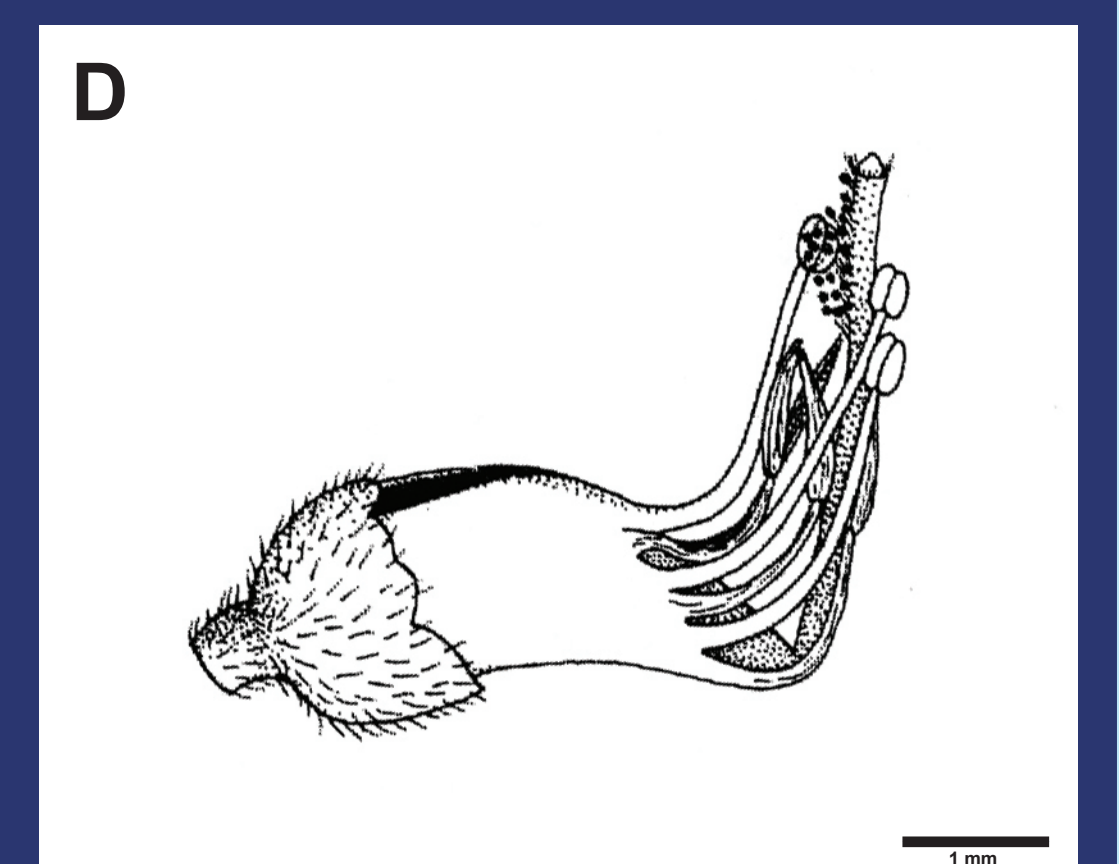
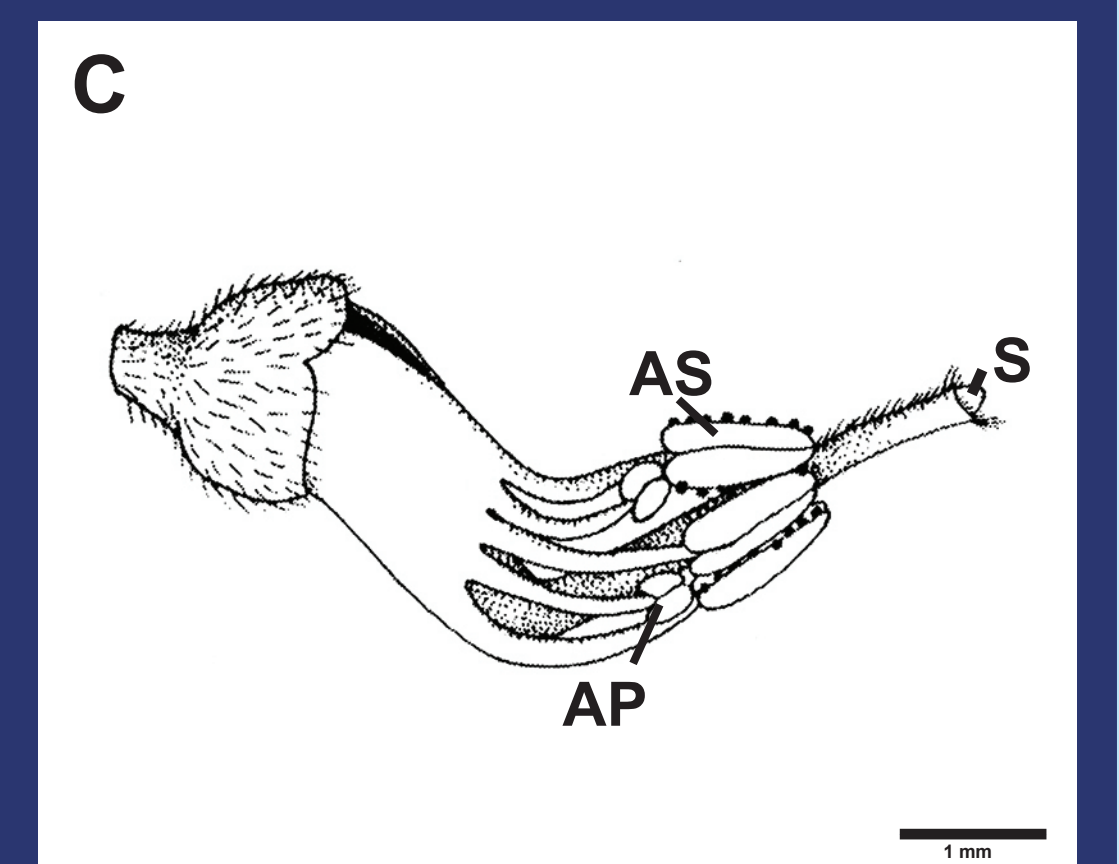


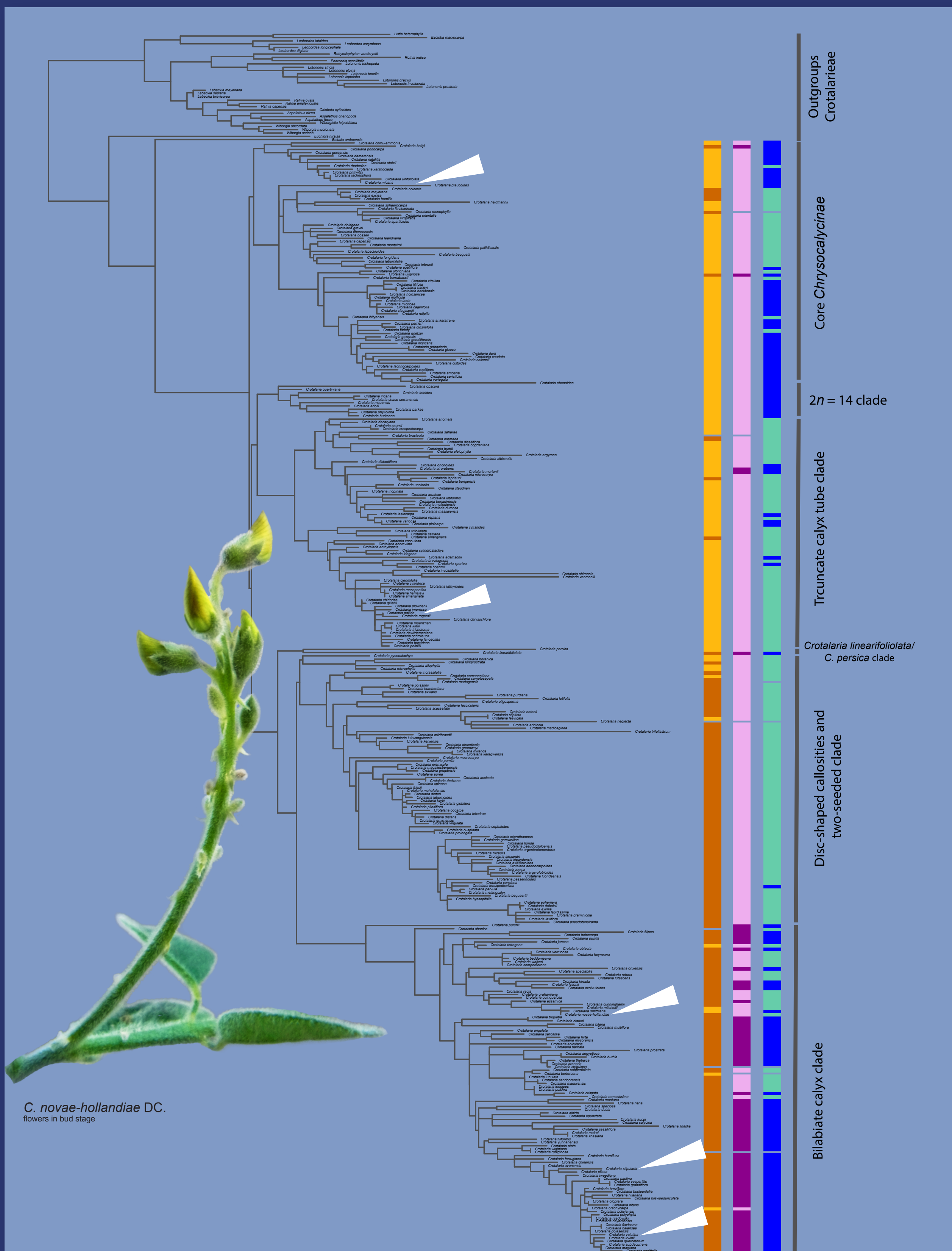
Plate 1. Development in *C. novae-hollandiae*

A and B) Early bud stage;
 C) One day before anthesis, Day 1: dehiscence of the antisepalous stamens (AS);
 D) Day 2: Growing of filaments towards the stigma (S) and dehiscence of the antipetalous stamens (AP);
 E) Day 3: Self-pollination

Drawings: *C. stipularia*, modified from Etcheverry 2001



A phylogeny, comprising 48% of the 700 species of *Crotalaria*, is in Fig. 1. Half of the species have a spirally twisted keel beak, the rest have straight beaks (Fig. 1). All flowers have a piston-type pollination mechanism in which the hairy style brushes out the pollen of the antisepalous anthers through the keel beak (Plate 1; Plate 2 B, C, E). This mechanism fits with the abdominal scopae of the pollinators of *Crotalaria*: bees of the cosmopolitan Megachilidae (4000 species). Later dehiscence of the antipetalous (Plate 1 E) anthers allows for delayed selfing (Etcheverry 2001; Etcheverry *et al.* 2003).



Flowers have been studied in:
C. micans (Americas, beak not twisted),
C. novae-hollandiae (Australia, twisted),
C. pallida (Africa, pantropical, not twisted),
C. stipularia (South America, twisted),
C. velutina (Brazil, twisted) (Fig. 1, white arrows). Developmental stages are identical in these species (Plate 1). Flowers last for 36–48 h. Presumably, the keel's function lies in proportioning the pollen.

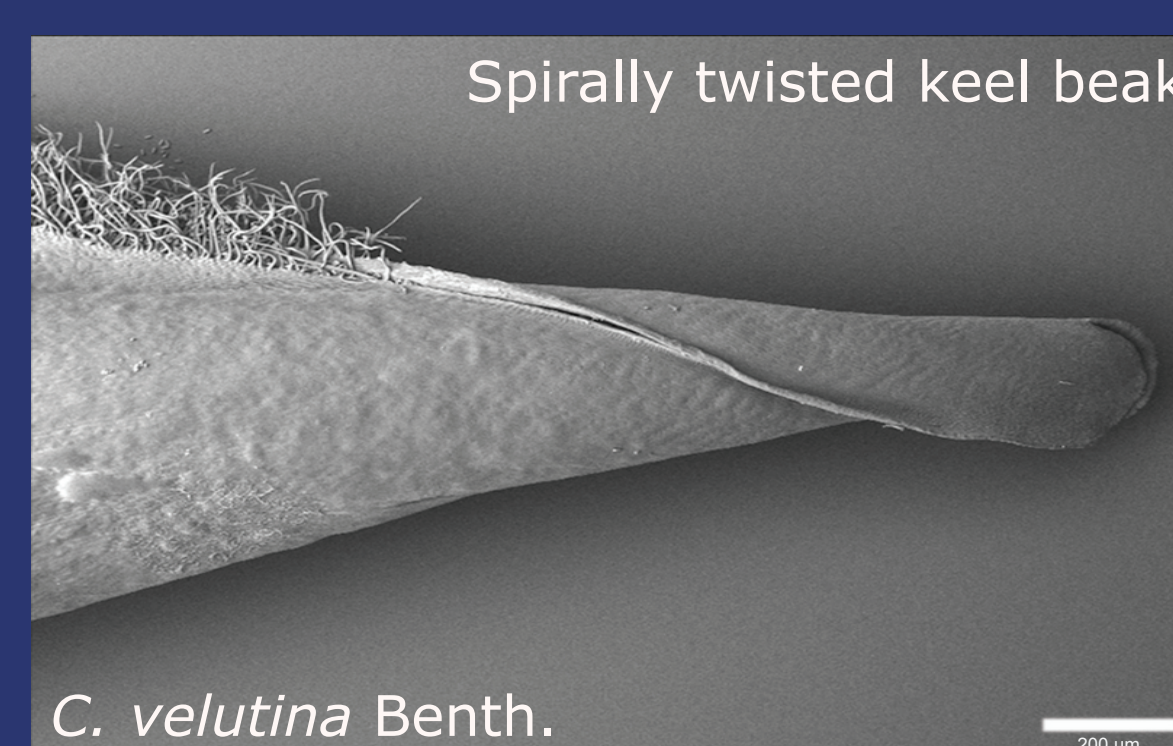


Plate 2. Foot holds, nectary, and pollen presentation

A) Foot holds for the bees' tarsi; B) Styler brush with non-receptive stigma and pollen grains; C) Style and ovary with rest of calyx and peduncule; D) Appendages on the standard petal block nectar access from the side; E) Pollen being released after the piston mechanism has been triggered; F) Staminal aperture granting access to nectar (calyx, standard, and wing petals removed)

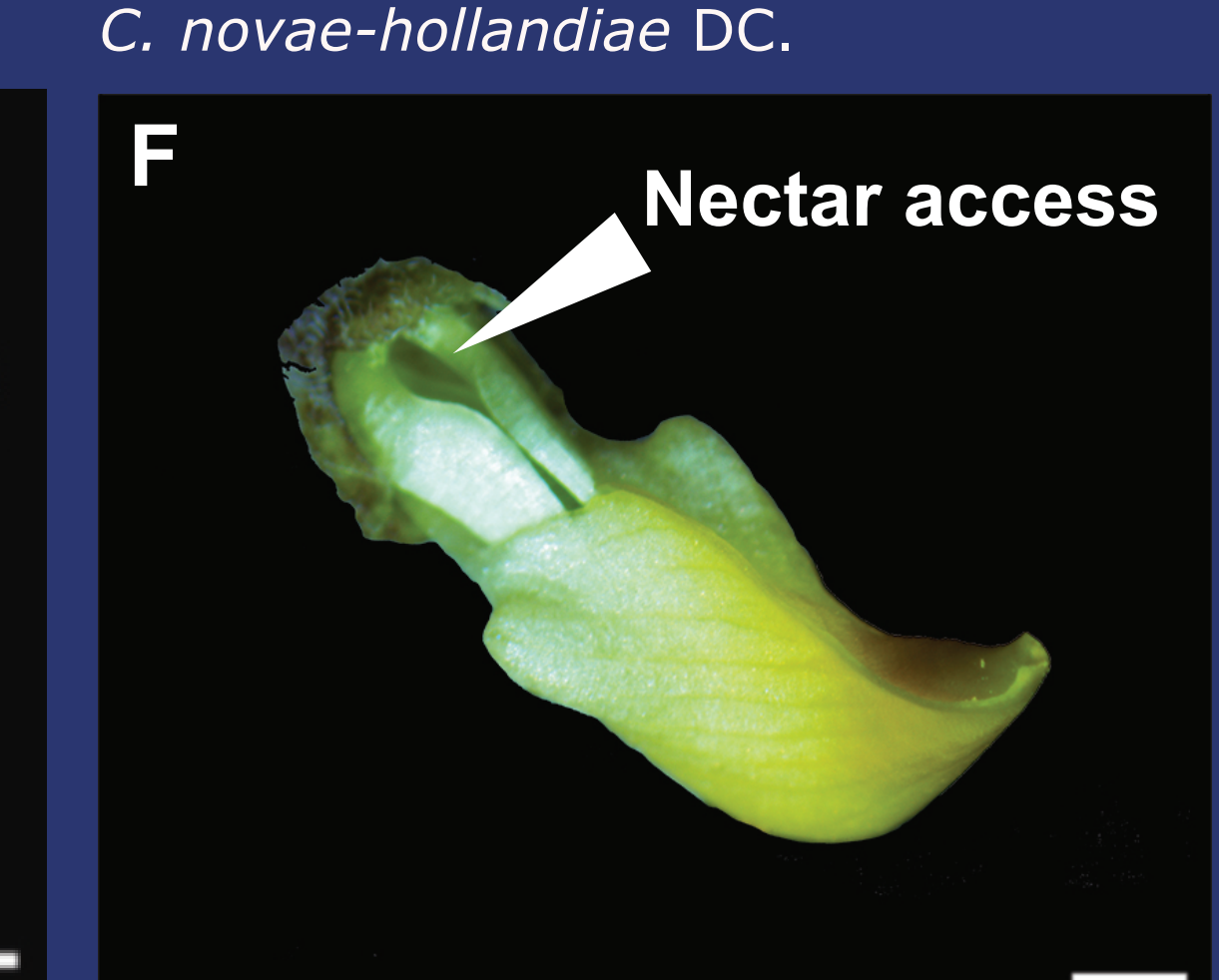
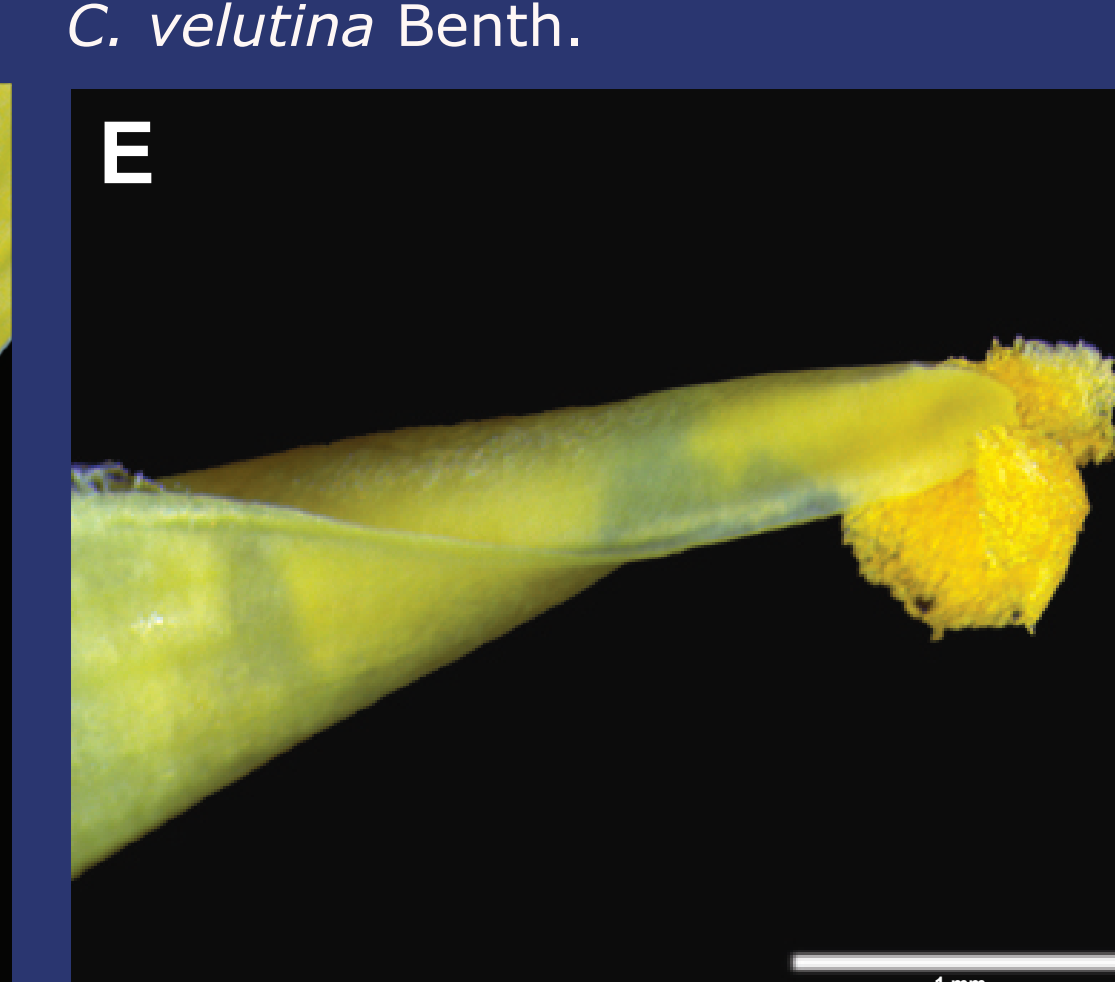
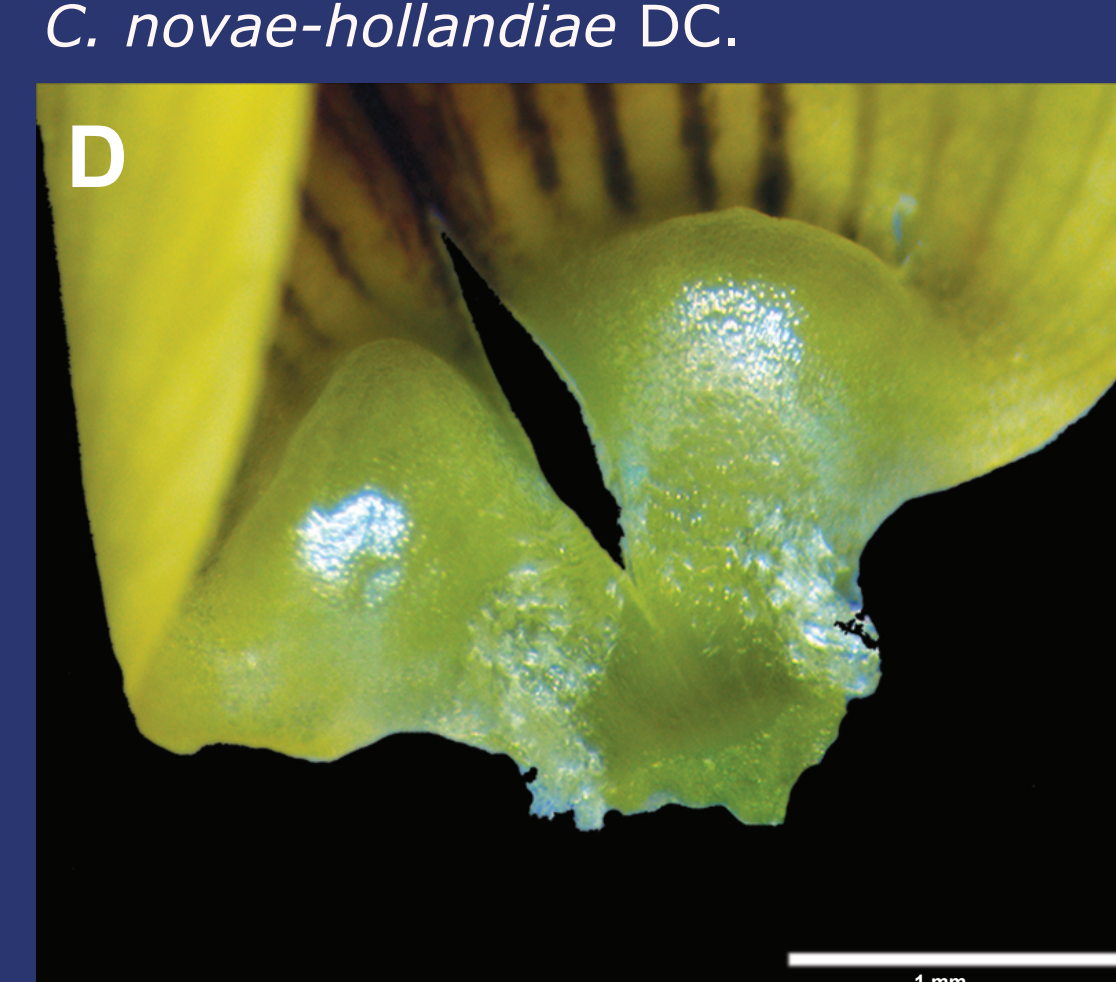
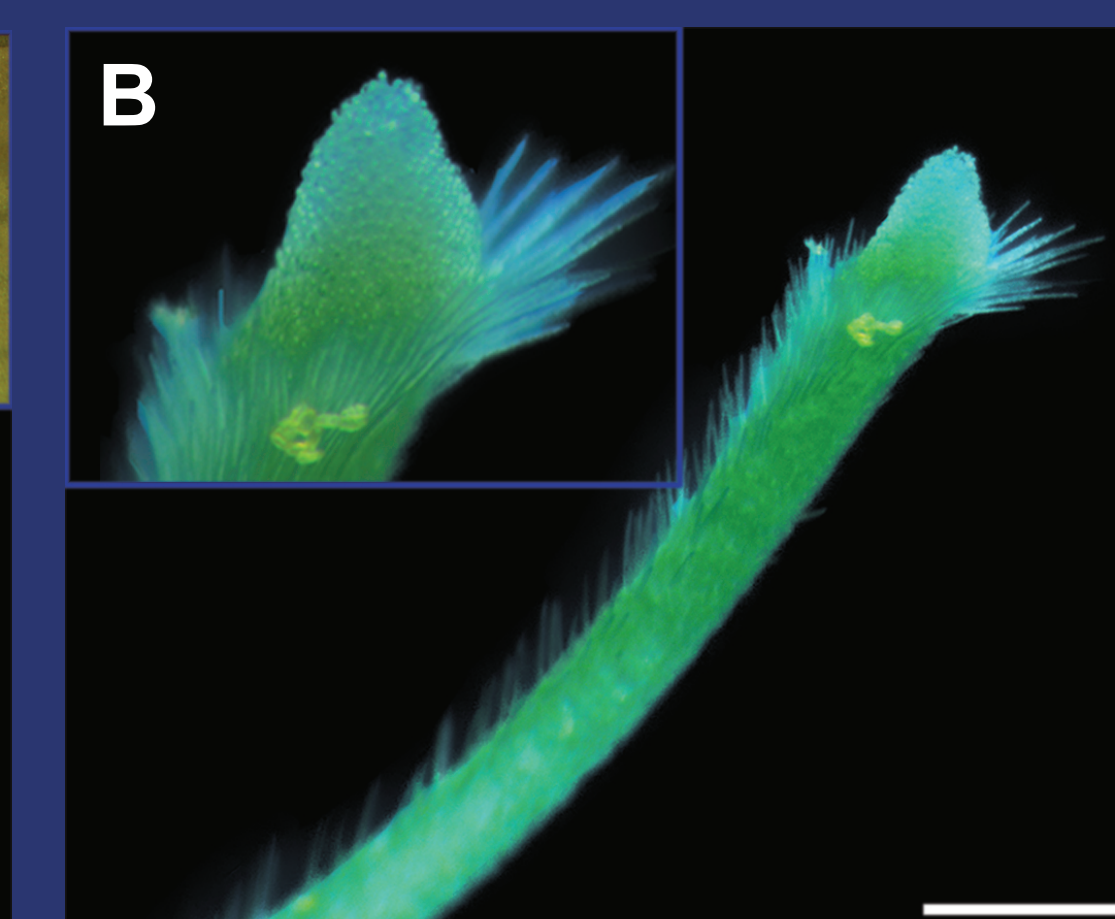
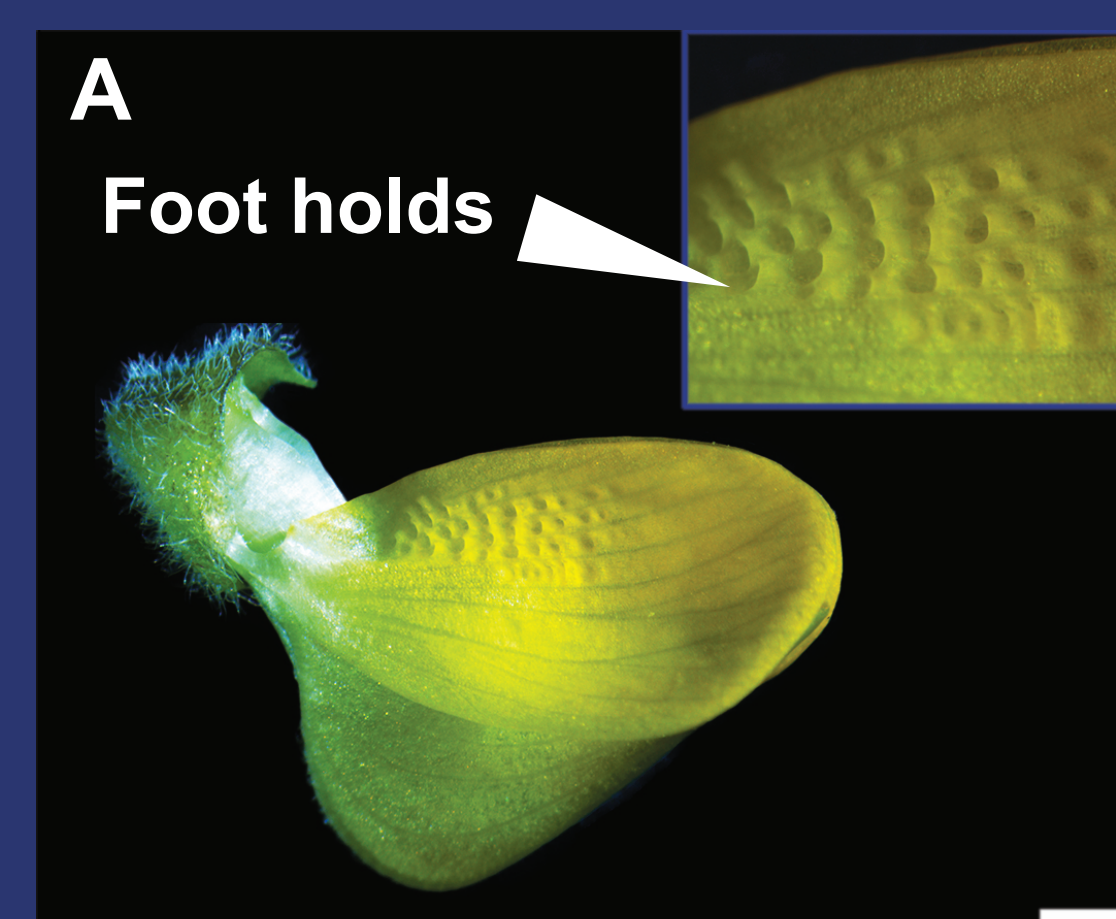


Fig. 1. Maximum likelihood tree for 372 accessions representing 338 species of *Crotalaria* and 33 species of the remaining 15 genera of Crotalariaeae based on 3171 aligned nucleotides of nuclear and plastid sequences, and with key flower traits plotted: Keel beak (spirally twisted; not twisted), calyx (bilabiate; equally lobed), and length of calyx (as long as/longer than keel; shorter than keel). Modified from Rockinger *et al.* (in review).