Pavel B. Klimov
Barry M. OConnor

University of Michigan, Museum of Zoology,
1109 Geddes Ave., Ann Arbor, MI

Multivariate Discrimination Among Cryptic Species of the Mite Genus *Chaetodactylus* (Acari: Chaetodactylidae) Associated with Bees of the Genus *Lithurgus* (Hymenoptera: Megachilidae) in North America

Context: Three cryptic species of *Chaetodactylus* associated with bees of the genus *Lithurgus* were detected on the basis of measurements of **27** variables in 111 specimens. Canonical variates analyses with best subset variable selection approach developed a **six**-variable classification model capable of discriminating the species with 100% accuracy in jackknife and external cross-validation. Elimination of variables based on the lowest potency index and stepwise CVA failed to find the most optimal subset of variables.

Mites of the genus *Chaetodactylus* are serious pests of several species of economically important pollinators. Correct identification of these pests is imperative to monitor for host shifts and assess their long-term effect on the bee welfare.

1. MATERIAL
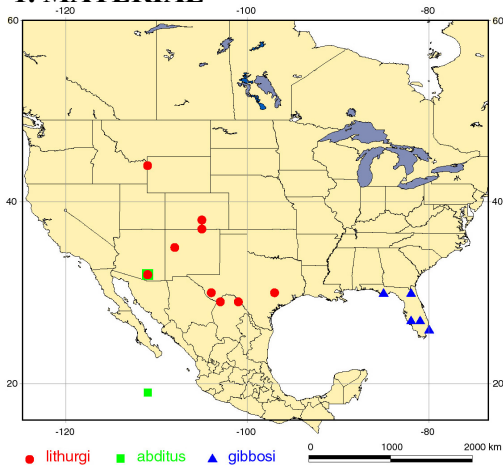
Mites were collected from museum bees. Five of seven species of *Lithurgus* were sampled. Several collections were made in the sympatric zone in Arizona. A total 27 variables of 211 specimens belonging to three putative morphs were measured.

3. HOST ASSOCIATIONS

Chaetodactylus is a cleptoparasite of megachilid and apid bees feeding on provisioned pollen in the bee nest. Many bees of the genus *Lithurgus* are pollinators of cacti.


A megachilid bee, *Lithurgus echinocacti*, covered with *Chaetodactylus* mites on a flower of a barrel cactus (*Ferocactus*)
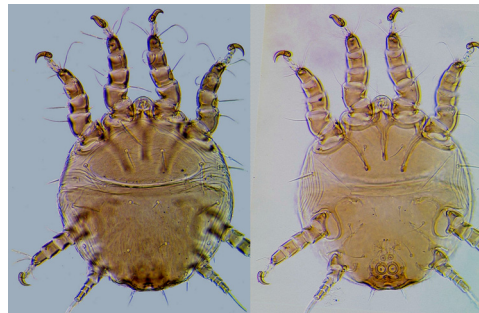
Chaetodactylus gibbosi (ms. n..) phoretic deutonymph: dorsal and ventral view

3. STATISTICAL ANALYSES

We conducted two principal component analyses on log raw data and log Darroch and Mosimann shape variables data to identify whether differences are due to size, shape, or both.

A glance to the size-and-shape (**1**) versus shape plots (**2**) suffices to show that most differences between the morphs are shape-related.

Now we can conclude that the three morphs are distinct species.

1. Before size-correction (raw, size-and-shape data)   2. After size correction (shape data)
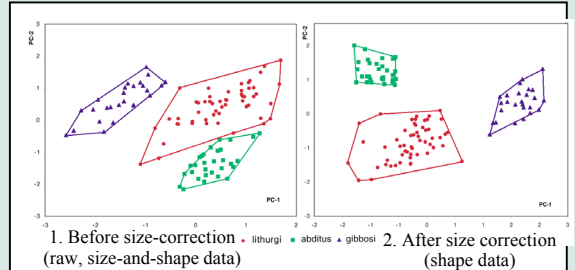
The next step is to build a classification model that has the smallest number of variables and the highest classification accuracy. We compared three methods of variable selection: elimination of variables based on the potency index, stepwise CVA, and best subset method. The latter method produced 29 five-variable models, while the two former methods gave models with larger numbers of predictors.

The results of the best subset approach were validated using an external sample (n=100), Only four six-variable models had 100% accuracy in both jackknife and external cross-validation. Based on Akaike information criterion., we selected model #4.
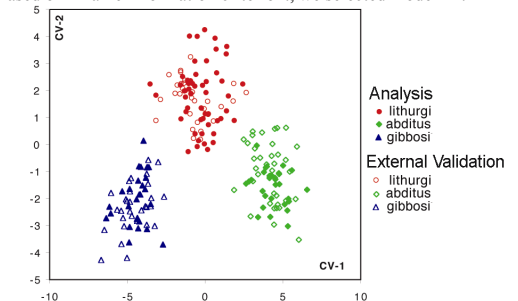
Results

- There are three cryptic species of *Chaetodactylus* associated with *Lithurgus* in North America; *Chaetodactylus gibbosi* ms. n. is geographically isolated from *C. lithurgi* ms. n.. Sympatric *C. lithurgi* and *C. abditus* ms. n. are seasonally isolated in Arizona.
- Host ranges *C. lithurgi*: *L. apicalis, L. littoralis, L. gibbosus*; *C. abditus*: *L. planifrons, L. echinocacti*;*C. gibbosi*: *L. gibbosus*.
- A six-variable model developed by CVA is capable of classifying the three species with 100% accuracy.