Comment

Oribatid mites and skin alkaloids in poison frogs

A recent publication in Biology Letters added a new family, Eleutherodactylidae, to the list of frogs known to possess defensive, toxic alkaloids in their skin—the so-called ‘poison frogs’ [1]. The alkaloids have attracted much attention since they are not synthesized by frogs de novo, but rather are obtained from dietary sources and subsequently sequestered in the frogs’ skin [2]. These ‘cleptotoxins’ comprise several pumiliotoxins and other lipid-soluble alkaloids that are known or suspected to be present in the frogs’ prey, which includes ants, beetles, millipedes and, most notably, oribatid mites [2,3]. Four lineages of phylogenetically unrelated poison frogs that sequester prey alkaloids were previously recognized (Dendrobatidae, Mantellidae, Bufonidae and Myobatrachidae), and the abovementioned miniaturized eleutherodactylid frogs from Cuba [1] represent a fifth.

As with dendrobatids [2], oribatid mites were suspected to be the major dietary source for alkaloids in eleutherodactylid frogs, since many specimens from different oribatid taxa—including Enarthronota, Mixonomata, Nothrina (Desmonomata s. stricto) and Brachyphyllina—were found among the stomach contents of Eleutherodactylus iberia and Eleutherodactylus orientalis. However, the majority of the collected mites probably do not produce alkaloids. Rather, they produce and secrete entirely different chemical classes of compounds, including hydrocarbons, terpenes and aromatics [4–15]. Alkaloids are known to occur only in certain restricted taxonomic groups of the derived cohort Brachyphyllina; these include certain families in Oripodoidea (Scheloribatidae, Drymobatidae and Mochlozetidae) and possibly also Galumnidae (Galumnidae), though the latter is uncertain. Alkaloid presence has been experimentally demonstrated for only two species of Scheloribates (Scheloribatidae) [2]. The production site of alkaloids in Scheloribates is assumed to be a pair of large exocrine glands that are referred to as ‘opisthoanal glands’ or ‘oil glands’ in the literature. These glands are present in all but the most primitive oribatid mites and constitute their main exocrine system. Their secretions appear to be taxon-specific, as shown by the large amount of chemical data compiled in the last 15 years [4–15].

Based on these data, the following points seem likely.

(i) All enarthronotan representatives found in stomachs of eleutherodactyid poison frogs (e.g. family Lohmanniidae) are unlikely sources for alkaloids since they do not possess opisthoanal glands. The same is true for certain mixonomatan representatives, such as Steganacaridae. (ii) Other mixonomatan representatives found in frog stomachs—such as Eupthiracaridae and especially Oribotritiidae—are known to synthesize characteristic iridoid monoterpenes and diterpenes, along with hydrocarbons, but not alkaloids. (iii) All nothrines found in eleutherodactylid stomachs (such as Nothridae and Thryphonchonidae) are well-known sources for terpenes, hydrocarbons and aromatics, but there is no evidence for alkaloid production. (iv) Thus, only the few brachypyline species among the prey of Eleutherodactylus can be regarded as possible sources for their skin alkaloids and, based on existing knowledge [3], of these only species of the genus Scheloribates seem likely. The exocrine chemistry of other brachypyline prey, including Galumnidae, Hermannniellidae and Oppiidae, remains to be elucidated.

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