

# *Colostethus beebei*



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## **Charismatic Jewel of the Lost World: The Golden Rocket Frog**

Photos by Philippe J. R. Kok





A small *Brocchinia micrantha*, exclusive biotope of the golden rocket frog, with Kaieteur Falls in the background



The genus *Colostethus* Cope, 1866, a Neotropical dendrobatid frog, encompasses more than 120 extant species (FROST, 2004), commonly known as the rocket frogs (FRANK and RAMUS, 1995) because of their explosive jumping ability. Many new species of *Colostethus* have been described in the past few decades, and we assume that many others still await discovery and scientific description.

In fact, no fewer than 25 species have been described just since the beginning of the 21st century, mostly from Colombia, Brazil, and Peru. *Colostethus* species diversity appears to be greatest in northwestern South America, decreasing to the east, southeast, and north (into Central America).

Rocket frogs are usually small with cryptic coloration, lacking the toxins and aposematic coloration characteristic of most other dendrobatids.

According to DALY et al. (1994b), the species of the genus *Colostethus* are unable to take up lipophilic alkaloids. Nonetheless, one species, *Colostethus inguinalis* (Cope, 1868), from Colombia, is known to be toxic (DALY et al., 1994a).

Rocket frogs are found from central Costa Rica to northern Peru and the Guianas (Guyana, Suriname, and French Guiana), and through the Amazon Basin to southeastern Brazil, as well as on the Caribbean island of Martinique (FROST, 2004). *Colostethus* species can be found at different elevations ranging from sea level to about 4,000 meters. Most rocket frogs are primarily diurnal, ground-dwelling inhabitants of the leaf litter in tropical forests.

The genus *Colostethus* shows great interspecific variability in reproductive behavior. Tadpoles of some species are exotrophic (feeding on materials not derived from a parent); tadpoles of other species are endotrophic (deriving their developmental energy and nutrition from vitellogenic yolk or other parent-produced material) (ALTIG and JOHNSTON, 1989).

Similarity in coloration, pattern, and morphology between different species of *Colostethus*, combined with conspecific color-pattern polymorphism (variation within single species), has led to some taxonomic confusion, especially within the species of the Guianas. For example, *Colostethus beebei* (Noble, 1923), which does not occur in French Guiana, has been erroneously reported from there on several occasions (LESCURE, 1976; LESCURE and MARTY, 2000; HOOGMOED and AVILA-PIRES, 1991; BOISTEL and DE MASSARY, 1999; KOK, 2000; FROST, 2004). *Colostethus brunneus* (Cope, 1887) has been reported from the Guianas, but the frogs seen probably belong to one or more undescribed species (MORALES, 2002).

Many *Colostethus* species have suffered severe local population declines during the past 10 to 20 years, and some species that were once very abundant are now difficult



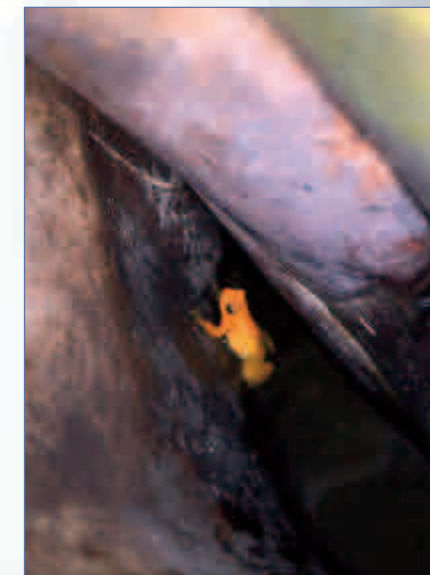
At least three golden rocket frogs inhabit this giant terrestrial bromeliad

to find. COLOMA (1995) presented disturbing evidence of declines in Ecuadorian populations of some *Colostethus* species. Habitat destruction and global warming are probably the main causes of decline, but a complex of factors including, diseases, increased UV radiation, environmental acidification, and agrochemicals are also implicated (POUGH et al., 2004). The paucity of data on the status of populations is clearly a major limitation on our ability to monitor trends in population numbers is needed for accurately determining threat status. *Colostethus* populations seem to remain stable in protected areas, but this must be confirmed by field censuses. In any case, endemic species with very restricted geographical ranges should always be considered at risk (POUGH et al., 2004).

#### Description

*Colostethus beebei* is a tiny, charismatic frog commonly called the golden rocket frog, or Beebe's rocket frog

(FRANK and RAMUS, 1995). The male reaches 16.6 millimeters in length; the female 19 millimeters (BOURNE et al., 2001). The species was first described from a single female specimen collected in 1921 by William Beebe near Kaieteur Falls,



The most commonly seen bright-yellow morph was usually seen on live green leaves, but sometimes also on dead brown leaves

Guyana. NOBLE (1923) distinguished the new species from other *Colostethus* species by its small size, brilliant coloration (extremely unusual for the genus), and short but well-defined webbing between the toes.

BOURNE (2001) recognized five different color-pattern morphs, three of which are brilliantly colored. In June 2004, during the first phase of our sampling of the Kaieteur herpetological richness, we collected two clearly distinct morphs: one bright yellow (the most commonly seen), and one brown. We observed the types of discrete variation within the yellow morph and brown morph as detailed by BOURNE (2001).

#### Distribution and habitat

As far as we know, *Colostethus beebei* is endemic to Guyana, and occurs only in Kaieteur National Park. Guyana is known as "Land of Many Waters" because of its numerous rivers and streams. The country lies over part of the Guiana Shield (or Guiana Highlands), one of the



world's oldest geological formations, renowned for its rich biodiversity. The higher, central parts of the Guiana Shield are covered with sandstone remnants of the Roraima formation (HOOGMOED, 1979), a breathtaking landscape marked by more or less flat-topped peaks called "tepui." Sir Arthur Conan Doyle's *The Lost World* was inspired by this area. The Pakaraima Mountains of central-western Guyana are part of the Roraima sandstone formation.

Kaieteur Park, one of the first national parks established in South America (in 1929 by the British Commonwealth) has recently been expanded to encompass an area of 62,680 hectares (154,882 acres) (KELLOFF, 2003). The centerpiece of the park is the impressive Kaieteur Falls situated where the Pakaraima Mountains give way to the coastal lowlands. With a volume of 600,000 liters per second going over an uninterrupted single drop of 226 meters, Kaieteur is one of the most powerful waterfalls on Earth. This pounding behemoth has carved a huge gorge, and expels millions of liters of water as mist. In conjunction with prevailing winds, this mist appears to influence the densities of *Colostethus beebei* (BOURNE et al., 2001). A cloud-forest environment formed by rising mist along the crest of the gorge also harbors endemic flora (KELLOFF, 2003).

*Colostethus beebei* is the only species of its genus known to be a bromeliad specialist — it lives and breeds exclusively on the giant terrestrial bromeliad *Brocchinia micrantha* (BOURNE et al., 2001). These giant bromeliads grow in humus caught in rock crevices, and can reach 3.5 meters in height (KELLOFF, 2003). Golden rocket frogs are found in open glades where the giant bromeliads are abundant. The frog population densities are highest in close proximity to Kaieteur Falls, but the species has also been observed as far as about 1 kilometer away on the Potaro plateau.

BOURNE (2001) reported that the brown morph of the golden rocket frog is more commonly seen on



Mist rising from the falls forms a cloud-forest habitat occupied by specialized species along the rim of the gorge



Aerial view of *Brocchinia micrantha* glades on the Kaieteur Tepui, where golden rocket frogs still abound



Typical habitat of *Colostethus beebei* on the Potaro River plateau



Portrait of a bright orange-yellow morph of *Colostethus beebei*

dead brown leaves, whereas the bright yellow morph is more commonly seen on live green leaves. We made similar observations, occasionally finding a few of the bright yellow frogs on dead brown leaves, but very rarely finding brown frogs on live green leaves.

The Kaieteur plateau supports unique and interesting habitat types. *Brocchinia* spp. dominated savannas, for example, harbor another endemic frog, *Tepuihyla talbergae*, recently described by DUELLMAN and YOSHPA (1996). During the daytime *Tepuihyla talbergae* often takes refuge in the much smaller, insectivorous terrestrial bromeliad *Brocchinia reducta*, but can sometimes also be found in the giant bromeliads with *Colostethus beebei*.

#### Ecology and behavior

BOURNE (2001) and BOURNE et al. (2001) studied the ecology and behavior of the golden rocket frog on the Kaieteur plateau. They found that male and female golden rocket frogs live together in stable groups,

breeding in the water-filled leaf axils, or tanks, of the bromeliads they inhabit — they do not gather at other aquatic sites for mating, as many other anurans do. Social behavior in amphibians generally involves interactions only in conjunction with mating, but our observations and earlier experiments by BOURNE (unpublished data) indicate that golden rocket frogs also interact with their conspecific neighbors on an everyday basis. On the premise that group-living naturally accrues costs but not necessarily benefits to individuals, we investigated why golden rocket frogs should remain together beyond the time required for reproduction.

The number of golden rocket frogs living on a single bromeliad was predicted to depend on the volume of water, amount of dissolved oxygen, and (negatively) accumulation of leaf litter in the bromeliad tanks. Water was found to be an important resource for non-breeding golden rocket frogs. Although males and females established individual all-purpose territories, they exhibited a pattern of daily

amicable visits (social interactions without aggression) between neighbors. This is the first report of non-reproductive sociality for unrelated individuals in any frog species.

BOURNE (unpublished data) induced group-living and changes of residence in captive *Colostethus beebei* by manipulating the temporal and spatial distribution of water — findings supported the hypothesis that sociality allows individuals to monitor spatial and temporal distribution of water, thereby minimizing mortality by desiccation. We speculate that the daily visits between neighbors increases recognition of individuals and thereby reduces energy expended competing for access to pools.

*Colostethus beebei* courtship (as in other dendrobatids) is long and elaborate, including close-range vocal, visual, and tactile stimulation. The female lays a clutch of three to seven eggs on leaves just above the water-filled axil of the bromeliad. There is a correlation between the number of clutches laid and the distance from the waterfall. More clutches were





*Tepuihyla talbergae*, another frog species endemic to Kaieteur National Park, is sometimes found with *Colostethus beebei* in the same bromeliads

found in bromeliads near the waterfall than in bromeliads away from the influence of the mist, suggesting that the species depends on the high humidity provided by the mist.

Both parents provide care of offspring. During times of low humidity, the male squirts fluid from his cloaca onto eggs to moisten them.

On hatching, the tadpoles slide into the bromeliad tank (phytotelmatum) where they feed on algae, detritus, and mosquito and midge larvae. Occasionally, if there is no food in the pool, the male may transport tadpoles on his back (one or two at a time) to another pool. The tadpoles may also be supplied with unfertilized eggs to eat — the paternal male displays renewed courtship behavior but does not fertilize the eggs laid by the female, this time directly into the water instead of onto the leaf. Larval cannibalism occurs but seems to be rare. Duration of larval development is still unknown, but metamorphosed juvenile frogs attain sexual maturity within 4–6 months. The species appears to have a life span of about 5 years.

An unidentified graspid crab, the colubrid tree snake *Imantodes cenchoa* (Linnaeus, 1758), and the larva of an unidentified drosophilid fly are known to feed on the eggs of the golden rocket frog; the crab and snake

also prey on the juvenile and adult frogs.

The golden rocket frog is primarily a sit-and-wait predator. It feeds mainly on emerging mosquito and midge imagoes, but also on ants, mites, small spiders, and on the same unidentified drosophilid fly whose larval stage depredates the eggs of the frog (BOURNE, 2001). The golden rocket frog apparently owes its brilliant coloration to diet-derived carotenes. BOURNE (2001) noted that in his captive research specimens the brilliant yellow faded in a few months. When fed on paprika-fortified fruit flies, the frogs regained their bright coloration.

#### Conservation

An endemic species with a small geographic range and a high degree of habitat specialization, it is especially vulnerable to extinction should its particular habitat be disturbed. Anthropogenic effects such as habitat alteration, fragmentation, and loss are probably the most important threats facing endemic species. The endemic golden rocket frog has a very restricted distribution and is also highly specialized, living and breeding exclusively in giant bromeliads. It is therefore very important that the government of Guyana continue enforcing laws that penalize any habi-

tat alteration within the small range of *Colostethus beebei*. Fortunately, the populations of this species in Kaieteur National Park appear to be healthy and quite stable at present.

Golden rocket frogs are fascinating creatures, which might attract hobbyists to keep them in captivity. This article is certainly not meant to promote the exploitation of *Colostethus beebei* for the pet trade. Kaieteur National Park is a protected area, within which it is illegal to collect or even disturb wildlife of any species, plant or animal. Our aim is primarily to promote *Colostethus beebei* as a charismatic representative of the biota of Kaieteur — an ambassador for increased awareness, education, and conservation. We feel it is important to share information on this poorly known species, and to emphasize the importance of Kaieteur National Park as a protected area. The conservation value of any region increases with the extent of endemic species there, and we are convinced that intelligent management of parks and protected areas is the best way to ensure the survival of endemic species and their landscapes. ■

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