



INTRODUCED SPECIES

Reptiles and Amphibians Introduced on St. Martin, Lesser Antilles

Mark Yokoyama

Grand Case, Saint Martin (marc@lesfruitsdemer.org)

Photographs by the author except where indicated.

St. Martin, an island of approximately 87 km² near the northern end of the Lesser Antilles, is perhaps one of the more interesting islands in an arc of very interesting islands. However, its unique characteristics are largely derived from political, economic, and demographic qualities that distinguish it from the rest of the Lesser Antilles. The island of St. Martin is the smallest body of land in the world that is divided into two countries. The north is an overseas department of France, whereas the south, Sint Maarten, is an independent nation within the Kingdom of the Netherlands. While this in and of itself has no biological ramifications, it

does relate the islands politically, economically, and culturally to other islands in both the French and Dutch Antilles. St. Martin is among the most intensely developed islands in the regions, it is the most densely populated island in the Lesser Antilles, with just under 900 people per km² (the 2009 population of French St. Martin in 2009 was 37,461 according to INSEE, Institut National de la Statistique et des Études Économiques and the population of Dutch Sint Maarten in 2009 was 40,917 according to the Sint Maarten Department of Statistics), and it is a major center of commerce, much of which is focused on tourism.



An adult male Green Iguana (*Iguana iguana*) beside Étang de Cimetière, Grand Case, St. Martin. Since being introduced in the mid- to late-1990s near Princess Juliana International Airport, Green Iguanas have expanded their range and today are found essentially islandwide on St. Martin.

Princess Juliana Airport is one of the largest airports in the Caribbean, serving over 1.5 million passengers annually. Services include inter-island flights as well as direct flights from the U.S., Central America, and Europe. The Port of Sint Maarten also serves approximately 1.5 million cruise-ship visitors annually. The Simpson Bay Lagoon is one of the largest lagoons in the Caribbean, hosting a large volume of pleasure craft from small boats to the largest mega-yachts. Popular destinations for these craft include other islands of the Lesser Antilles, as well as those on the Puerto Rico Bank, especially the U.S. and British Virgin Islands.

These factors contribute to extreme environmental degradation due to population pressure and the attendant infrastructural requirements. They also increase the potential for the introduction of non-native species by virtue of the high volume of trade and tourism on the island. Although other islands in the region may suffer even greater population pressures (e.g., New Providence in the Bahamas and Bermuda), no island in the Caribbean shares the same variety and volume of interconnections to locales inside and outside the region.

Studying islands with relatively pristine environments (e.g., Guana Island in the British Virgin Islands, Dominica) is important and attractive to biologists; understanding the biology of islands that are most at risk, like St. Martin, would seem equally valuable. While St. Martin may be of less interest to those wishing to understand the native ecology of the Antilles, to understand St. Martin is to gain some insight into the environmental destruction that increasingly plagues the Caribbean. To the pessimist, or perhaps, realist, St. Martin is indicative of the possible (or probable) future of many West Indian ecosystems.

With regard to introductions of non-native species and their possible impact, St. Martin could help us address a variety of questions. It might serve as one extreme in a study attempting to relate the volume of trade and tourism to the rate of introductions or the extent of habitat disruption on the successful colonization of new species and the survival of native species. It also is an excellent example of how political and social ties might impact the origins of introduced species (i.e., comparing the arrival of species from relatively distant islands that are strongly connected, like Guadeloupe and Martinique, to closer islands with fewer political and social ties).

St. Martin has ten known native species of reptiles (excluding marine turtles), three of which (*Iguana delicatissima*, *Spondylurus martinae* [until recently considered one of many Lesser Antillean populations of a species in the genus *Mabuya*; Hedges and Conn 2012], and *Alsophis rijgersmaei*) appear to be extirpated. Eleven established introductions have been documented (Powell et al. 2011), not including waifs (i.e., one or few individuals of species that have not established any known breeding population). One of those (*Anolis bimaculatus*) seems to have been extirpated. Two additional species (*Chelonoidis carbonaria* and *Hemidactylus mabouia*) are

of uncertain origins and might or might not have reached the island by natural means. Excluding the species of uncertain origin, more non-native species inhabit the island than native species. Following is a discussion of the history and current status of non-native herpetofauna on St. Martin.

Puerto Rican Crested Anole (*Anolis cristatellus*)

Anolis cristatellus, endemic to the Puerto Rico Bank, was first observed on St. Martin by Karl Questel in November 2008 at Port de Plaisance Resort and Casino (Questel 2011). The sighting included four males, a female, and one juvenile, all located in a patch of ornamental foliage. In January 2011, Questel (pers. commun.) observed seven males and thirteen females at the same location, an islet in the Simpson Bay Lagoon connected to the rest of the resort complex by a bridge.

In January 2012, I happened upon a population of *A. cristatellus* at the same resort. The population I found was located in a stand of *Ficus* sp. along a fence (~100 m long and 1.5 m high) as well as in the scrub in the adjacent vacant lot.



Adult male Puerto Rican Crested Anole (*Anolis cristatellus*) at the Port de Plaisance resort in Cole Bay, Sint Maarten (10 August 2012).



Puerto Rican Crested Anoles (*Anolis cristatellus*) mating on Sea Grape (*Coccoloba wifera*) at the Port de Plaisance resort in Cole Bay, Sint Maarten (10 August 2012).

I also found the two native species, *A. gingivinus* and *A. pogus*, at this site.

On 10 August 2012, I conducted a more careful survey of the area in an attempt to better understand the range of *A. cristatellus* on the island. In the intervening months, the scrub in the lot had been cleared. I found no *A. cristatellus* in the original *Ficus* stand and only a single female opposite the now-cleared vacant lot. *Anolis gingivinus* and *A. pogus* were still present in both areas. However, I found all three species in two stands of Sea Grape (*Coccoloba uvifera*) near the lagoon waterfront, in one of which *A. cristatellus* was the most abundant (15 *A. cristatellus*, 5 *A. gingivinus*, and no *A. pogus*). I also observed a mating pair.

Anolis cristatellus also was present in the hotel area on a small islet in the lagoon connected to the rest of the complex by a bridge. One individual was on an ornamental plant near the center of the complex and another near the entrance to the complex on Union Road. On 18 October 2012, I observed a mating pair and two juveniles at the same location, which is a considerable distance from the observed population center at the heart of the resort near the Simpson Bay Lagoon.

A color photographic voucher was deposited in the Milwaukee Public Museum (MPM P769) with the following data: Sint Maarten, Port de Plaisance, Cole Bay (18.03964108080661, -63.088240921497345). 10 August 2012, 1408 h. Jonathan B. Losos and Manuel S. Leal confirmed the identity of the lizard from the photograph.

Observations seem to indicate that a breeding population has been present on the island for at least four years. Founders probably arrived with shipments of ornamental plants from Puerto Rico or Florida, where the species is established (e.g., Krysko et al. 2011, Meshaka 2011). Currently, the population is concentrated around a very small geographic area of the resort near the edge of the lagoon, which might have been the site of the original introduction. Within this area, several small population islands occupy stands of trees separated by inhospitable habitat (sidewalks, parking lots, lawns, and buildings). The fact that suitable habitat is highly fragmented and isolated in this area may have limited the spread of this lizard on the island.

Recent sightings near the entrance to the complex, approximately 500 m from the other populations, might be of interest for two reasons. First is the possibility that the spread to this area was facilitated by the removal of brush and small trees from the waterfront area. These were deposited in an area near the new population, and perhaps more importantly, connected to it by a border of thick vegetation. This is suggestive of direct (albeit inadvertent) human involvement in the expansion of the species' range. Second, the new population is now separated by less than 100 m from suitable habitat comprising essentially the entire interior of the island. Given the species' currently restricted distribution, eradication might still be feasible and should certainly be attempted.

Cuban Brown Anole (*Anolis sagrei*)

Fläschendräger (2010) first reported the presence of *Anolis sagrei* on St. Martin based on one sighting of three females and two males within a 30-minute period in the harbor area of Philipsburg, the capital of the Dutch side (Sint Maarten). Considering the location, these lizards almost certainly arrived with shipments of ornamental plants or some other cargo, probably originating from the site of an introduction (most likely Florida; see Powell et al. 2011). Beginning in January 2012, I conducted several searches without finding any lizards. However, on 4 January 2013, I found two females just outside the cruise ship terminal (Dr. A.C. Wathey Cruise and Cargo Facilities). Given the location, they likely were members of the same population originally observed in 2010. Restricted access to the terminal grounds renders further assessments difficult.



An adult female Cuban Brown Anole (*Anolis sagrei*) near the A.C. Wathey Cruise and Cargo Facilities in Philipsburg, Sint Maarten.

Statia Bank Tree Anole (*Anolis bimaculatus*)

Powell et al. (1992) noted the presence of *Anolis bimaculatus* at Simpson Bay in May 1992. The apparent breeding population included adult males and females as well as juveniles. The resort grounds where these lizards were originally encountered are adjacent to the landing for ferries that sail to St. Eustatius, the probable source of the founding individuals. Surveys of the area in subsequent years failed to record the species (Powell et al. 2005)



An adult male Statia Bank Tree Anole (*Anolis bimaculatus*) near Simpson Bay, Sint Maarten. This population was discovered in 1992, but subsequent visits to the site failed to find more animals. Photograph by Robert Powell.

Guadeloupe Anole (*Anolis marmoratus*)

A single individual *Anolis marmoratus alliaceus* appears to have been collected in Philipsburg, Sint Maarten on 7 June 1963 by Dr. James Lazell. According to the collection data, it was the only specimen collected in Philipsburg that day (he collected numerous *A. pogus* in Colombier) and the only *A. marmoratus* collected on St. Martin. The next specimens collected by Dr. Lazell were on 9 June in Guadeloupe, where *A. marmoratus* is native, suggestive of the possibility that the specimen was mislabeled.

Dr. Lazell (pers. commun.) did not make any reference to this specimen in his field journals, and has no recollection of it today. That a mislabeled specimen would have a different locale than the other specimens collected on that day seems unlikely. Also, Philipsburg would have been a likely point of colonization; even in the 1960s, it was a bustling port for tourists and goods. With no evidence that the collection data are incorrect, the most prudent approach would be to assume that this specimen was a waif or part of an introduction that was subsequently extirpated.

Green Iguana (*Iguana iguana*)

Iguana iguana has become increasingly common on St. Martin, particularly during the last decade. By most accounts, the catalyzing event was the destruction of Flamingo Pond in 1998 as part of an expansion of Princess Juliana Airport, after which iguanas spread to other parts of the island. Previously, the range of *I. iguana* was largely restricted to the areas surrounding the airport. During the first season of field research on St. Martin in 2000, Environmental Protection in the Caribbean (EPIC) recorded *I. iguana* at over ten locations (Princess Juliana Airport, Mullet Bay, Little Bay Pond, Fresh Pond, Great Salt Pond, and Dawn Beach on the Dutch side and Grand Case, Marigot, Friar's Bay, Baie Rouge, and Baie Orientale on the French side) indicating a near-islandwide distribution at that time (A. Brown, pers. commun.). In addition to St. Martin and the satellite islets where *I. iguana* has previ-



An adult male Green Iguana (*Iguana iguana*) at Salines de l'aéroport, Grand Case, St. Martin.



A juvenile Green Iguana (*Iguana iguana*) laps water droplets from grass after a rainstorm near Grand Case, St. Martin.

ously been documented, I also confirmed that it is established on Petite Clef, a small islet between St. Martin and Pinel, where I observed five individuals of varying sizes as well as copious amounts of droppings while visiting on 27 July 2012.

The story of the introduction is apocryphal, and typically involves two crates of iguanas flown to the island, presumably for the pet trade, but left uncollected. A sympathetic worker released them into the wild so they would not die in the crates. In some versions, these events coincided with Hurricane Luis, which devastated the island in 1995. Although this account is plausible in some ways (e.g., a mid-1990s introduction that was still relatively localized at the time of the 1998 destruction of Flamingo Pond), I have been unable to confirm it.

No studies have addressed the impact of *I. iguana* on the native flora or fauna of St. Martin. The Lesser Antillean Iguana (*Iguana delicatissima*), once native to St. Martin, was most likely extirpated before the introduction of *I. iguana*, eliminating the possibility of competition or interbreeding, such as reported on other Lesser Antillean islands having extant populations of *I. delicatissima* or genetically unique native populations of *I. iguana* (e.g., Powell 2004, Morton and Krauss 2011). However, the large and apparently growing population of *I. iguana* on St. Martin could indirectly impact neighboring islands with native iguana populations (e.g., *I. delicatissima* on Anguilla and St. Barthélemy and *I. iguana* on Saba) by intentional or even accidental introductions (as has apparently occurred for Cuban Treefrogs; see below).

Tropical House Gecko or Woodslave (*Hemidactylus mabouia*)

Hemidactylus mabouia is widespread on the island and occurs in a variety of habitats from urban to scrub and forest. Its origin on St. Martin and in the Caribbean in general is uncertain (e.g., Powell et al. 2011), but inadvertent human-mediated introductions are considered to be the most likely source. Its impact on native species is unknown, but it does share habi-



Tropical House Gecko (*Hemidactylus mabouia*) found beneath Tamarind (*Tamarindus indica*) bark during the day near Bellevue, St. Martin.

tat with the two large native geckos, *Thecadactylus rapicauda* and the recently described *T. oskrobapreinorum* (Köhler and Vesely 2011). Although *H. mabouia* is the only one of the three typically found in urban environments, all can be found under the bark of trees (non-native *Tamarindus indica* in particular) and under rocks or logs.

The question of whether Woodslaves adversely affect native populations of geckos in the genus *Thecadactylus* has gained some urgency since *T. oskrobapreinorum* was described in 2011, if only because the latter is known to occur only on St. Martin.

Smooth-scaled Worm Lizard (*Gymnophthalmus underwoodi*)

Gymnophthalmus underwoodi is well established and widely distributed on St. Martin. The first record of the species on the island was an individual found in Sea Almond (*Terminalia catappa*) leaf litter on sand at Point Blanche, Back Bay, Sint Maarten on 22 March 2003 (van Buel and Powell 2006). In 2007, EPIC captured one specimen and saw approximately a dozen others in thorn scrub below Loterie Farm on the lower



Smooth-scaled Worm Lizard (*Gymnophthalmus underwoodi*) found in short grass on a roadside near Grand Case, St. Martin.

slope of Pic Paradis (A. Brown, pers. commun.). Since then, I have seen them in a variety of locations on the French side of the island (Grand Case, Friar's Bay, Hope Estate), typically in sunny areas such as fields, roadsides, open scrub, and rocky beaches.

Native to northern South America and presumably to the southern Lesser Antilles (Williamson and Powell 2004), these lizards are appearing regularly on northern Lesser Antillean islands, St. Thomas (U.S. Virgin Islands; Cole et al. 1990), and the Dominican Republic (Scantlebury et al. 2010). The founders of most introduced populations probably arrive as stowaways in cargo. Their success at colonization (e.g., Powell et al. 2011) is greatly enhanced because these lizards are parthenogenetic, and only one individual is necessary to establish a population.

Flowerpot Blindsnake (*Ramphotyphlops braminus*)

Ramphotyphlops braminus is widespread on St. Martin. I have observed it in Grand Case, Cole Bay, Cupecoy, and other locations on both the French and Dutch sides of the island.



Flowerpot Blindsnake (*Ramphotyphlops braminus*) on a rock wall at night, Grand Case, St. Martin.



Flowerpot Blindsnake (*Ramphotyphlops braminus*) found under a rock at Emilio Wilson Park near St. Peters, Sint Maarten.

Also, although it is small, nocturnal, and may be mistaken for a worm, many residents of the island are familiar with it. It was an accidental introduction to St. Martin and St. Barthélemy during the 1990s (Breuil 2002), presumably with shipments of ornamental plants (its common name is testament to its frequent association with plant roots), and it was first reported on nearby Anguilla in 1997 (Censky and Hodge 1997). Like *Gymnophthalmus underwoodi*, this species is parthenogenetic, which has undoubtedly assisted its colonization of a great number of locations worldwide. The impact of this species on native herpetofauna is unknown, but no native blindsnakes occur on the island. Any potential effects on native ants or termites are unknown.

Red-footed Tortoise (*Chelonoidis carbonaria*)

Chelonoidis carbonaria is rare in the wild on St. Martin today, although it is commonly kept as a pet. I have seen one juvenile in the wild on the satellite island of Pinel. Whether this species is native to the Lesser Antilles is unclear (e.g., Censky 1988, Hodge et al. 2003). It might have been introduced by Amerindians or during the early colonial period. Regardless, extant populations, including that on St. Martin, are likely of mixed heritage, with native tortoises or early introductions now mixed with animals introduced more recently via the live animal trade (e.g., Powell et al. 2011). The first account of a tortoise on St. Martin by Charles de Rochefort was published in 1658, in which he mentions tortoises in the woods (he separately mentions sea turtles in his account of the island, reducing any possible ambiguity).



Red-footed Tortoise (*Chelonoidis carbonaria*) from Pinel Island, a satellite islet approximately 200 m offshore from St. Martin.

Red-eared Slider (*Trachemys scripta elegans*)

Trachemys scripta elegans is abundant in Fresh Pond, and I have seen it occasionally in the adjacent Great Salt Pond. I have never seen it elsewhere on the island. Any expansion



Red-eared Slider (*Trachemys scripta elegans*) in Fresh Pond, near Philipsburg, Sint Maarten.



Red-eared Sliders (*Trachemys scripta elegans*) at the Sint Maarten Zoo. All animals on display at the zoo in 2004 when this photograph was taken originated on Sint Maarten. They either were donated, captured in the wild, or hatched at the zoo. Photograph by John S. Parmelee, Jr.

of its current range is unlikely without human assistance, as sixteen of the twenty ponds on the Dutch side of the island have been destroyed. Pond turtles have been introduced onto some islands for food (e.g., Powell et al. 2011), but Red-eared Sliders are popular in the pet trade, which is the most likely source of the population on St. Martin.

Lesser Antillean Frog (*Eleutherodactylus johnstonei*) Martinique Frog (*Eleutherodactylus martinicensis*)

These two frogs are addressed together because they are very similar in appearance and are not always easily distinguishable except when males are calling. Both are native to different Lesser Antillean islands. *Eleutherodactylus johnstonei* is one of the most successful amphibian colonizers in the Caribbean, whereas *E. martinicensis* has been introduced outside of its native range only twice (Powell et al. 2011; although the species also might have been introduced and subsequently extirpated on Antigua). Two of the four islands where *E. martinicensis* is native are French-governed (Martinique and Guadeloupe), and both Caribbean introductions were recorded on islands that are also French (St. Barthélemy) or half-French (St. Martin) (Powell et al. 2011). The high volume of trade attributable to political and social ties between



Male Lesser Antillean Frogs (*Eleutherodactylus johnstonei*) calling at night in Colombier, St. Martin.



Cuban Flathead Frog (*Eleutherodactylus planirostris*) captured at Emilio Wilson Park near St. Peters, Sint Maarten.

these islands might have increased the likelihood that a French frog would hop to other French islands. The most likely means of introduction for both species is stowing away in shipments of ornamental plants or other goods.

During the day, these frogs are most frequently found in leaf litter and under stones, usually in forested areas and in the ravines that channel water during rains. They also can be found in water reservoirs such as those in bromeliads and other plants. They are widely distributed on the island, and their calls are heard in both urban and natural environments.

Cuban Flathead Frog or Greenhouse Frog (*Eleutherodactylus planirostris*)

On 19 July 2012, I observed *Eleutherodactylus planirostris* in Emilio Wilson Park on the Dutch side. I initially found three individuals that I collected for photography. Two days later, I found a fourth individual. On 20 November 2012, I observed two individuals, each within 100 m of the original sightings. These are the first recorded sighting of this species on St. Martin, although Henderson and Breuil (2012) recorded a third *Eleutherodactylus*, possibly extirpated, that was not identified to species. The presence of multiple indi-

viduals indicates a possible breeding population on the island. This species, native to Cuba, the Cayman Islands, and the Bahamas, has been established elsewhere in the Caribbean (Powell and Henderson 2012) as well as Florida (Dundee and Rossman 1989), the latter the most probable source of the introduction in St. Martin. Florida is a major source of ornamental plants and building materials for the Caribbean, and has previously been implicated as the source of Caribbean herpetofaunal introductions, including species that were previously introduced from the Caribbean to Florida (Powell et al. 2011).

A color photographic voucher was deposited in the Milwaukee Public Museum (MPM P768) with the following data: Sint Maarten, Emilio Wilson Park, Cul de Sac/St. Peters (18.042869804781738, -63.06406617164612). 19 July 2012, 1219 h. S. Blair Hedges confirmed the identity of the frog from the photograph.

Because this species coexists with congeners in both its native range and in other invaded areas (e.g., Florida; Krysko et al. 2011, Meshaka 2011), it is likely to become firmly established on St. Martin unless eradication efforts are initiated quickly.

Cuban Treefrog
(*Osteopilus septentrionalis*)

Osteopilus septentrionalis is very common on St. Martin. I have observed them in Grand Case, Cul-de-Sac, Pointe Blanche, Pic Paradis, Terres Basses, and other locations. Tadpoles are in puddles, abandoned swimming pools, livestock troughs, and any other standing water. They are rare in running water, where introduced Guppies (*Poecilia reticulata*) are common and will eat them, although I have occasionally seen larger tadpoles coexisting with Guppies. During the day, adults are found in the water reservoirs of bromeliads and similar plants, the hollows of trees in forested areas, Papaya (*Carica papaya*) leaves, and other shaded/sheltered areas. At night they are found on vegetation and human structures such as stone walls and buildings. As on Anguilla (Townsend et al. 2000) and for other frogs established on St. Martin, the founders probably arrived as stowaways in shipments of ornamental plants from Florida.

No studies have examined their possible impact on native wildlife on St. Martin. Although they are voracious and might decimate native invertebrates, interactions with other species



Cuban Treefrog (*Osteopilus septentrionalis*) resting in the water reservoir of an ornamental plant at a nursery in Hope Estate, St. Martin.



Cuban Treefrog (*Osteopilus septentrionalis*) tadpole. Although tadpoles are rarely encountered in running water, Cuban Treefrogs lay their eggs in puddles, abandoned swimming pools, livestock troughs, and essentially any other standing water.



Cuban Treefrogs (*Osteopilus septentrionalis*) on St. Martin originally were misidentified as *Oloolygon rubra* (now *Scinax ruber*). Today, these frogs occur almost islandwide.

of frogs would seem to be of little interest to conservationists, because all frog species on the island are introduced. However, St. Martin apparently was the source of Cuban Treefrogs that have been found on Saba (Powell 2007), suggesting that well-established populations of successful colonizers can trigger a chain reaction of introductions.

Note that specimens of this species from St. Martin were once misidentified as *Oloolygon rubra* (now *Scinax ruber*). Although this identification was subsequently corrected (Powell et al. 1992), some sources might still list *S. ruber* on St. Martin.

Conclusions

St. Martin supports a large and expanding collection of introduced herpetofauna, but its impact has yet to be assessed. The sheer numbers of Green Iguanas on the island appear likely to have some impact on the ecology of the island as a

whole, although perhaps not on any native reptiles. If *Anolis cristatellus* and *A. sagrei* survive and expand their ranges on St. Martin, interactions with the two native anoles (*A. gingivinus* and *A. pogus*) would be of concern. The similarity between these four species is unusual for the Eastern Caribbean. The ratio of body length for *A. gingivinus* to that of *A. pogus* is the smallest recorded for any two-species island (approximately 1.2, compared to 1.6–1.8 for most islands; Roughgarden 1995). Additionally, analyses of morphological characteristics have shown that *A. gingivinus* is similar to Greater Antillean trunk-ground ecomorphs, which include *A. cristatellus* and *A. sagrei*. Even *A. pogus*, which more closely resembles the grass-bush ecomorph, was found to be similar to one trunk-ground species (Beuttell and Losos 1999). Of particular conservation interest would be any possibly impact on *A. pogus*, which is found nowhere else.

As a small island with a proportionately huge number of introduced reptiles and amphibians, ongoing monitoring for new introductions is important for preserving any semblance of the native herpetofauna. In addition to the species in this article, six additional species of snakes thought to be waifs (species that have not established breeding populations) have been documented on St. Martin (Powell et al. 2005, 2011; Henderson and Breuil 2012). Visiting the most likely sites of introduction is not difficult. I inspected the majority of the marinas on the island during the summer of 2012 to check for introductions and found none, but regular surveys could greatly increase our knowledge of the specific times and locations of any further introductions and increase the likelihood that invasions could be prevented. Imports of plants, vegetables, pets, and construction materials have all been implicated in the introduction of non-native herpetofauna in the Caribbean (Powell et al. 2011), suggesting that additional points of interest may include garden nurseries, sites of new construction, and landscaping and grocery stores, in addition to the island's ports and airports.

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