THE AUSTRALIAN BROAD-HEADED SNAKE *HOPLOCEPHALUS BUNGAROIDES* IN THE WILD

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INTRODUCTION

The Australian genus Hoplocephalus includes three species of smallish snakes, the Stephen's Banded Snake (*Hoplocephalus stephensi*), Pale-headed Snake (*Hoplocephalus bitorquatus*) and Broad-headed Snake (*Hoplocephalus bungaroides*). All are restricted to eastern New South Wales and Queensland.

All are slender bodied snakes with distinct broad, somewhat flattened heads set off from the neck. Adults average somewhat between 50 and 70 cm (total length), although 100 cm. species are known. All have smooth dorsal scales. The keeled ventrals are an adaptation for climbing. Other diagnostic characters for the genus are: 19-21 mid-body rows, over 190 ventrals, the frontal shield is longer than broad, internasals present, suboculars absent, anal and subcaudals are single, and two to three solid maxillary teeth follow the fang (Cogger, 1992).

These snakes are relatively unusual for mainly nocturnal species in that they have a round pupil. Most nocturnal species have elliptical pupils.

The three species are easily distinguishable and can be separated at a glance or from photos. Pale-headed snakes are greyish in colour without spots or bands on the body. The back of the nape is light in colour. Stephen's Banded Snakes are usually banded (or a variant thereof), except for a distinctive unbanded morph. They can always be separated from Pale-headed Snakes by the generally dark head and blackish colour at the back of the nape. Broad-headed Snakes have a unmistakably black body with numerous scattered white or yellow scales, usually forming irregular cross-bands, which rarely exceed one scale in width. For general details of all three species see Cogger (1992), or Hoser (1989).

THE BROAD-HEADED SNAKE *HOPLOCEPHALUS BUNGAROIDES*

Broad-headed Snakes are effectively restricted to sandstone habitat within a 200 km radius of Sydney city, New South Wales, Australia. The approximate limits to the distribution of the species is the sandstone escarpment west of Nowra to the south, and outlaying sandstone escarpment near Lithgow and Mudgee to the west and north-west (see Swan 1990). They are unknown outside of sandstone habitat, except near Bathurst, NSW, were recently specimens were found some distance from sandstone. Here they were found in forest growing on shale adjacent to conglomerate slopes and bluffs. It should be noted that the conglomerate mentioned here is a common formation on the western edge of

the Sydney sandstone formation in the transition zone to a larger granite belt. The rock also exfoliates in a similar manner to the nearby sandstone formations.

Broad-headed snakes are most commonly confused with the (potentially much larger) Diamond Python (*Morelia spilota spilota*) wich occur in the same areas. However, the two snakes may be easily seperated by the fact that Diamond Pythons have numerous irregular head shields and labial heat-sensing pits - Broad-headed snakes don't. Furthermore Broad-headed snakes are an even greyish-black colour ventrally, whereas Diamond Snakes have unevenly coloured belly markings.

It has been suggested that young Diamond Pythons have evolved in a manner to mimic Broad-headed snakes. Such mimicry by non-venomous species to look and act like venomous species is well known. Certainly young Diamond Pythons are more pugnacious than the adults, a habit more in line with that of similar sized Broad-headed snakes. A more widely accepted scenario however is that similarities in appearance and habits between the two species are due to convergent evolution to cope with similar environmental problems and so on, rather than a non-venomous species mimicking a venomous one.

IN THE WILD

The overwhelming majority of Broad-headed snakes are found during the day, sheltering under large exfoliating slabs of sandstone and rock crevices in areas of undisturbed bushland during autumn, winter and spring (sometime excluding the coldest parts of mid-winter). During summer these snakes are rarely found during the day.

It is very rare (in cooler months) to find these snakes under cover that is not 'rock-on-rock' in this context also includes crevices in cliff faces and so on. These snakes are rarely found under rocks which have a soil substrate.

In Broad-headed snake areas, collectors often go along the tops of cliffs lifting only rock-on-rock exfoliations, and ignoring any others. Thus the maximum number of likely rocks can be lifted over a given period of time, even though this means much greater distances are travelled. Although other species, including Small-eyed snakes (*Cryptophis nigrescens*) and Red-naped snakes (*Furina diadema*) also occur under rock-on-rock formations these species are likely to also be found under rocks with dirt substrate, which are usually found further behind the cliff-tops where these snakes occur. (Readers should note that sandstone ridges in the 'Sydney basin' run along valleys in a linear fashion, so a given ridge may often run continuously for several miles). The Copper-tailed Skink (*Ctenotus taeniolatus*) is a known food item of the Broad-headed snake. It is particularly common under rocks on soil found at the back of and behind the outcrops where Broad-headed snakes occur.

It is thought that these snakes shelter under smallish and/or exposed rocks in winter to enable them better opportunities to 'bask' while remaining under cover during the day. Clear sunny weather is typical of winter months where these snakes occur. To further support this assertion, this species been observed basking in the open in sunny winter weather (Adams, 1973). On 21 May, 1966, (later autumn) he found a male specimen basking at Kanangra Walls, National Park (about 100-150 km. west of Sydney) on a track down a steep mountain side. The weather was very cold and sunny and it had even snowed the night before.

It is also thought that Broad-headed snakes can and do move about under these rocks during the day to actively thermoregulate. This indicates that diurnal activity dominates during winter months, while nocturnal activity is prevented by excessive cold at that time of year. The practice by which the snakes regulate their body temperature during the day, while remaining under cover is sometimes called 'indirect basking'. Usually these snakes are found under rocks with a fairly 'tight fit' to the rock substrate below, indicating highly

restricted micro-habitat requirements for this species. Broad-headed snakes are largely nocturnal in warm weather.

A feature sometimes noted in wild and captive Broad-headed snakes is the potentially low metabolic rate. This is reflected in a sometimes lower than usual food intake, when compared to other snake similar sized species. Marian Anstis had a captive specimen fast for over 12 months - without apparent ill effect - remember this is only a small species of snake, so much a fast is of far greater significance than in a larger snake such as a ten foot python.

Early references such as Anstis (1973), Hosmar (1952), Kingshorn (1969), Ormsby (1947) and White (1973) only tended to give vague information as to what wild Broad-headed snakes eat, using broad categories such as 'frogs', 'lizards' etc. Other Hoplocephalus are known to opportunistically feed on frogs, agamid and skink lizards, small mouse-like mammals (including mice), bats and birds when in the wild.

Besides the habitant requirement for exfoliating sandstone in undisturbed habitat, Broad-headed snakes usually only seem to be found in areas with large numbers of Lesueur's Geckos (*Oedura lesueurii*), which according to a number of sources including Wells, Wellington and Williams (1988) are this snake's preferred food in the wild. Areas of apparently suitable habitat without this food lizard rarely appear to have Broad-headed snakes, even though they are known to opportunistically feed on other reptiles. In my own experiences, the best spots for Broad-headed snakes are those areas which have absolutely HUGE numbers of Lesueur's Geckos.

Foto 1: *Hoplocephalus bungaroides*. Blue Mountains, New South Wales. Foto: Raymond Hoser.

Captive specimens freely take mice and birds. However Shine's dissection of 52 museum specimens only revealed lizards in the diet of (what were presumed to be) wild specimens (inside 4 snakes only - the other 48 had empty guts). Although Shine suggested that this paucity of food items reflected a low metabolic rate in this species, it has since been suggested that the method of sourcing the snakes themselves (how they came to be in the museum) could offer a partial explanation. A disproportionate number of snakes could have been sourced from captivity (after death), which could perhaps explain the empty stomachs.

White (1973), Wells, Wellington and Williams (1988) and others have actually noted that their captive specimens fed mostly in winter and spring. This could well be a reflection of ease in finding food during those months (in wild specimens), setting the biological 'clock' to feeding mode at that time of year or perhaps related to breeding activity.

Shine's study of wild Pale-headed snakes indicated that sexual maturity in that species occurred at 3-4 years of age. It is assumed that a similar situation occurs for wild Broad-headed snakes. Captive specimens however are noted to mature far quicker when food intake and temperatures are raised.

Vitellogenesis (egg formation) commences in late autumn/winter and continues until mid spring (about September/October) with ovulation around October. This would necessitate a higher than usual food intake for females, particularly in view of the fact that they usually cease feeding for at least two months prior to giving birth. Acheson and Shearim noted year-round feeding in their Broad-headed snakes but with no strong seasonal biases. Males tended to go off food when mating.

Wild snakes in this genus appear to reproduce only every second year. Those who have bred Broad-headed snakes in captivity haven't indicated whether or not it is the same or different snakes reproducing each year, (they tend to hold several reproductive specimens). However a single large female held by Charles Acheson did reproduce in successive years. As yet, these is no indication as to how rare such s scenario (yearly reproduction) is in Broad-headed snakes, although such clearly isn't the norm.

Whether reproduction every second year in this species (in the wild) is determined by genetic or environmental factors isn't known. Shine notes that less than annual reproductive frequency is fairly common in cold climate snakes, including species with relatively high survivorship of young. Broad-headed snakes fit this pattern.

Worrel (1970) and others have stated that these snakes shelter in trees during the summer months. However this assertion has recently been (in part) challenged by some herpetologists.

Rick Shine and a student of his, Jonathon Webb, at the University of Sydney, have recently commenced a detailed study into Broad-headed snakes, including radio-telemetry. They hope to further establish where these snakes go during warmer weather. Certainly some specimens range a substantial distance from rocks. Furthermore some are known to have takes shelter in hollow limbs of large Eucalypts (Eucalyptus sp.) some distance above the ground. This habit is in line with known habits of the closely related Pale-headed snake. That species is caught by collectors near Rockhampton in Queensland who drive along roads at night shining strong lamps onto adjacent tree trunks.

DECLINE AND DISTRIBUTION OF BROAD-HEADED SNAKES

This species was once common over a wide area that has now been built upon. The Australian Museum in Sydney hold specimens from heavily built up inner Sydney suburbs such as Randwick, which now lack anything resembling natural bushland. Krefft (1869), stated that in 1969 Broad-headed snakes were still common along the rocky coastline from the

Foto 2: *Hoplocephalus stephensi*. Mount Glorious, Queensland. Foto: Raymond Hoser.

Foto 3: *Hoplocephalus stephensi*. Volwassen exemplaar uit Mount Glorious, Queensland. Adult from Mount Glorious, Queensland. Foto: Raymond Hoser.

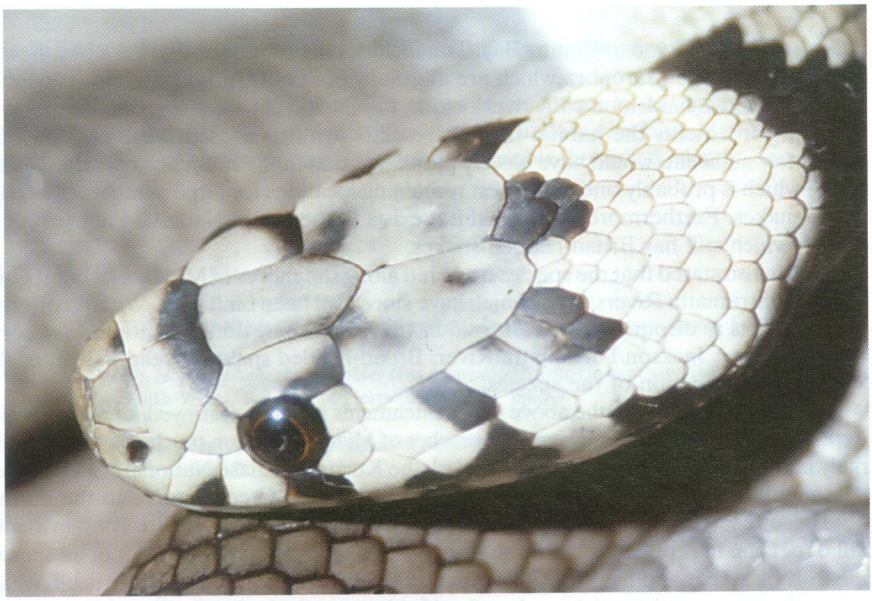

Foto 4: *Hoplocephalus bitorquatus*. Moonee, Queensland.
Foto: Raymond Hoser.

Foto 5: *Hoplocephalus bitorquatus*. Volwassen exemplaar uit Moonee, Queensland. Adult from Moonee, Queensland.
Foto: Raymond Hoser.

entrance of Port Jackson to Botany Bay. This includes the suburb of Watson's Bay, Bondi, Bronte, Coogee and Maroubra which are all totally built out. Although multi-story units are built over the sandstone cliffs overlooking the Pacific ocean, it is clear that prior to European settlements the habitat near these cliffs, with their associated 'seas of rock' immediately adjacent, would have closely paralleled that in the hills/cliffs of Yalwal (near Nowra) which is probably one of the best remaining locations for large numbers of Broad-headed snakes. Furthermore similar habitat exists in the Royal National Park (south of Sydney), which still has Broad-headed snakes.

Krefft also stated that the species occurred along the shores of Middle Harbour, Lane Cove and Parramatta Rivers, all of which have since also been built over. Without offering any direct facts to dispute what Krefft said in 1869, I have my doubts as to how far north (if at all) of Port Jackson/Parramatta River, Broad-headed snakes spread in light of the present day distribution of the species.

Bushland remaining in the above water catchments is all but destroyed for many species of reptile with the exception of the upper reaches of Middle Harbour, much of which remains largely intact. This area directly connects with the Kurringai Chase National Park between St. Ives and Terry Hills along with the Oxford Falls/Deep Creek reserve to the north.

These reserves are huge and bushland within them is virgin. There is no evidence at all of decline in reptiles within these reserves and all existing populations of all species appear to be stable and healthy. Other than Port Jackson/Parramatta River itself, which acts as a significant north/south boundary (having it's source in the flat clay-based Cumberland Plain which totally lacks sandstone), there are no other natural barriers to sandstone dependent wildlife. Within Kurringai Chase and other unnamed reserves which also run onto it there are no Broad-headed snakes. However there is no evidence of or no records of herpetological collecting within the Kurringai Chase or adjoining National Parks in any way capable of wiping out just this one species. Furthermore, Hersey (1980) documented minimal impact in this species numbers by collectors in any area.

Broad-headed snakes also do not occur in the vast National Parks immediately to the north of the Hawkesbury River (just beyond Kurringai Chase). This is in spite of almost the entire areas of all these reserves containing excellent Broad-headed snake habitat (including the obligatory Lesueur's Geckos).

I therefore conclude that Broad-headed snakes have not occurred in the near coastal National Parks north of Post Jackson as far as the New South Wales central coast since prior to European settlements. Any previous records from these areas should therefore be treated as either doubtful or possibly based on individual released specimens.

Furthermore I note here that the Royal National Park and adjoining Heathcote State Park to Sydney's South is of similar area and of identical habitat to that of Kurringai Chase. It has been demonstrably more heavily collected by reptile people in the last 30 years, and suffered far more intensive recreational development, but still holds populations of Broad-headed snakes.

A number of people have speculated that Hoplocephalus is a relictual genus. Such may be the case and it may be in long term decline as evidenced by the patchy distribution of all three species.

As far back as 1869, Krefft noted that gardeners taking sandstone exfoliations from the bush appeared to be causing a decline in numbers of this species. In spite of this pressure, urbanization, and the possible threat of collection by hobbyists, most remaining populations of this species do not seem to be in decline. They also tend to be within National parks and other government controlled land.

No feral animals are believed to place undue pressure on the species, nor do they appear to be overly vulnerable to bushfires. Parts of the Blue Mountains and Royal National

Parks subjected to repeated and fierce bushfires still have stable populations of Broad-headed snakes.

Based on records of previous collections of specimens by hobbyists from the Royal National Park on Sydney's immediate southern boundary, the Blue Mountains National Park to the west and sites near Nowra, responsible hobbyists clearly don't threaten populations.

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HOPLOCEPHALUS BUNGAROIDES, THE BROAD-HEADED SNAKE IN CAPTIVITY

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Contents: Introduction - In capivity - Venom - Literature.

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INTRODUCTION

Broad-headed Snakes are easy to maintain in captivity. As captives they are very easy to maintain, so handling them is rarely necessary. They are also long lived. Captives held in excess of ten years are common. Wollongong herpetologist Marion Anstis successfully kept a specimen on a diet of mice for over 19 years. That was the same specimen that didn't eat at one stage for over 12 months. I have never kept this species myself, so the following account in relation to keeping these snakes is in effect second-hand.

No keeper has ever indicated problems with these snakes. The general consensus is that they are among the easiest and most durable Australian elapids to keep. They don't seem to be prone to any particular ailments and breed readily.

IN CAPTIVITY

Probably the most expedient method to keep these snakes is in shoe-box style accommodation used successfully with small colubrids and other reptiles. Most keepers however seem to house these snakes in modified fish tanks and/or wooden snake cages set up with rocks and other natural artifacts, the mandatory water bowl and so on. The most common substrate used is gravel.

Temperatures should not go below 10°C or above about 30°C. The cage should always have a temperature gradient so that the snake(s) can select their preferred temperature. Captive snakes will actively thermoregulate. Seasonal/overwinter cooling is recommended and probably essential for breeding success. Three separate breeders regularly achieved success without separation of the sexes prior to breeding. There has never been a need to attempt to induce mating in Broad-headed Snakes. Hayes (1973a) documented a case of a male Broad-headed Snake mating with a female Stephen's Banded Snake in the same cage. The male snake apparently chases and 'corners' the female before mounting her. Mating has been observed at as low as 12°C.

Male combat hasn't been documented for *Hoplocephalus* and according to Shine (1983) it is unlikely as the females tend to be larger. It is when the males are usually the larger sex that male combat is a common behaviour. Certainly keepers of Broad-headed Snakes have not yet documented fights between co-habitants of cages or similar behaviour.

Adams (1973) stated that, based on his experiments keeping the genus, he thought Broad-headed Snakes weren't cannibalistic, but that the other species in the genus were. In spite of the above statement, there have since been documented cases of cannibalism in this species. Herpetologist Greg Sinclair had a large adult Broad-headed snake eat a cage-habitant of the same species that was less than half it's length. It was later regurgitated

partially digested. In a similar incident a large specimen (s-v 53 cm.) ate another individual (s-v 41 cm.) which was not regurgitated. White (1973), also reported an adult consuming two large Small eyed Snakes *(Cryptophis nigrescens)* whilst in captivity. Wells, Wellington and Williams (1988) also reported on a captive Broad-headed Snake feeding on an immature Yellow-faced Whip Snake *(Demansia psammophis)*. Captive Broad-headed Snakes have also been induced to eat young Bluetongue Lizards *(Tiliqua scincoides)* and even live fish dropped onto the cage substrate. How much of this behaviour was unusual to captive specimens, as opposed to what takes place in the wild is yet to be established. Where these snakes occur in the wild, tadpoles/frogs of several species are sometimes available and may constitute food in some circumstances.

When feeding, these snakes will usually sit and wait for food to approach as opposed to actively forage for it, although this is in part depends on the set-up of the cage. When snakes bite their food, they tend to hang on to it and immobilize it by using their body to push it against a restraining surface such as a rock. Using coils to restrain prey (like constriction) has also been observed. Food is eaten only when the prey is completely subdued by venom.

Shine and Fitzgerald (1989) documented mating in captive snakes in spring (September/October) with live young being born in January to March (4 breedings). This correlates with what is seen in terms of reproduction in wild specimens. However I have been advised by other keepers that male Broad-headed Snakes will mate, and mate repeatedly

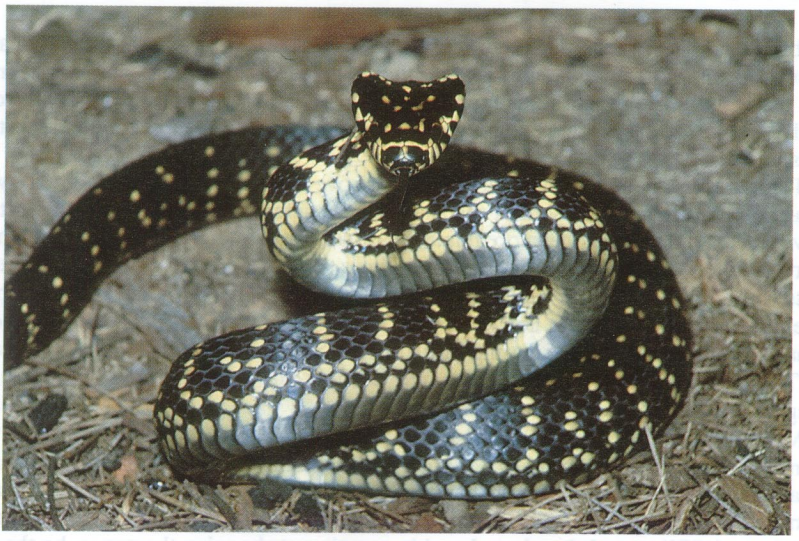

Foto 1: *Hoplocephalus bungaroides*. Volwassen exemplaar uit Lawson, New South Wales. Adult from Lawson, New South Wales.
Foto: Raymond Hoser.

at any time of years. The Autumn and Spring periods were the periods of most intense mating activity. However, offspring were only produced in the period Summer/Autumn. Mark Fitzgerald got litters of between 4 and 12 youngs in four breedings. Including other documented cases, all liters for the species range between 2 and 12 and in the period January to April. All breedings to date have been in Eastern Australia which is where the species occurs naturally. However there is nothing to suggest these snakes won't reproduce just as successfully if kept elsewhere.

The actual mating act in Broad-headed Snakes has only been observed once by myself (when visiting a keeper of this species). Mating appeared no different to that observed by myself in other Australian Elapids. The male had aligned his body over that of the female and was rubbing himself (in particular the head and chin) over the female. He was trying to raise the female's tail with his own. Both snakes moved their tails vigorously when this was done. I've been told that observed copulation usually lasts from one to several hours (often seeming to go on all night.) See Hoser (1983) for a description of mating behaviour in Death Adders *(Acanthophis antarcticus)*. The main observed difference between the two species is that the female Broad-headed Snake does not rapidly twitch her tail in the same 'end-shaking' manner as the female Death Adder, when first mounted by the male. Hayes (1973a) documented five repeated copulations between a male Broad-headed Snake and a female Stephen's Banded Snake. No offsprings were reported. Carpenter and Ferguson (1977) discuss stereotyped mating behaviour in reptiles in detail.

Known distribution of Hoplocephalus bungaroides.

According to Sydney breeder Charles Acheson, the actual act of giving birth is very quick, with the young snakes being expelled from the female at great speed, making photographing the act fairly difficult. He also noted the young snakes rapidly moved away from the female shortly after birth. He has bred these snakes many times.

Like the adults, young snakes are also pugnacious. Shine and Fitzgerald (1989) quoted snout-vent lengths of newborns ranging from 21.8 to 22.7 cm. A problem indicated by Shine and Fitzgerald, Acheson and another breeder, Richard Shearim, has been stillborn young and unfertilized ova (eggs). An identical scenario seems to commonly occur in Death Adders *(Acanthopis antarcticus)* another live-bearing Australian elapids. It also probably occurs in other reptiles. Shine is now investigating the cause/s of this phenomenon.

Mirtschin (1985) has speculated that a cause of stillborn young in captive snakes may due to overheating of the gravid female. When he altered the substrate of his cages to

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make them cooler, he reduced the rate of stillborn young. However the reduction in stillborn young may also have been a result of some other factor such as the female snake/s increasing in age/maturity.

Also in line with Death Adders *(Acanthophis antarcticus)*, Broad-headed Snakes will feed prior to sloughing while the eye scales are clouded. There are no accurate records of growth rates or sloughing frequencies in either captive or wild snakes although Shine, Webb and others are presently attempting to address these issues.

VENOM

Broad-headed snakes are highly strung and won't hesitate to attempt to bite. When agitated a snake will raise the forepart of it's body in an s-shape, flatten and broaden it's head and strike repeatedly at any object brought within range.

Although one fatally is known from the bite of this snake, it isn't usually regarded as dangerous. The bite is however painful. Severe bites can be neutralized with Tiger Snake *(Notechis)* anti-venom, although this is rarely indicated because the effects of the horse-serum may well be worse than those from the venom itself.

The venom is powerfully coagulant and neurotoxic. It also has weak blood destroying properties (Mirtschin and Davis, 1992). Severe bite symptoms include drowsiness, slurred speech, lack of muscle control and local swelling.

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