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*Gopherus agassizii*, commonly known as Agassiz's or the Mojave Desert Tortoise. Photo © 2008 by the Desert Tortoise Recovery Office, Pacific Southwest Region USFWS. Public domain.

featured species

## Agassiz's Desert Tortoise, *Gopherus agassizii*

# Winter and Summer Dormancy of the Wild Desert Tortoise

by M. A. Cohen

**Agassiz's or the Mojave desert** tortoise (*Gopherus agassizii*) is an herbivorous (plant-eating), diurnal (active during the day) reptile that is native to the Mojave Desert of North America. Like other desert-dwelling animals, the desert tortoise has developed strategies for coping with the extreme conditions of its habitat. These extremes include fluctuations in air temperature from searing heat to bitter cold, as well as the scarcity of food and water for much of the year.

One of the desert tortoise's primary adaptations to its inhospitable habitat is retreating into an underground burrow or a protective cave or rock crevice as environmental stress forces escape from potential harm. Withdrawal to these relatively benign surroundings is crucial to its survival, as lethal surface temperatures are common in the tortoise's habitat. Researchers estimate that between its winter and summer intervals of torpor, the desert tortoise typically spends at least 95% of its life underground in the shelter of its burrow.

CONTENTS


| | |
|---|---|
| Winter and Summer Dormancy of the Wild Desert Tortoise by M. A. Cohen | 1 |
| Turtles, Tortoises, and Gratitude by Karen Berry and Cristina Perovich | 8 |
| Mike's Turtle Net Picks by Michael J. Connor, Ph.D. | 12 |
| The Turtle's Garden: Indian Fig (*Opuntia ficus-indica*) | 14 |
| Meetings and Programs | 16 |
| 2019 CTTC Directory | 17 |


Desert amphibians and reptiles in general, and *G. agassizii* in particular, belong to a class of animals that animal behaviorists call evaders. These animals avoid excessive heating and cooling of their bodies by retreating from, or evading temperature extremes. Evaders shelter in benign microenvironments such as underground burrows in order to thermoregulate, i.e., regulate their body temperatures (OpenLearn - The Open University n.d.).

## Hibernation, Brumation and Estivation

The terms hibernation, brumation and estivation all refer to types of thermal adaptation during which an animal retires to a safe place and experiences a period of inactivity in order to conserve its energy and endure some severe condition in its environment. Each of these three terms refers to a type of metabolic depression, the reduction of the animal's metabolic rate as a strategy for coping with adverse environmental conditions, whether the adversity is excessive heat or cold, or scarcity of sustenance. The following discussion examines the terminology of torpor more closely. Torpor is key to these forms of thermal adaptation: animals become lethargic, entering a state of hypothermia coupled with behavioral inactivity.

## Hibernation

Hibernation is a zoological term for the period of profound winter dormancy that is routine for many mammals and some birds and insects native to subtropical and temperate regions of the world. Extremely low air temperatures and food shortages occurring in winter force creatures into a state of sustained physiological depression and metabolic dormancy in order to survive environmental extremes. Hibernation is a type of adaptive hypothermia, a survival strategy involving both physiological and behavioral components. Shorter day length and lower air temperature are the primary environmental cues that prompt animals to prepare for hibernation.

In late summer and autumn, animals living in cold-winter areas prepare for hibernation by eating as much high-quality food as possible. The greater intake of food prior to dormancy results in an increase in body fat. It is this body fat which sustains the hibernating animal's essential life processes through its dormancy. During hibernation the animal burns stored body fat but does not lose muscle mass.

Preparation for hibernation also includes seeking or constructing a safe, suitable hibernaculum, or chamber in which to hibernate. Burrows, caves, rock crevices, dens or nests, depending on the animal utilizing the chamber, may serve as hibernacula.

The physiological changes that accompany true hibernation are profound and sustained, including a lowering of the basal metabolic rate, lowering of the core body temperature, and slowing of respiration and heart rates. These physiological changes conserve the animal's energy during the long period of inactivity. As the air temperature falls, so does the animal's body temperature, until its body temperature is comparable to that of its surroundings.

In true hibernation, an animal may appear to be dead. It is totally unresponsive to outside stimuli. So complete is the torpor of true hibernation that the animal may even be physically removed from its hibernaculum without awakening.

## Brumation

Brumation (pronounced broo-may-shun) is the unique term zoologists use to characterize winter dormancy in reptiles. This term is based on the adjective "brumal," meaning "occurring in winter," which itself is derived from the Latin bruma, meaning "winter." Shorter days, cooler temperatures and changes in barometric pressure are some of the environmental cues that are thought to trigger the brumation of reptiles.

Some of the physiological changes that occur in reptiles during brumation parallel those that occur in other animals during hibernation. However, brumation in reptiles differs from hibernation in other animals in several significant ways. Hibernation involves more drastic physiological changes than does reptile brumation. A reptile does

not physiologically regulate its body temperature; its body temperature is comparable to the ambient, or surrounding temperature of the burrow microenvironment, typically 40 to 60°F (4.4 to 15.5°C). While the mammal or bird is sustained by its fat reserves during hibernation, the reptile is sustained by glycogen (stored glucose) reserves during brumation (Tosney n.d.).

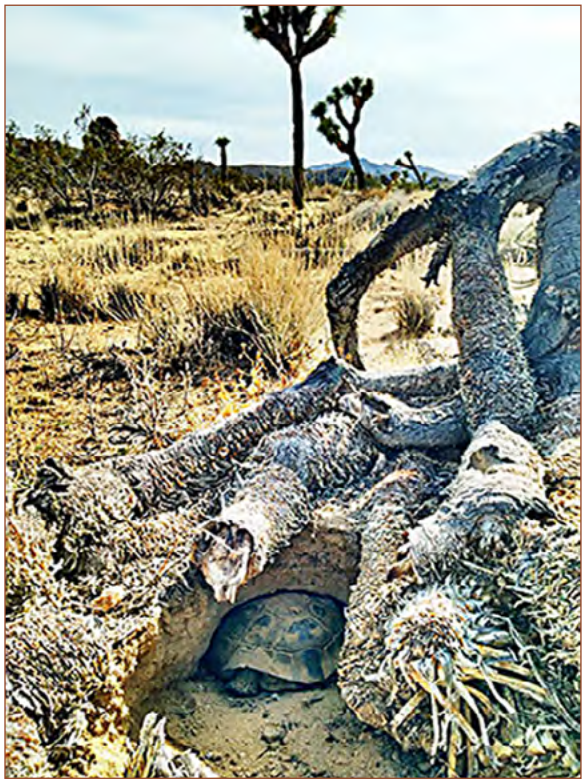
Even though their dormancy is termed brumation, the chamber in which reptiles shelter is termed a hibernaculum. Reptiles will shelter in their hibernacula and may remain largely inactive for months at a time. Metabolic, heart and respiratory rates in the brumating reptile slow to minimal levels. Feeding, digestion and defecation effectively cease. However, on milder days, reptiles may emerge to bask. During rainfall, they may emerge to drink. After such an emergence, they return to their hibernacula and resume their energy-conserving lethargy.

Brumation may entail biological cues such as hormonal changes, neurotransmitter shifts, and changes in amino acid concentrations. These internal cues are not well understood and may, in fact, be a consequence of the environmental cues which trigger brumation in the wild.

## Estivation

Estivation, also spelled "aestivation," is a zoological term for the period of summer dormancy that occurs in animals when environmental conditions are excessively hot and dry. When food supplies dwindle and water is essentially unavailable, many animals, including the desert tortoise, resort to the safety of estivation as a survival strategy. As with brumation, estivation involves energy and water conservation by a slowing of the life processes: metabolic, heart and respiratory rates all slow significantly. The desert tortoise is native to the Mojave and Sonoran deserts of the southwestern United States and northern Mexico, a region where mid-day air temperatures in summer may reach lethal levels. It is vital that *G. agassizii* seek refuge in a benign microenvironment. When milder daytime temperatures return in early fall, the desert tortoise emerges from its estivation chamber to feed on any available forage prior to entering its winter dormancy phase known as brumation.

Estivation may last for days, weeks or the entire dry season. During summer thunderstorms in the desert, estivating *G. agassizii* often emerge from their burrows to drink from the temporary rainpools that form, after which they retreat once again to the microenvironment of their shelters to evade summer's excessive heat. During estivation as much as 25% of the desert tortoise's body mass may be the water stored in its bladder.



In Joshua Tree National Park, Adele the desert tortoise burrows beneath a fallen Joshua Tree (*Yucca brevifolia*). Photo by Kristen Lalumiere for the National Park Service. Public domain.

## Desert Tortoise Ectothermy and Thermoregulation

Desert tortoises are known to zoology as ectotherms, animals whose internal body temperature is dependent on external (environmental) conditions. An ectothermic animal is sometimes said to be "cold-blooded," but the term cold-blooded is vague and misleading because ectotherms can actually have higher body temperatures than the so-called "warm-blooded" mammals living in their ecosystem (Wareham 1993). The ectotherm regulates its body temperature by exchanging heat with its environment. Because of this dependence on external circumstances, the body temperature of an ectothermic animal is subject to considerable fluctuation.

On sunny days, *G. agassizii* may experience substantial heat gain and must avoid hyperthermia (excessive heating) and dehydration as it forages for food, seeks mates, and so on. In cold weather, low temperatures may cause hypothermia, the consequences of which can be as life-threatening as excessively high temperatures. In desert environments dominated by temperature extremes, ectotherms such as the desert tortoise must thermoregulate in order to survive. Thermoregulation, the maintenance of body temperature within a range conducive to survival, involves distinct behaviors, specifically basking in the warmth of sunlight and cooling off in the shelter of a cover site.

## Water Conservation and the Desert Tortoise Bladder

Water is perhaps the most precious commodity in the desert

environment. All desert organisms require some amount of water to sustain life, and *G. agassizii* is no exception. While the tortoise does drink from temporary rainpools that form during rainstorms, most of the desert tortoise's water intake comes from the plants it eats. Grasses and herbs, especially wildflowers, provide the most of the desert tortoise's dietary water as they are consumed during spring and summer foraging.

*G. agassizii* possesses a large urinary bladder with some remarkable capabilities. The bladder is able to store as much as 40% of the desert tortoise's body weight as water, urea, uric acid and nitrogenous wastes. The desert tortoise bladder can cause uric acid solids ('urates') to be precipitated and excreted as semi-solid wastes, while enabling water to be reabsorbed into the desert tortoise's system for maintenance of its water balance. In addition to urate excretion, there are other means by which the desert tortoise loses water, including respiration, evaporation and defecation. In additional to being a thermal refuge for the desert tortoise, the burrow acts as a hydric refuge, enabling the desert tortoise to conserve precious moisture.

## The Desert Tortoise Burrow Microenvironment

In order to thermoregulate, reptiles will seek the shelter of an underground burrow, cave, rock crevice, or in the shade cast by a plant such as creosote (*Larrea tridentata*) in order to cool off. *G. agassizii* often digs a pallet in the shade of a plant when no burrow is nearby. The pallet is a shallow depression typically no deeper than the carapace of the tortoise, scraped into the earth under a desert shrub to create a temporary resting site during daytime heat. On warm summer nights desert tortoises often sleep in these pallets rather than in underground burrows.

A study conducted in 1991-2 at a site in Clark County, Nevada included recording the ambient temperatures within tortoise burrows. The research indicates that the burrow temperatures typically varied less than 0.55°F (1°C) per day. The average temperature within the burrow in late August was 84.2°F (29°C); the average temperature within the burrow in December was 44.6°F (7°C) (Zimmerman et al. 1994).

In Joshua Tree National Park, a desert tortoise is tucked into a burrow. Note the half-moon shape of the burrow entrance, mimicking the shape of the tortoise's carapace. Photo by Joshua Tree National Park. Public domain.

The burrow serves as an immediate refuge in which to escape dangerously high or low surface temperatures for *G. agassizii* (Bulova 2002). It is vital that the desert tortoise seeks the shelter of a burrow when surface conditions become life threatening. For example, the intense direct rays of the sun can cause a desert tortoise to overheat and die within an hour. Conditions in the burrow microenvironment are benign relative to the extremes occurring on the surface.

Skin temperature is generally a good indicator of body temperature in *G. agassizii*. The stable situation within the burrow is conducive to maintenance of a favorable body temperature (Bulova 2002).

A desert tortoise entering a burrow at midday may have a skin temperature of 102.2°F (39.3°C), while the ambient temperature within the burrow may be 86.9°F (30.5°C), a difference of 15.3°F (8.8°C) (Bulova 2002). As the desert tortoise rests within the shelter of the burrow, its body temperature equalizes with that of its surroundings.

The relative humidity within the burrow is significantly higher than that of the surface. At a Clark County, Nevada study site, when the surface air temperature measured 91.4°F (33°C), the relative humidity (RH) on the surface of the desert at midday was 10.0% while the RH within a burrow measured 19.5% (Bulova 2002). The higher RH in its burrow helps the desert tortoise conserve its water balance while resting between intervals of activity and during periods of dormancy.

Evaporative water loss can lead to dehydration, an ever-present risk in arid environments. Research shows that the RH in a tortoise burrow is increased by as much as 40% when the tortoise is present. Evaporation of moisture from the lungs, exposed skin and eyes of *G. agassizii* all contribute to the increase in the

burrow's RH. The eyes of the desert tortoise are covered with moist corneas rather than the dry scales that are typical of snakes and many lizards (Bulova 2002). Closing its eyes while resting in the burrow is another way for the desert tortoise to reduce its evaporative water loss.

## Physical Characteristics of the Desert Tortoise Burrow

It is the burrow that affords a desert tortoise its best option for coping with the daily and the annual temperature extremes of its habitat. The burrow provides a desert tortoise with several benefits, including a warmer temperature in winter and a cooler temperature in summer than the surface temperature, generally higher and more constant humidity than surface humidity, and protection from predators (Luckenbach 1982).

*G. agassizii* is well-equipped to excavate its burrow. Using its strong, flattened forelimbs to shape the burrow, the tortoise labors to kick displaced soil away from the burrow entrance. The burrow entrance is typically a half-dome which is slightly taller than the tortoise itself, allowing the animal to enter without completely extending its legs (Lawler n.d.). The narrow tunnel beyond the entrance leads to an inner chamber that is typically just large enough for the tortoise to turn around in. Desert tortoises often rest facing out of their burrow entrances before they begin their morning activities.

The desert tortoise is native to desert regions in Arizona, California, Nevada, Utah and northern Mexico. These areas have significantly different geographical features. Both burrow configuration and utilization vary considerably from one locality to another, depending largely on the topography of the region. Climate, weather, landforms and soil composition dictate the depth of a burrow, the length of its tunnel, its orientation, and other features.

### Arizona burrows

In northern and central Arizona, winters can be harsh, and low temperatures compel the resident tortoises into dormancy. Burrows are excavated in the banks of arroyos with sufficient depth that the posterior margin of the tortoise's carapace is flush with the arroyo wall (Luckenbach 1982). In southern Arizona winters are more moderate and desert tortoises may use shallow burrows or pallets in which to shelter. Desert tortoises native to Arizona's Sonoran Desert and that of northern Mexico may not brumate at all, but will use their shelters for midday and seasonal protection from overheating.

The majority of *G. agassizii* in Arizona are found in Sonoran Desert habitat along rocky slopes and bajadas, ranging from 508 ft (155 m) to 5,250 ft (1600 m) in elevation (Desert Tortoise Management n.d.). The boulders and coarse-grained soil composition of this habitat impede the construction of an excavated burrow. Native desert tortoises are likely to shelter in naturally formed rock caves, crevices and depressions. Where soil composition permits, desert tortoises in southern Arizona and northern Mexico may dig burrows up to 6.6 ft. (2 m) long.

"The desert tortoise can live where ground temperatures may top 140 degrees F [60 degrees C] because it digs burrows to escape the heat." Photo © 2005 by Lake Mead National Recreation Area Public Affairs. Source: Wikimedia Commons; license: CC-BY-SA-2.0.

### California burrows

In California, *G. agassizii* excavates both permanent deep burrows and temporary shallow burrows and pallets. Permanent burrows are commonly about 3.3 ft (1 m) deep and descend at an angle between 10 and 30°. Occasionally a burrow may be as long as 9.8 ft (3 m). Shallow burrows are typically just deep enough to cover the desert tortoise (Luckenbach 1982).

Research conducted at the Desert Tortoise Preserve in Kern County, CA indicates that an adult desert tortoise usually has one to three permanent burrows and two to three shallow burrows or pallets. These shelters are used repeatedly. An individual tortoise will often return to the same burrow after a lengthy feeding or mating excursion (Luckenbach 1982).

Desert tortoises routinely spend the night above ground in pallets or under shrubs during spring and summer. Nighttime surface temperatures drop to 68 to 75°F (20 to 24°C) while the temperature in the burrow may be 86 to 93°F (30 to 34°C). It appears that sleeping above ground gives the tortoise the thermal advantage of starting its morning activities with a lower body temperature, thus extending the amount of time before seeking shelter becomes necessary (Luckenbach 1982).

### Nevada burrows

*G. agassizii* in Nevada utilizes four

types of cover sites. Dens, burrows, pallets, and nonburrows all provide shelter for the resident tortoises. These cover sites are typically excavated in soils with varying amounts of coarse gravel, in the banks or beds of arroyos, and under desert shrubs. Desert tortoises in Nevada that were fitted with radio transmitters and tracked by researchers utilized 12 to 25 cover sites during their annual activities (Burge 1978).

Nevada researchers define a den as a type of burrow often formed by geologic activity in consolidated-gravel formations, that may be further excavated by a tortoise. A burrow is a subsurface cavity formed by erosion or excavated by tortoises, or a combination of the two. A pallet is a shallow depression utilizing a canopy of shrub branches or an overhanging rock formation as a "roof." A nonburrow cover site may be exposed ground shaded by overhanging shrubs or a cavity that partially covers the desert tortoise (Burge 1978).

In a study conducted in Nevada, researchers found that 72% of cover sites in the study area were located under shrubs such as creosote (*Larrea divaricata* [=*tridentata*]), Nevada ephedra (*Ephedra nevadensis*), and Catclaw acacia (*Acacia greggii*) (Burge 1978).

### Utah burrows

In the state of Utah the northern limit of *G. agassizii* native habitat occurs. Winters are harsh and cold in their habitat, and Utah's resident desert tortoises spend 100 to 200 days per year in their hibernacula, which include soil burrows, rock crevices, and caves in caliche, or hardpan soils. Researchers believe that the number of freezing days per year determines the length of the hibernaculum's tunnel (Natural History Notes 2002). The burrows in Utah are usually horizontal tunnels measuring 6.6 to 16.4 ft (2 to 5 m), but may measure up to 33 ft. (10 m) in length (Luckenbach 1982). Often referred to as "dens," winter burrows in Utah can be located in the banks of arroyos but may also be located on hill slopes, flatlands or naturally-formed rock crevices. The burrow entrance is typically south-facing. Winter burrows are often used communally. Researchers have found as many as 25 brumating tortoises in one den, but fewer than five individuals is much more common (Luckebach 1982).

When the weather warms sufficiently, Utah's desert tortoises emerge from their hibernacula and migrate to their spring and summer foraging areas. Summer burrows in Utah are typically located on flatlands, between arroyos or in arroyo banks or under desert shrubs. Summer burrows are shallow, domed hollows up to 3.3 ft (1 m) long which angle downward. Tortoises may excavate new summer quarters or may use existing burrows that they clean out and utilize (Luckenbach 1982).

Desert tortoise, *Gopherus agassizii*, in a crevice burrow. Photo © Pierre Fidenci. Source: http://calphotos.berkeley.edu; license: CC-BY-SA-2.5

### Northern Mexico burrows

*G. agassizii* in northern Mexico, a region of relatively mild winters, usually rely on pallets or shallow burrows as their nocturnal and seasonal shelters. Pallets tend to be situated under desert shrubs, providing some additional thermal and predator protection. The burrow in Mexico is usually a shallow hollow carved out of the bank of an arroyo, a dry creek bed that may temporarily fill with water during heavy rainfall.

Many other desert animals, known in zoology as commensals, benefit from the burrow a desert tortoise excavates. Researchers in Utah, Nevada and California have documented the presence of more than thirty types of animals in desert tortoise burrows, including lizards, snakes, insects, spiders, small mammals and birds (Luckenbach 1982).

## Selecting a Burrow: Chemical Cues from Other Desert Tortoises

*G. agassizii* typically utilizes several burrows within its individual range. A single tortoise may use as few as 3 or as many as 18 burrows (or more) during its annual active period. Numerous researchers have observed that a desert tortoise will often enter and exit several burrows before selecting one in which to rest. Researchers studying burrow selection have made some other interesting observations. The desert tortoise appears to select or reject a given burrow based on chemical cues left by other desert tortoises (Bulova 1997). In zoology members of the same species are known as conspecifics, so the chemical cues left by desert tortoises are described as "conspecific chemical cues."

There are two primary types of chemical cues on which a given tortoise relies when selecting a given burrow: chin-gland secretions and deposited fecal pellets. The wild desert tortoise does not rely on urine deposits during its burrow selection process. In an effort to conserve as much bodily moisture as possible, the tortoise stores water in its bladder and does not urinate during its active period (Bulova 1997).

The males of all four species of *Gopherus* tortoises, the Bolson tortoise (*G. flavomarginatus*), the Texas tortoise (*G. berlandieri*), the gopher tortoise (*G. polyphemus*), and the desert tortoise (*G. agassizii*), possess glands on their lower jaws known to zoologists as subdentary glands, commonly known as "chin glands." These chin glands secrete a substance to which other tortoises apparently respond. In addition to being a visual cue as to a male's maturity (i.e., readiness to mate), chin-gland secretions may be an olfactory cue used in social behaviors such as courtship, sex recognition and combative interaction (Bulova 1997).

Male *G. agassizii* possess remarkably prominent chin glands that produce a secretion to which other male desert tortoises have a noticeable reaction. Chin-gland secretions may be deposited directly by rubbing the chin glands on burrow surfaces or may be transferred to burrow surfaces by way of the gular horn, a shell structure that protrudes from the plastron of the adult male desert tortoise under his lower jaw. Female desert tortoises have significantly smaller chin glands and gular horns than those of the male. It appears that the chin glands of the female desert tortoise produce minimal, if any, secretions (Bulova 1997).

During a 1997 study conducted in Clark County, Nevada that examined the factors involved in burrow selection, Bulova tested the responses of 16 male and 16 female desert tortoises to both chin-gland secretions and fecal pellets placed in artificial burrows on the study site. The male tortoises in this study preferred the burrows treated with the chin-gland secretion to burrows that were untreated. Female desert tortoises appeared largely indifferent to chin-gland secretions in this study. Research suggests that this attraction to chin-gland secretions on the part of male desert tortoises may better position them to compete directly with other males for available females (Bulova 1997).

Both male and female *G. agassizii* reacted to the presence of desert tortoise feces in a burrow. Fecal pellets in a burrow from a male tortoise inhibited burrow use by other male tortoises. Bulova concludes that the male tortoises' avoidance of burrows with other males' feces present contributes to a healthy distribution of male tortoises throughout a given habitat (Bulova 1997).

Female desert tortoises were significantly less likely to use burrows in which fecal pellets from other female tortoises were present, particularly during nesting season. Females frequently deposit their eggs in nests they dig within their burrows. Female tortoises' avoidance of burrows with other females' feces present, especially during nesting season, appears related to the possibility of previously laid clutches of eggs. To sidestep interference with her own nesting activity, the current female may choose to avoid a burrow where another female has previously rested and perhaps nested (Bulova 1997).

## Conclusion

The importance of the burrow to the wild desert tortoise cannot be overemphasized. Quite simply, without the moderate microenvironment of its burrow, the wild desert tortoise could not survive the extreme conditions of its habitat. ☯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**Author's note:** This article went to press on or about 1 June 2011 for publication in the July/August 2011 *Tortuga Gazette* 47(4). At that time, *Gopherus agassizii*, Agassiz's desert tortoise, was the single recognized species of desert tortoise, a native of California, Nevada, Utah, Arizona, and northern Mexico.

On 28 June 2011 an article was published in the online journal **ZooKeys** describing a **new** *Gopherus* species, *G. morafkai* (Murphy, Berry, Edwards, Leviton, Lathrop & Riedle, 2011), Morafka's desert tortoise, endemic to Arizona and northern Mexico.

The publication of this research effectively split the single *agassizii* species into two distinct species, *G. agassizii* and *G.morafkai.*

# 2019 CTTC Valley Chapter Annual Show
# Turtles, Tortoises, and Gratitude

Story by Karen Berry; photos by Cristina Perovich and Karen Berry, Valley Chapter

Cristina Perovich and "Bubba"-Valley's official greeter.

CTTC Valley Chapter held its annual educational and fundraising show on May 18, 2019. With many thanks to our first responders for all their dangerous and grueling work during the Woolsey Fire last November, the Chapter extended free admission to the show. Our two primary desert tortoise foster locations are located in areas which were under mandatory evacuation orders. The adoption team leader evacuated a total of 33 tortoises to a house in the Valley, where they had to remain for almost 3 days until the evacuation order was lifted. Fortunately, they were able to return to undamaged properties; those that could, resumed brumation (reptile hibernation), and the medical patients remained up and active. In addition to fulfilling the educational mission of CTTC, the show also benefits the "sick and injured" fund that helps those turtles and tortoises with serious medical issues, or may need long term rehabilitation. A recent surge in vet costs inspired one of our members to create a campaign to get our fundraising underway. You can see her remarkable efforts at: **https://www.gofundme.com/sick-amp-injured-tortoise-fund** as well as at: **https://www.paypal.com/fundraiser/charity/1627845** This is an ongoing effort, as we currently have several desert tortoises that were left at shelters and require major surgery or other procedures.

Show attendance was very good, many tickets were purchased for another phenomenal raffle, and the Tortuga Gift Shop offered items ranging from jewelry to books, handmade crafts, figurines, and ever-popular succulents and other plants. New members joined the chapter, and interested parties submitted adoption applications.

Dr. Kenneth Coscarelli from Newbury Park Vet Clinic answers questions about turtle and tortoise health

Dr. Kenneth Coscarelli, **Newbury Park Veterinary Clinic**, who also treats many of our sick or injured tortoises, staffed the "Ask the Vet" booth, sharing his many years of experience and expertise to answer questions on health and veterinary care. **https://newburyparkvet.com/**

But you can't have a "turtle and tortoise show" without the stars. "Bubba", an adult male Sulcata and Valley's "official greeter", roamed the live exhibit area with his chaperones, showing everyone that the world's third largest tortoise can be a wonderful and friendly pet. Our members exhibited not only desert tortoises, but Texas tortoises, Russians, Leopards, Greeks, Red Foots, Wood Turtle, Red-Eared Sliders, and more exotic tortoises, such as Radiated and Star tortoises. As always, the hatchling and juvenile desert tortoise exhibit was a popular stop for our guests.

Visitors were very surprised to see representatives of the two largest tortoises in the world. "GG", a young Galápagos tortoise, and "Pandora", a young Aldabra tortoise, both large, but not fully grown, came with members of the Santa Clarita Chapter, along with a young desert tortoise "Punkin", a juvenile Galápagos tortoise named "Geronimo", and a Mud Turtle, which lives around water, but does not swim well. **www.tortoise.org/santaclarita**

"GG" a Galápagos tortoise (left) and "Pandora" an Aldabra tortoise (right), visitors from Santa Clarita Chapter

In addition to CTTC members, the following organizations joined us for the fun, and not only helped make the show a success, but were able to "get the word out" about other animals that need the support of the public.

❖ **American Tortoise Rescue** – Susan Tellem and Marshall Thompson, our wonderful longtime friends and creators of "World Turtle Day", celebrated in May each year, lost everything in the Woolsey fire. Currently staying in a rented house, and working to get their home rebuilt, they have also been raising money to rebuild their turtle and tortoise sanctuary and to continue their mission of education about the plight of turtles and tortoises worldwide. **www.tortoise.com**

Susan Tellem and Marshall Thompson-ATR-continuing their mission and rebuilding after their home & turtle/tortoise sanctuary, were destroyed in the Woolsey fire.

❖ **Friends of California Condors Wild and Free**, affiliated with US Fish & Wildlife, teaches people about the preservation of these magnificent birds, and assists in efforts to increase their numbers in the wild.
**www.friendsofcondors.org**

Friends of California Condors teach people about conservation of this magnificent bird and efforts to increase their numbers in the wild.

❖ **Southwestern Herpetologists Society** is an organization dedicated to education regarding reptiles and amphibians, their preservation and rescue, and brought an assortment of snakes, lizards, and amphibians for all to see.
**http://www.swhs.org/**

Southwestern Herpetologists Society members brought snakes, lizards, amphibians to educate visitors

❖ **Ghost Cat Publications** raises awareness of coexistence with wildlife, and raises money through the sale of books about the local mountain lions, which, along with other animals, will benefit from the proposed wild animal crossing over the 101 freeway in the Calabasas/Agoura area.
**https://www.facebook.com/GhostCatPublications/**

❖ **Vickie Anderholdt**, a local bunny rescuer, brought a number of rabbits available for adoption, including an unusual Angora rabbit, and emphasized the need for more "forever homes" for bunnies.
**www.adoptabunnyrabbit.org**

A big thank you to these wonderful organizations, and we hope they will join us again next year.

The bunny rescue of Vickie Anderholt (on the right) focuses attention on the need for "forever homes" for the large number of unwanted rabbits.

Putting together our annual show requires a lot of planning. Both veteran and newer members took part in the before, during, and after, working very hard together to make the show and our "Thank You" to first responders a big success. Many thanks to all of them !!! ☯

Ghost Cat Publications raises awareness of living with wildlife and raises money for the proposed 101 freeway wild animal crossing.

Tim Perovich, raffle organizer, has reason for a big smile—another very successful raffle.

See pages 10–11 for more photos of the staff and exhibitors who helped make the 2019 event so successful.

# Gallery of Photographs
# Turtles, Tortoises, and Gratitude

Captions by Karen Berry; photos by Cristina Perovich and Karen Berry, Valley Chapter

Jodi Inzerella and Howard Suer greeted visitors at the front gate.

Brent Haffey, aka "The Yard Check King", provided adoption information and recruited many prospective adopters.

Barbara Devries, raffle team, sold tickets for anther high-earning raffle.

Local veterinarians, businesses, and chapter members donated great prizes for our raffle.

Kirk Weber taught visitors about exotic tortoises.

Bob Hazard, aka "Bob the Builder", discussed various kinds of turtle and tortoise housing with visitors.

Sioux Ratkovic's display of baby desert tortoises is one of the most popular booths at the show.

Handmade items, books, and plants were popular sales items in the Tortuga Gift Shop.

From the left, Maggie Elliot, Cristina Perovich, and Maria Kennedy. "The Russians are Coming!!"

Ruth Dewar and Maggie Elliot displayed a wood turtle and Russian tortoises.

"Geronimo", a juvenile Galápagos tortoise visiting from Santa Clarita chapter.

Jeannine Porter displayed both Texas tortoises and red-eared sliders.

Elaine Miller, keeper of Gimpy the desert tortoise.

Gimpy the desert tortoise. Elaine Miller and Gimpy teach an important lesson on kids and proper behavior toward tortoises

Members of Santa Clarita Chapter displayed "Punkin",a juvenile desert tortoise.

# Mike's Turtle Net Picks by Michael J. Connor, Ph.D.

A varied selection of recent articles, stories and sites on the Web that some of you may find as interesting as I did. This list is also posted on tortoise.org/turtlenetpicks/turtlenetpicks.html

**First Sighting of Impressed Tortoises in India**
A population of impressed tortoises has been discovered in northeastern India.

**First Captive Breeding of Asian Giant Tortoises in Bangladesh**
*Manouria emys* are being bred at Bhawal National Park to augment the Chittagong Hill Tracts population.

**Chimps Prey on a Hinge-back Tortoise**
For the first time, wild chimpanzees have been filmed killing and eating a reptile — in this case an unfortunate hinge-back tortoise. (WARNING, THE VIDEO IS QUITE GRAPHIC)

**Yangtze Giant Softshell Imperiled**
The only captive female Yangtze Giant Softshell has died. Biologists hope there may still be other females in the wild.

**Conservation Genetics of Dahl's Toad-headed Turtle**
The critically endangered *Mesoclemmys dahli* has lost most of its natural habitat due to severe habitat modification. Restoring gene flow is key to its conservation.

**Tracking Kirby the Loggerhead**
Follow radio-tagged loggerheads and other sea turtles as they go about their business.

**Pacific Green Sea Turtle Populations Are Recovering**
- New study finds that conservation efforts have increased green sea turtle density around Pacific Islands.
- **The research paper is available online.**

**Sea Turtles Nesting Earlier**
Climate change has brought the earliest recorded start to the sea turtle nesting season in South Carolina.

**Columbus Zoo Honors Karen Eckert**
The Columbus Zoo and Aquarium awarded Dr. Karen Eckert, the executive director of the Wider Caribbean Sea Turtle Conservation Network, its biennial Commitment to Conservation Award. Congratulations to Dr. Eckert!

**Protecting Rare Species Benefits Human Life**
Improving our understanding of how rare species help support human lives and well-being.

**What Turtles Can Teach Us**
Study using heart muscle cells from snapping turtles explains how the turtles survive long periods under water without oxygen and offers new approaches to protect humans at risk of heart attack and protect organs for transplantation.

**Wildlife Rehabbers Using Bra Clasps to Repair Injured Turtles' Shells**
Never underestimate the ingenuity of wildlife rehabilitators!

**CTTC on Facebook**
For breaking news updates visit and "like" us on Facebook!

A green sea turtle, *Chelonia mydas*, and a Hawaiian monk seal, *Neomonachus schauinslandi*, enjoy a mid-afternoon nap on a pristine beach in the Papahānaumokuākea Marine National Monument.

Located in the northwestern Hawaiian Islands, the Papahānaumokuākea Marine National Monument comprises more than 580,000 square miles (1,502 square kilometers) of ocean and atolls, protecting the ecosystem and its inhabitants.

Additional information about this World Heritage site is available online at the official website: **https://www.papahanaumokuakea.gov**

Photo by Mark Sullivan/NOAA. Public domain.

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the Turtle's Garden
planting for chelonians
by M A Cohen

## Indian Fig, a.k.a. Prickly Pear, *Opuntia ficus-indica*

# The Nutritional Content of Prickly Pears and Pads

**Resistant to drought, adaptable** to a diverse array of climates, and uncommonly nutritious: these are only some of the desirable qualities possessed by the Indian Fig, *Opuntia ficus-indica*.

At least 150 recognized species exist in the genus *Opuntia*, and members of the genus are collectively called opuntiads. The name *Opuntia* is derived from Opus, the name of a city in ancient Greece where an edible plant grew that was propagated by rooting its "leaves."

The current article will focus on *Opuntia ficus-indica*. Also known by the common names cactus fig, Barbary fig, cactus pear, and prickly pear, *Opuntia ficus-indica* is a true cactus, a member of the Cactaceae family of succulent plants.

According to Opuntiaweb, Indian fig "is actually a collection of *Opuntia* cultivars rather than a discrete species." It was originally domesticated by plant breeders for use as livestock forage for its relatively spineless pads and fruit, its ability to thrive in arid and semi-arid climates, and its abundant nutritional attributes. At least four species of *Opuntia* were selectively bred in the domestication of *O. ficus-indica*, which, according to Cota-Sanchez, is the "most agro-economically important" member of the genus *Opuntia*.

However, *Opuntia* species have been an essential part of Latin American culinary and medicinal traditions for as many as 8,000 to 9,000 years of cultivation.

The ripe fruit of *Opuntia ficus-indica*, commonly called a cactus pear, prickly pear, or cactus fig in English. The Spanish word for this fruit is *tuna*. Photo © 2010 by H. Zell. Source: Wikimedia Commons; license: CC-BY-SA 3.0.

Edible cactus leaves, also called cactus pads or prickly pads in English. The Spanish word for these pads is *nopales*. The botanical term for these flattened stems in cladodes. Photo by the Centers for Disease Control. Public domain.

Foraging for wild *Opuntia* by prehistoric peoples may have started as early as 12,000 years ago.

Developed in central Mexico, *O. ficus-indica* is now grown throughout North, Central and South America on large and small plantations. The species has been cultivated or has naturalized in frost-free areas worldwide, including Africa, Asia, Australia, the Mediterranean region, and the Middle East.

In addition to being a food crop, *O. ficus-indica* is grown as a host for the cochineal insect, a scale insect that lives on the surface of the prickly pads. The female cochineal insect secretes carminic acid, likely as a defensive mechanism. This substance is collected and processed to produce a red dye for fabrics, cosmetics, and food.

### The Prickly Pear

Botanically, the prickly pear is a fleshy berry that contains a "high number of important nutrients... [including] betalains, vitamins, minerals, amino compounds, and antioxidants." The composition of the prickly pear is typically "85% water, 15% sugar, 0.3% ash [ed. note: minerals], and less than 1% protein," as stated by Cota-Sanchez.

The pulp of the prickly pear is comparable in flavor to watermelon, and its sugar components are primarily glucose and fructose in approximately equal amounts. The oval-shaped fruit, typically 1 to 3 centimeters (0.4 to 1.2 inches) or larger in length, occurs in various colors, including white, yellow, red, green, orange, and purple. These colors are due to the presence of betalains, natural, water-soluble, non-toxic plant pigments that are antioxidants and also have other beneficial properties.

The flesh of the prickly pear is a delectable source of vitamins and

minerals of nutritional importance. Scientific analysis of the fruit's pulp reveals the presence of valuable vitamins such as vitamin C (ascorbic acid), vitamin E, vitamin K, and beta-carotenes, as well as trace amounts of several B vitamins. Important minerals include calcium, magnesium, phosphorus, and potassium.

Research has identified various antioxidants in *O. ficus-indica*, including several flavinoids and pectin, in addition to the aforementioned ascorbic acid, betalains, and carotenoids.

In the *African Journal of Biotechnology*, Chiteva and Wairagu published the results of their study of the nutritional values present in prickly pears grown in the African nation of Kenya. Results of their efforts were consistent with the findings of researchers in North America regarding the nutritional profile of prickly pears.

Chiteva and Wairagu also note that, while "nutritional composition...varies with respect to age, postharvest handling and season," the prickly pear represents a "good natural reservoir" of nutrition, especially given the absence of the toxic elements lead and cadmium in the mineral profile of *O. ficus-indica* fruits.

## The Prickly Pad

In a detailed scientific study published in the *International Journal of Environmental Research and Public Health* in 2011, Hernández-Urbiola et al. analyzed the nutritional content of *O. ficus-indica* pads grown organically on a *nopalera* (i.e., a prickly pear plantation) in Silao, Guanajuato, Mexico. The focus of their research was the nutritional values of ten groups of prickly pads at "differing stages of growth maturity" ranging from 40 days to 135 days.

Fresh, young prickly pads are known botanically as cladodes.

The method of preparation was the same for all ages of cladodes: thorough cleaning and disinfecting the pads, drying the tissue using a vacuum system, and grinding the dessicated tissue into a powder on which the chemical analysis was performed.

The research team's findings reveal that the protein content of all stages of prickly pads was low, similar to other vegetables. Protein synthesis appears to be related to the availability of water as well as air temperature and amount of sunlight and darkness.

Flower, flower bud and cactus pad of the *Opuntia ficus-indica* 'Burbank's Spineless' developed by American botanist Luther Burbank (1849–1926) in the early 20th century. After flowering, a sweet, edible fruit will develop. This horticultural cultivar is a nearly spineless variety of prickly pear that was originally hybridized for use as cattle fodder. Photo © 2006 by George Hull. Source: Creative Commons; license: CC-BY-SA-2.5.

As with other vegetables, carbohydrates were the primary element comprising the prickly pads. Older pads contained higher carbohydrate content than younger pads. Like most vegetables, prickly pads had a low fat content overall, and the fat levels in the pads dropped even more as they aged.

Calcium content of prickly pads doubled as the pads aged, and iron content also increased with age. Magnesium levels rose somewhat around 100 days and flattened out thereafter. Phosphorus, manganese, and zinc values showed no difference related to age. Based on their increase in calcium content, prickly pads are best consumed when they are more mature.

The research of Hernández-Urbiola et al. suggests that the mineral content of prickly pads depends on these factors: soil and water pH, availability of water, and the texture and components of the soil in which the cactus grows. ☯

Mature *O. ficus-indica* growing in Secunderabad, India. Photo © 2008 by J. M. Garg. Source: Creative Commons; license: CC-BY-SA-3.0.

### References


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## Meetings and Programs

Click on your Chapter's website link for the latest program information. Programs may be scheduled after newsletter publication.

**Chino Valley**
19 July; 16 August

**Foothill**
26 July; 23 August

**High Desert**
8 July; 12 August

**Inland Empire**
5 July; 2 August

**Kern County**
8 July; 12 August

**Low Desert**
5 August

**Orange County**
12 July; 9 August

**Ridgecrest**
8 July; 12 August

**Santa Barbara-Ventura**
Contact the chapter for meeting information.

**Santa Clarita**
20 July

**TOOSLO (San Luis Obispo)**
16 July; 20 August

**TTCS (Long Beach)**
19 July; 16 August

**Valley**
19 July; 16 August

**Executive Board**
13 July. Meetings take place at the Los Angeles County Arboretum in Arcadia, CA.

Juvenile Morafka's desert tortoise, *Gopherus morafkai*, with an *Opuntia* cactus laden with fruit. Public domain.

# 2019 California Turtle & Tortoise Club Directory

**Executive Board**
General Information:
CTTCEBOfficers@tortoise.org
Chair: **Don Williams**
Vice-chair: **Robyn Kohr**
Treasurer: **Javier Gonzalez**
**Meeting:** quarterly (January, April, July and October) at 10 AM at the Los Angeles County Arboretum, 301 No. Baldwin Avenue, Arcadia, CA 91007

**Chino Valley Chapter**
President: **Lynda Misiak**
Vice president: **David Bowman**
Secretary/treasurer/adoptions:
**Jim Misiak**
**Meeting:** Third Friday, 7:30 PM at Chino Girl Scout House, 5007 Center Street, Chino, CA 91710

**Foothill Chapter**
President: **Robin Robb**
Vice president: **Joanna Bolt**
Secretary: **Mardy Graves**
Treasurer/membership:
**Jeanette Lea**
**Meeting:** Fourth Friday, 7:30 PM at Los Angeles County Arboretum, 301 No. Baldwin Avenue, Arcadia, CA 91007

**High Desert Chapter**
President/adoptions: **Dave Zantiny**
Secretary/adoptions: **Mary Dutro**
**Meeting:** Second Monday, 7:00 PM at Sterling Inn Regency Room, 17738 Francesca Road, Victorville, CA 92395

**Inland Empire Chapter**
President: **Monica Dirac**
Vice president: **Richard Roosman**
Corresponding Secretary:
**Amy Taylor**
Treasurer: **Robyn Kohr**
**Meeting:** First Friday, 7:30 PM at "The Ark" Church of the Nazarenes in the Fellowship Hall in Young Hall, 1307 East Citrus Avenue, Redlands, CA 92374

**Kern County Chapter**
General Information:
TurtleTortoiseClubKern@gmail.com
President/membership:
**Heather Ponek**
Vice president: **Tim Brennan**
Secretary: **Lisa Marriott-Smith**
Treasurer: **Kathy Studer**
Adoptions:
**Richard Marriott-Smith**
**Meeting:** Second Monday, 6:30 PM at St. Philip of the Apostle Church, St. Ann's Room (east side of church), 7100 Stockdale Hwy (on the north side, between Ashe and Gosford), Bakersfield, CA 93309

**Low Desert Chapter**
General Information:
**Tony Vaninetti**
Secretary: **Marlies Dietrich**
Adoptions: **Bill Powers**
**Meeting:** First Monday of every even-numbered month 7:00 PM at The Living Desert Reserve, 47-900 Portola, Palm Desert, CA 92260-6156

**Orange County Chapter**
General Information:
orangecounty@tortoise.org
President/membership:
**Stephanie Roberts**
Vice president: **Richard Montagna**
Secretary: **Joyce Keyak**
Treasurer: **Marian Bronston**
**Meeting:** Second Friday, 7:30 PM at Grand Street Center (First Presbyterian Church), 146 N. Grand Street, Orange, CA 92866

**Ridgecrest Chapter**
President: **Robert Parker**
Vice president: **Sue Parker**
Adoptions: **Montynne Yates**
**Meeting:** Second Monday, 7:30 PM at Maturango Museum, 100 East Las Flores Ave., Ridgecrest, CA 93555

**Santa Barbara-Ventura Chapter**
President: **Don Williams**
**Meeting:** Contact the Chapter for meeting information.

**Santa Clarita Chapter**
President: **George Ordway**
Secretary: **Jennifer Fields**
Treasurer/membership/adoptions:
**Abigail DeSesa**
**Meeting:** Third Saturday of odd-numbered months at 6:30 PM at Valencia United Methodist Church, 25718 McBean Pkwy, Valencia, California 91355

**TOOSLO (San Luis Obispo) Chapter**
President: **Brandon Froelicher**
Vice president: **Brian Kusko**
Treasurer/membership/adoptions:
**Lola McAulay**
**Meeting:** Second Wednesday, 7:00 PM at PG&E Community Center, 6588 Ontario Road, San Luis Obispo, CA 94505

**Turtle & Tortoise Care Society (Long Beach) Chapter**
President: **Richard Roosman**
Vice president: **John Kim**
Secretary/Membership:
**Anita De Leon**
Treasurer: **John Wong**
**Meeting:** Third Friday, 7:30 PM at University Baptist Church, 3434 Chatwin, Long Beach, CA 90808-2613

**Valley Chapter**
President: **Bob Hazard**
Treasurer: **Karen Berry**
Adoptions: **Valley Adoption Team**
**Meeting:** Third Friday, 7:30 PM at Woodland Hills Christian Church, 5920 Shoup Ave., Woodland Hills, CA 91367-3327

NOTE: The postal mailing addresses for each Chapter are listed on the last page of this newsletter.

## Classified Advertisements

Classified advertisements run for one issue at $5^{00}$ for up to four lines. Ads are accepted at the discretion of the Editor. Classified ads are available to members and subscribers only and are run as a service to our members. California Turtle & Tortoise Club is not responsible for merchandise placed for sale in the *Tortuga Gazette*.

**Please make your check payable to the California Turtle & Tortoise Club.**

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## Is your email changing?

[1] Contact your chapter's membership officer and provide your new email address; *OR*

[2] update your email address through your MailChimp account by clicking the "Update Your Preferences" link in your newsletter notice; *OR*

[3] send your changes and corrections to tgdistribution@tortoise.org

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## 2019 CTTC Events Calendar

**27 July: Inland Empire Chapter Annual Show—**Redlands Senior Citizen Center, 111 W. Lugonia Ave., Redlands, CA 92374. 10 AM to 3 PM.

**25 August: Chino Chapter/Orange County Chapter Show—**La Habra Community Center, 101 La Habra Blvd., La Habra, CA. 91631. 9 AM to 3 PM.

The California Turtle & Tortoise Club (CTTC) is a non-profit 501(c)(3) corporation. Contributions are tax deductible to the full extent of the law. Please pay by USA funds only (US bank check, money order, or International Postal Order).

Membership in the CTTC and subscriptions to the *Tortuga Gazette* are handled through the CTTC Chapters. The Chapters also manage membership renewals (see postal addresses below).

Many members choose to join a nearby Chapter to participate in Chapter meetings and other activities. Print membership forms from the CTTC website.

Your Chapter and your renewal date (month/year) are displayed on your newsletter notification. Mail your new or renewal membership/subscription to the Chapter of your choice.

### Membership fees

- **Student membership $15^{00}**
- **Individual membership $25^{00}**
- **Family membership $35^{00}**
- **Life membership $500^{00}**

## CTTC Mailing Addresses

**Chino Valley Chapter**: P. O. Box 1753, Chino, CA 91708-1753

**Foothill Chapter**: P. O. Box 51002, Pasadena, CA 91115-1002

**High Desert Chapter**: P. O. Box 163, Victorville, CA 92393

**Inland Empire Chapter**: P.O. Box 2371, San Bernardino, CA 92406-2371

**Kern County Chapter**: P.O. Box 81772, Bakersfield, CA 93380-1772

**Low Desert Chapter**: P.O. Box 4156, Palm Desert, CA 92261

**Orange County Chapter**: P.O. Box 11124, Santa Ana, CA 92711

**Ridgecrest Chapter**: P. O. Box 1272, Ridgecrest, CA 93555

**Santa Barbara-Ventura Chapter**: P.O. Box 3086, Camarillo, CA 93011-3086

**Santa Clarita Chapter**: P.O. Box 4012, Castaic, CA 91310

**TOOSLO Chapter**: P.O. Box 763, Grover Beach, CA 93483

**Turtle & Tortoise Care Society Chapter**: P O Box 15952, Long Beach, CA 90815

**Valley Chapter**: P.O. Box 7364, Van Nuys, CA 91409-7364

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