

= Horn shark =

The horn shark (*Heterodontus francisci*) is a species of bullhead shark , in the family Heterodontidae . It is endemic to the coastal waters off the western coast of North America , from California to the Gulf of California . Young sharks are segregated spatially from the adults , with the former preferring deeper sandy flats and the latter preferring shallower rocky reefs or algal beds . A small species typically measuring 1 m (3 @. @ 3 ft) in length , the horn shark can be recognized by a short , blunt head with ridges over its eyes , two high dorsal fins with large spines , and a brown or gray coloration with many small dark spots .

Slow @-@ moving , generally solitary predators , horn sharks hunt at night inside small home ranges and retreat to a favored shelter during the day . Their daily activity cycles are controlled by environmental light levels . Adult sharks prey mainly on hard @-@ shelled molluscs , echinoderms , and crustaceans , which they crush between powerful jaws and molar @-@ like teeth , while also feeding opportunistically on a wide variety of other invertebrates and small bony fishes . Juveniles prefer softer @-@ bodied prey such as polychaete worms and sea anemones . The shark extracts its prey from the substrate using suction and , if necessary , levering motions with its body . Reproduction is oviparous , with females laying up to 24 eggs from February to April . After laying , the female picks up the auger @-@ shaped egg cases and wedges them into crevices to protect them from predators .

Horn sharks are harmless unless harassed , and are readily maintained in captivity . They are not targeted by either commercial or recreational fisheries , though small numbers are caught as bycatch . In Mexico this species is used for food and fishmeal , and in California its spines are made into jewelry . The International Union for Conservation of Nature (IUCN) does not yet have enough information to determine the horn shark 's conservation status . It faces few threats off the coast of the United States .

= = Taxonomy = =

The French biologist Charles Frédéric Girard published the first scientific description of the horn shark under the name *Cestracion francisci* in 1855 , in the Proceedings of the Academy of Natural Sciences of Philadelphia . This species was later placed in the genus *Gyropleurodus* , which was eventually synonymized with the genus *Heterodontus* . The specific epithet *francisci* is a reference to San Francisco , although the range of the horn shark does not extend that far north . The type specimen from Monterey Bay has since been lost . The scientific name for this species has been given erroneously as *Heterodontus californicus* .

= = Description = =

Like other bullhead sharks , the horn shark has a short , wide head with a blunt snout and prominent supraorbital ridges over the eyes . The horn shark 's supraorbital ridges are low and terminate abruptly ; the space between them on top of the head is deeply concave . Each eye lacks a nictating membrane and is followed by a tiny spiracle . The nostrils are split into inflow and outflow openings by a long flap that reaches the mouth . The inflow openings are encircled by a groove , while another groove connects the outflow openings to the mouth . The mouth is small and curved , with prominent furrows at the corners . There are 19 ? 26 tooth rows in the upper jaw and 18 ? 29 tooth rows in the lower jaw . The teeth at the front of the jaws are small and pointed , with a central cusp flanked by a pair of lateral cusplets ; those at the sides of the jaws are much larger , elongated lengthwise , and molar @-@ like .

The body is cylindrical , with two high , somewhat falcate (sickle @-@ shaped) dorsal fins bearing stout spines at the front . The fin spines of reef @-@ dwelling horn sharks are shorter than those living in algal habitats , as their spines become worn down on rocks from the sharks ' movements . The first dorsal fin originates over the bases of the large pectoral fins , while the second dorsal fin originates slightly anterior to the free rear tips of the pelvic fins . The caudal fin has a short lower

lobe and a long , broad upper lobe with a strong notch near the tip . The horn shark 's dermal denticles are small and smooth , numbering some 200 / cm² on the back in adults . The dorsal coloration consists of various shades of gray or brown with many small dark spots , though these may be absent in older sharks ; the underside is yellowish . There is a dark patch of small spots below the eye . This species may reach a length of 1 @. @ 2 m (3 @. @ 9 ft) , though most individuals do not exceed 1 m (3 @. @ 3 ft) .

= = Distribution and habitat = =

The horn shark inhabits the continental shelf of the eastern Pacific Ocean , occurring off the coasts of California and Baja California from Monterey Bay southward , and in the Gulf of California . Uncommon influxes of warm water northward may bring it as far as San Francisco Bay . There are unconfirmed reports of this species off Ecuador and Peru , which may be misidentifications of other species .

For most of the year , horn sharks are most common at a depth of 2 ? 11 m (6 @. @ 6 ? 36 @. @ 1 ft) . At the onset of winter , they migrate to water deeper than 30 m (98 ft) . This species has been found in caves as deep as 200 m (660 ft) . Juvenile horn sharks between 35 ? 48 cm (1 @. @ 15 ? 1 @. @ 57 ft) long prefer sandy flats with low vertical relief , in water 40 ? 150 m (130 ? 490 ft) deep . They often take advantage of large feeding pits excavated by the bat ray (*Myliobatis californica*) for shelter and food . As they mature , horn sharks shift into shallower water and their preferred habitat becomes structurally complex rocky reefs or algae beds . This strongly benthic species seldom ventures more than 2 m (6 @. @ 6 ft) above the substrate .

The relative abundances of the horn shark and the swellshark (*Centroscyllium ventriosum*) , which shares the same habitat , are negatively correlated because horn sharks prefer temperatures warmer than 20 ° C (68 ° F) while swellsharks are more cold @-@ tolerant . At Santa Catalina Island , a 20 @-@ year warming trend has resulted in an increase in the horn shark population and a decrease in the swellshark population . Horn sharks are less common than swellsharks in the northern Channel Islands , where the water is cooler .

= = Biology and ecology = =

The horn shark is a clumsy , sporadic swimmer that prefers to use its flexible , muscular pectoral fins to push itself along the bottom . It is usually solitary , though small groups have been recorded . During the day , horn sharks rest motionless , hidden inside caves or crevices , or within thick mats of algae , though they remain relatively alert and will swim away quickly if disturbed . After dusk , they roam actively above the reef in search of food . Horn sharks maintain small home ranges of around 1 @, @ 000 m² (11 @, @ 000 sq ft) , which they may remain faithful to for over a decade , returning to the same shelter every day . The shelter is usually located at the edge of the resident shark 's foraging area . The longest documented movement for an individual horn shark is 16 km (9 @. @ 9 mi) .

Unlike most fishes , the daily activity pattern of the horn shark is under exogenous control , meaning that it is regulated by environmental factors rather than by an internal physiological cycle . Observations of captive horn sharks show that the relevant cue is light intensity : the sharks become active immediately after the lights are turned off , and stop as soon as they are turned back on . In one experiment where the sharks were kept in darkness , they remained continuously active for 11 days before slowing , possibly from fatigue . In nature , horn sharks exposed to a bright light at night may stop swimming and sink to the bottom .

The horn shark is preyed upon by larger fishes and the northern elephant seal (*Mirounga angustirostris*) , which consumes adults , juveniles , and egg cases . In addition , they are captured and eaten by bald eagles (*Haliaeetus leucocephalus*) at Catalina Island , and large marine snails are able to drill into their egg cases to extract the yolk . The tough skin and spines of this species confer some protection ; a Pacific angelshark (*Squatina californica*) has been filmed engulfing a juvenile horn shark , only to spit it out due to its spines . Known parasites of this species include the

tapeworms *Acanthobothrium bajaensis* and *Acanthobothrium puertecitense* , the copepod *Trebius heterodonti* , and the nematode *Echinocephalus pseudouncinatus* , which spends its larval stage inside potential prey such as scallops and sea urchins .

== Feeding ==

Some 95 % of the adult horn shark 's diet consists of hard @-@ shelled mollusks (e.g. bivalves and gastropods) , echinoderms (e.g. sea urchins) and crustaceans (e.g. crabs , shrimp , and isopods) . To crack their shells , the horn shark generates the highest known bite force relative to its size of any shark , well in excess of other measured species such as the spiny dogfish (*Squalus acanthias*) and the blacktip shark (*Carcharhinus limbatus*) . One study found the average bite force for this species in the wild to be 95 N with a maximum of 135 N , while under experimental conditions sharks could be induced to bite with over 200 N of force . Large horn sharks that feed mainly on sea urchins (particularly the short @-@ spined purple urchin , *Strongylocentrotus purpuratus*) have their teeth and fin spines stained purple .

Other prey items of adults include peanut worms , sea stars , cephalopods , and small bony fishes . Juveniles feed primarily on polychaete worms , sea anemones , and small clams , and have been known to " pounce " on anemones to bite off tentacles before they can be retracted . Off southern California , horn sharks are known to take advantage of seasonal opportunities . In the summer , diurnally active fishes , in particular the blacksmith (*Chromis punctipinnis*) , are especially abundant and are easily captured at night when they lie dormant . In the winter , the sharks scavenge on market squid (*Loligo opalescens*) , which die by the tens of thousands after their mass spawning event . Horn sharks hunt mainly using their sense of smell . Although electroreception certainly plays a role in locating prey , this species has only 148 ampullae of Lorenzini . This is much fewer than in most other sharks , which may have over 2 @, @ 000 . Like other sharks , the horn shark 's teeth are regularly replaced ; it takes 4 weeks for a dropped tooth to be replaced .

The horn shark captures prey via suction , created by expanding its buccal cavity . Its labial cartilages are modified so that the mouth can form a tube , facilitating the suction force . Once the prey is drawn into the mouth , it is secured with the sharp front teeth and then ground into pieces by the flat lateral teeth . To extract buried or affixed prey , the horn shark grips it and adopts a vertical posture with the head and pectoral fins against the substrate and the tail arched above . The shark then acts as a lever with its pectoral fins as the fulcrum : with a downward stroke of the tail , it forces its head upwards and pulls the prey loose ; this mode of feeding has not been observed in any other shark . The horn shark is also capable of protruding its upper jaw up to 15 % the length of its head ; this motion takes only 20 milliseconds to accomplish and allows the shark to use its upper jaw like a chisel to dislodge firmly attached prey .

== Life history ==

Mating in the horn shark occurs in December or January , on a possibly annual reproductive cycle . The male chases the female to indicate interest ; once she is ready both sharks settle on the bottom , where the male grips the female 's pectoral fin in his teeth and inserts one of his claspers into her cloaca . After 30 ? 40 minutes of copulation , the pair disengages and the female spins with her snout in the sand for another 30 minutes . From February to April , the females lay a maximum of 24 eggs two at a time once every 11 ? 14 days , in water 2 ? 13 m (6 @. @ 6 ? 42 @. @ 7 ft) deep . The egg case has two flanges spiraling around it , and thus may take the female several hours to deposit . At first the case is soft and light brown , and over a few days it hardens and darkens in color . Not including the flanges , the case measures 10 ? 12 cm (3 @. @ 9 ? 4 @. @ 7 in) long and 3 ? 4 cm (1 @. @ 2 ? 1 @. @ 6 in) wide ; sharks from the Channel Islands produce longer egg cases than those from mainland California , suggesting that they are separate populations .

One of the few sharks to exhibit parental care , female horn sharks in the wild pick up their eggs in their mouths and wedge them into crevices . However , in captivity the eggs are simply dropped on the bottom and may later be cannibalized . The eggs hatch in 6 ? 10 months ; at emergence the

young measure 15 ? 17 cm (5 @. @ 9 ? 6 @. @ 7 in) long . Newly hatched sharks are provisioned with an internal yolk sac and do not have to feed until they are a month old , though they are capable of feeding and will accept food during this period . Horn sharks grow slowly and at a highly variable rate that does not correspond to their size ; this has frustrated attempts to determine their aging process . Males mature at a length of 56 ? 61 cm (22 ? 24 in) and females at a length of at least 58 cm (23 in) . Individual sharks have lived to over 12 years old in captivity , and there exists an unconfirmed report of a shark reaching 25 years of age .

= = Human interactions = =

Under normal circumstances , horn sharks are harmless to humans and can readily be approached underwater . However , they can be provoked into biting , and some pugnacious individuals have been known to chase and bite divers after being harassed . These sharks should be handled with care as their fin spines can inflict a painful wound . The horn shark adapts well to captivity and has been maintained and bred in many public aquariums across the United States .

The horn shark has no commercial value in California , where it is captured unintentionally in traps and trawls and by recreational anglers . The shark 's hardiness ensures that it can often be returned to the water alive . This species benefits from general restrictions placed on coastal fishing gear by the State of California . The average annual bycatch off California is 1 @, @ 800 kg (4 @, @ 000 lb) , though historically it has varied from 2 @. @ 5 kg (5 @. @ 5 lb) in 1976 to 9 @, @ 500 kg (20 @, @ 900 lb) in 1979 . Divers sometimes kill them for sport or to make jewelry out of their fin spines , which may be the cause of a decline in the numbers of horn sharks in the most intensely dived areas of southern California . Off Mexico , this species is caught incidentally in shrimp trawls and demersal gillnets , and used for human consumption and fishmeal . The expansion of Mexican gillnet fisheries may pose a conservation concern in the future . At present , the International Union for Conservation of Nature (IUCN) does not have sufficient information to assess the overall conservation status of this species ; its status in United States waters is likely Least Concern .