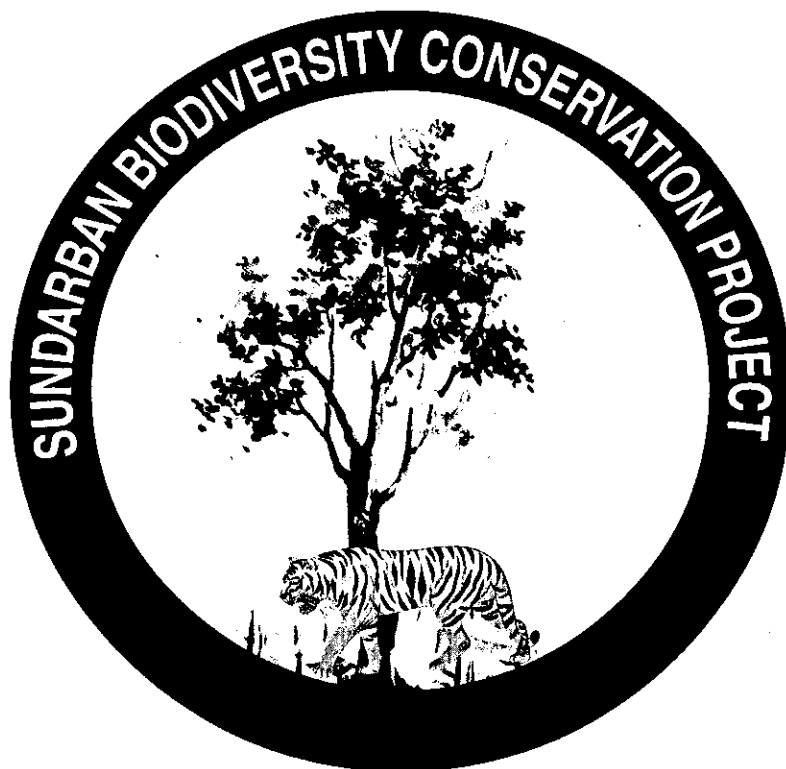


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Ministry of Environment and Forests
Dhaka, Bangladesh**

**Asian Development Bank
Global Environment Facility
Government of the Netherlands**



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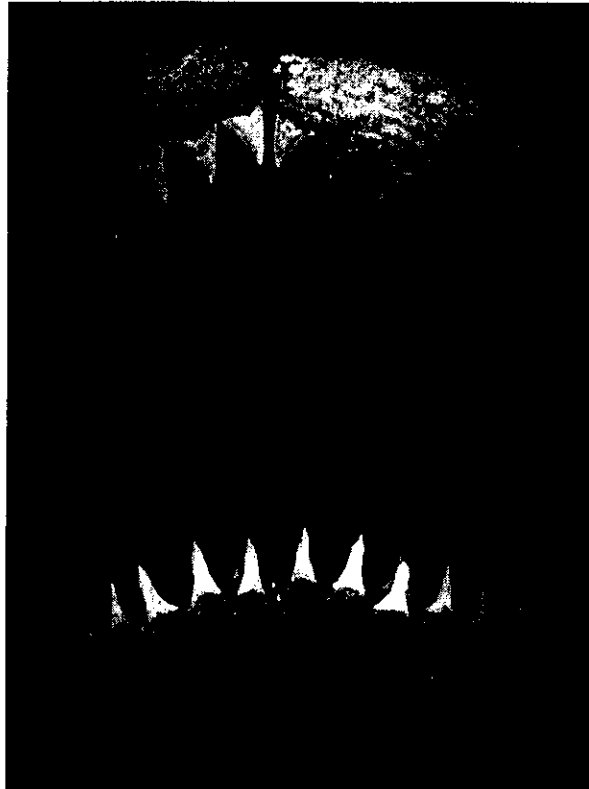
**Technical Note on Endangered Sharks of the Sundarbans
Internal Notes – IN No. 28**

**by Mr. Garry Bernacsek, Fisheries Management Specialist
and**

Mr. Emdadul Haque, DFO, Aquatic Resources Div.

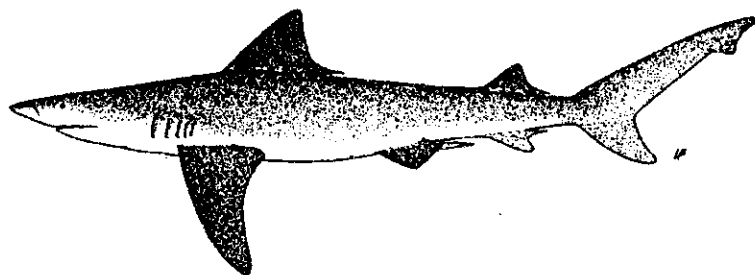
ADB: BAN 1643/3158

28th March 2001



TECHNICAL NOTE ON ENDANGERED SHARKS OF THE SUNDARBANS

by
Garry Bernacsek
Fisheries Management Specialist
and
Emdadul Haque
DFO Fisheries



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Attachment 3. Reproduced Text on *Glyphis* from Compagno (1984)
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1. INTRODUCTION

This report presents recent findings of rare and endangered shark species of the genus Glyphis in the Sundarbans. The records are of substantial systematic importance and increase scientific understanding of the biology and distribution of this little known group of sharks.

The authors of this technical note are fortunate to be able to collaborate with Dr Leonard J V Compagno of the Shark Research Centre, South African Museum, Cape Town. Dr Compagno is a leading world expert on shark taxonomy and has had occasion to examine Glyphis type material.

The findings to date are very preliminary and leave many questions unanswered about the taxonomic status and biology of these rare animals. More observations and research will be conducted by the project in the future. Due to the critically endangered status of Glyphis species, a high priority is to formulate a protection and conservation strategy and programme for these special sharks.

2. MATERIAL AND INFORMATION COLLECTED

2.1 Jaws of Adult Specimen of *Glyphis* sp indet (= *Behundi* Net Jaws)

Collection of Material

Wednesday 24 January 2001: The authors were presented with one complete set of articulated jaws (Fig 1) of a large shark by a Forestry Department (FD) officer at the FD station at Office Kella on Dubla Island.

Monday 12 February 2001: The authors attended a fishermen consultation meeting at Meherali fishing camp on Dubla Island, where they met the FD officer (Anwar Hussain) who first obtained the jaws. He obtained it from a fish trader (Mr Butaburua) from Chittagong. Butaburua was at the meeting and he provided the following information:

- The shark was caught in January 2000 by a fishing boat using a large *behundi* net in the sea.
- The approximate location was about 20 km south of Alokor (Dubla Island) in the Bay of Bengal. This is marked as x1 on the location map (Fig 2).
- The shark was described as having a large head, and being about 10 ft long and estimated weight of around 100 kg.
- Butaburua saw the shark and cut out the jaws because he thought the shark was peculiar.
- Anwar obtained the jaws from Butaburua in February or March 2000, and kept them because he thought they were special.
- Butaburua says that 10-15 specimens are caught of this special shark each year. It is called *ilish hangar* (in Bangla, *hangar* means shark, and the important shad *Hilsa ilisha* [= *Tenulosa ilisha*] is called *ilish*). The implication is that this shark species feeds on *ilish* (however the authors cannot confirm that this is indeed the case).

Storage of Material

The jaws are the property of the Aquatic Resources Division (Khulna/Sundarbans Operational Circle, Bangladesh Forestry Department), and is currently stored in the fish specimen store of the SBCP fish laboratory. As the jaws may pertain to a new species, there is a possibility that they may be used as type material in the future. This would require depositing the specimen in an internationally recognized ichthyology museum (preferably one specialized in shark taxonomy, such as the South African Museum) for safe long-term storage.

Fourteen teeth from the jaws were sent to L Compagno for identification, and are now stored at the South African Museum in Cape Town:

- 1 tooth from upper jaw, left side. This is a replacement tooth from behind outer tooth No 1 (Fig 3).

- 12 teeth from upper jaw, left side. These are replacement teeth from behind outer teeth No 3, 4, 5 and 6 (Fig 4).
- 1 tooth from lower jaw, right side. This is a replacement teeth from behind outer tooth No 1 (Fig 5).

Negatives and one set of prints of the jaws are with Emdadul Haque, and one set of prints with Garry Bernacsek. Digital files of the photos are with Leonard Compagno. Digital scans of the jaws and teeth are with Gary Bernacsek and Leonard Compagno.

Description of Material

Digital scans of the jaws are shown in closed (Fig 6) and open (Fig 7) positions. The jaws measure 419 mm transversely across the articulation (which is still intact and flexible on both sides at the time of writing). With the jaws closed, there is a sizable gap of 6.5 cm between the upper jaw and lower jaw (symphysis to symphysis). This suggests that the animal swims with its mouth partly open at all times (as also suggested by Fig 9)

Lab notes describing the teeth in the upper and lower jaws are reproduced in Attachment 1. The main features are as follows:

- Upper jaw: 13 teeth in outer row of each half of upper jaw; teeth triangular in shape with broad bases; all teeth with fine serrations on both cutting edges; largest tooth has crown height of 25 mm; teeth decreasing in size in posterior direction; 4-5 rows of replacement teeth behind outer tooth row; small blunt tooth at upper jaw symphysis.
- Lower jaw: 12 teeth in outer row of each half of lower jaw; teeth slim and elongate in shape, with double curvature in lateral view; teeth nos 1 to 4 with lateral flanges at tip which bear very fine serration (giving a spear-like appearance to these teeth); outer teeth nos 4 and 5 (and some of their replacement teeth) bear a small lateral cusplet on each side of base; largest tooth has crown height of 27 mm; teeth decreasing in size in posterior direction; 5 rows of replacement teeth behind outer tooth row; 6 small elongate teeth at lower jaw symphysis.

Identity of Material

The following comments on the identity of the species represented by the specimen were received from L Compagno (email dated 20 March 2001 – see Attachment 2) based on scans and photos of the jaws and teeth emailed earlier to him¹:

"From its jaws and teeth, this specimen (represented by the set of jaws) is apparently NOT *Glyphis gangeticus*, but instead is most likely *Glyphis glyphis* or something very close to it. *Glyphis* sp. A, from Queensland and Northern Territory (the tentative name from Last &

¹ Text from two publications by L Compagno (1984, 1988), as well as text from a taxonomic work by Talwar and Jhingran (1991) and a recent download from the IUCN Shark Specialist Group Website (Shark News 9) are included in this report as background information on the taxonomy of the genus Glyphis (Attachments 3, 4, 5 and 6, respectively).

Stevens, 1994, and Compagno & Niem in the 1998 FAO Western Central Pacific species sheets), and likely Papua-New Guinea, may be the same species, that is, *G. glyphis*. All of these have big jaws and teeth even for a *Glyphis*, fewer tooth rows compared to other species, hastate lower teeth with spearlike cusps, very large second dorsal fins even for a *Glyphis*, and, in two Australian specimens, much higher precaudal vertebral counts than any other *Glyphis*. The holotype of *G. glyphis* is an old stuffed specimen with its precaudal vertebrae absent, but its caudal counts agree with the Australian specimens of *G.* sp. A (as well as certain other species except *G.* sp. C from Australia and Papua-New Guinea, which has much lower vertebral counts). ... The scanner shots show a nice likeness to the teeth of large specimens of possible *G.* sp. A from Papua-New Guinea, as well as the holotype of *G. glyphis*

The following additional comment on the identity of the species represented by the specimen were received from L Compagno (email dated 23 March 2001 – see Attachment 2) based on the 14 teeth sent by courier to him:

“This is to confirm that the teeth arrived safely here. I compared with them with the material on hand, and they look especially like the *G.* sp. A from Papua-New Guinea, only more robust (presumably due to their larger size).”

Therefore the best available opinion on the identity of the shark jaws is that it is not Glyphis gangeticus, but may be one of the following:

- Glyphis glyphis
- Glyphis sp indet A (known from Australia and Papua New Guinea)

A third option is that it is a species completely new to science.

2.2 Whole Adult Specimen of Glyphis sp indet (= Shark net specimen)

Collection of Material

Monday 12 February 2001: The authors had attended a fishermen consultation meeting at Meherali fishing camp on Dubla Island. After finishing discussions, the authors were called to the nearby jetty to look at the catch of a fishing boat that had just pulled in. The body of a large shark was laid out on the deck (Figs 8). It had been removed from the fish hold (the body was cold from laying on ice) for the authors to see. The specimen was photographed and videoed. Information on the specimen is as follows:

- It was caught using a 9 inch (= 23 cm) stretch mesh gillnet typically used for sharks and other large fish.
- The capture location was about 40 km south from the mouth of the Baleswar River, marked as x2 in Fig 2.
- It had been caught one week ago and had been kept on ice in the hold of the boat.
- Other large fish in the catch included a large silver croaker, a large Indian salmon and a Spanish mackerel. It is not known if these were caught at the same place and time as the shark, as the boat had been out for a week.

Storage of Material

The specimen was not purchased from the fishermen, and they were unwilling to sever the head or remove the jaws. The available evidence consists of:

- 2 photos (Fig 8). Negatives and one set of prints are with Emdadul Haque, and one set of prints with Garry Bernacsek. Digital files of the photos are with Leonard Compagno.
- 3 minute video. Camera tape and one VHS dud are with Garry Bernacsek, one VHS dud is with Emdadul Haque, and another with Leonard Compagno.

Description of Material

The photos (see Fig 9 for enlarged views of the specimen) and video provide the following information:

- Length: Estimated at about 2 m.
- Weight: Estimated at about 60-80 kg.
- Body: Body is gray-green above and white below; fairly deep bodied in profile with hydrodynamic shape; large pectoral fins.
- Sex: Male; large pelvic claspers clearly visible in the video.
- Head: Large; first gill flap is fairly large and the others smaller (hence fishermen say it has 'ears').
- Eyes: Very small (suggesting poor eyesight).
- Jaws: When the specimen was first seen the upper and lower jaws were quite protruded. The crew then turned the fish over, and the jaws became retracted somewhat. The two photos show the jaws in the retracted position. The jaws are relatively large.
- Dentition: Teeth in upper jaw triangular with broad bases and serrated edges. Teeth in lower jaw slim and dagger-like.

Identity of Material

The following comments on the identity of the species represented by the specimen were received from L Compagno (email dated 20 March 2001 – see Attachment 2) based on the photos of the specimen emailed earlier to him:

"Did you get a look at the jaws and teeth of this specimen? It looks like it has a large second dorsal fin and heavy jaws as with *G. glyphis* - *G.* sp. A."

Therefore the best available opinion on the identity of the shark jaws is that it may be one of the following:

- Glyphis glyphis
- Glyphis sp indet A (known from Australia and Papua New Guinea)

A third option is that it is a species completely new to science.

Until more definitive evidence is available, it is assumed that the Glyphis jaws described above and the present specimen are probably of the same species.

2.3 Whole Specimen of Glyphis sp indet or Lamiopsis temmincki (= Poacher's gillnet specimen)

Collection of Material

Wed 14 March 2001: The specimen of a female shark was photographed by Floris Deodatus (SBCP Wildlife Specialist) while looking for crocodiles at nite in the Sundarbans (Fig 10). The specimen was caught in a poacher's gillnet inside the Sundarbans East Wildlife Sanctuary. The location was Chora Betmar Khal, at its western junction with Betmar Gang (indicated as x3 in Fig 2). The mesh size is estimated at 6 inches stretched from a photograph of FD guards pulling the net from the water. The shark was a female and is estimated at 70-80 cm from the photo.

Storage of Material

The specimen was not retained. The available evidence consists of:

- 1 digital photo (Fig 10). The original digital photo file is with Floris Deodatus (Wildlife Specialist of SBCP). Copies of the digital photo file are with Garry Bernacsek and Leonard Compagno.

Description of Material

The specimen was in poor condition when removed from the water and bore 'noose' marks from the gillnet around the head and trunk. The head is depressed dorsoventrally. The pectoral fins are elongate.

Identity of Material

The following comments on the identity of the species represented by the specimen were received from L Compagno (email dated 20 March 2001 – see Attachment 2) based on the digital photo file of the specimen emailed earlier to him:

"I assumed it was *S. laticaudus* also at first glance, until I started to look at it in detail. Maybe I'm hallucinating, and have contracted Glyphis-fever, but it apparently isn't *Scoliodon* (which your first picture certainly was). The relatively large, falcate narrow pectoral fin, big second dorsal fin relative to the anal fin, first dorsal fin far anterior with its origin over the

pectoral bases suggest instead yet another *Glyphis* (if not *Lamiopsis temmincki*, which has the first dorsal fin somewhat more posteriorly situated and the second dorsal fin about as large as the first, also a broader pectoral fin). There is an Australian-Papuan species, *Glyphis* C, which has a flat broad head also; the holotype of *G. siamensis* looks like a road-kill, but may have a flatter head than *G. gangeticus* and certainly *G. glyphis*. Whatever it is, I'd like to see more pictures and material."

Therefore the best available opinion on the identity of the shark jaws is that it may be one of the following:

- Glyphis sp indet C (known from Australia and Papua New Guinea)
- Glyphis siamensis (which is not a well established species)
- Lamiopsis temmincki

A fourth option is that it is a species completely new to science.

Until more definitive evidence is available, no assumption will be made about the identity of this specimen.

FIGURES

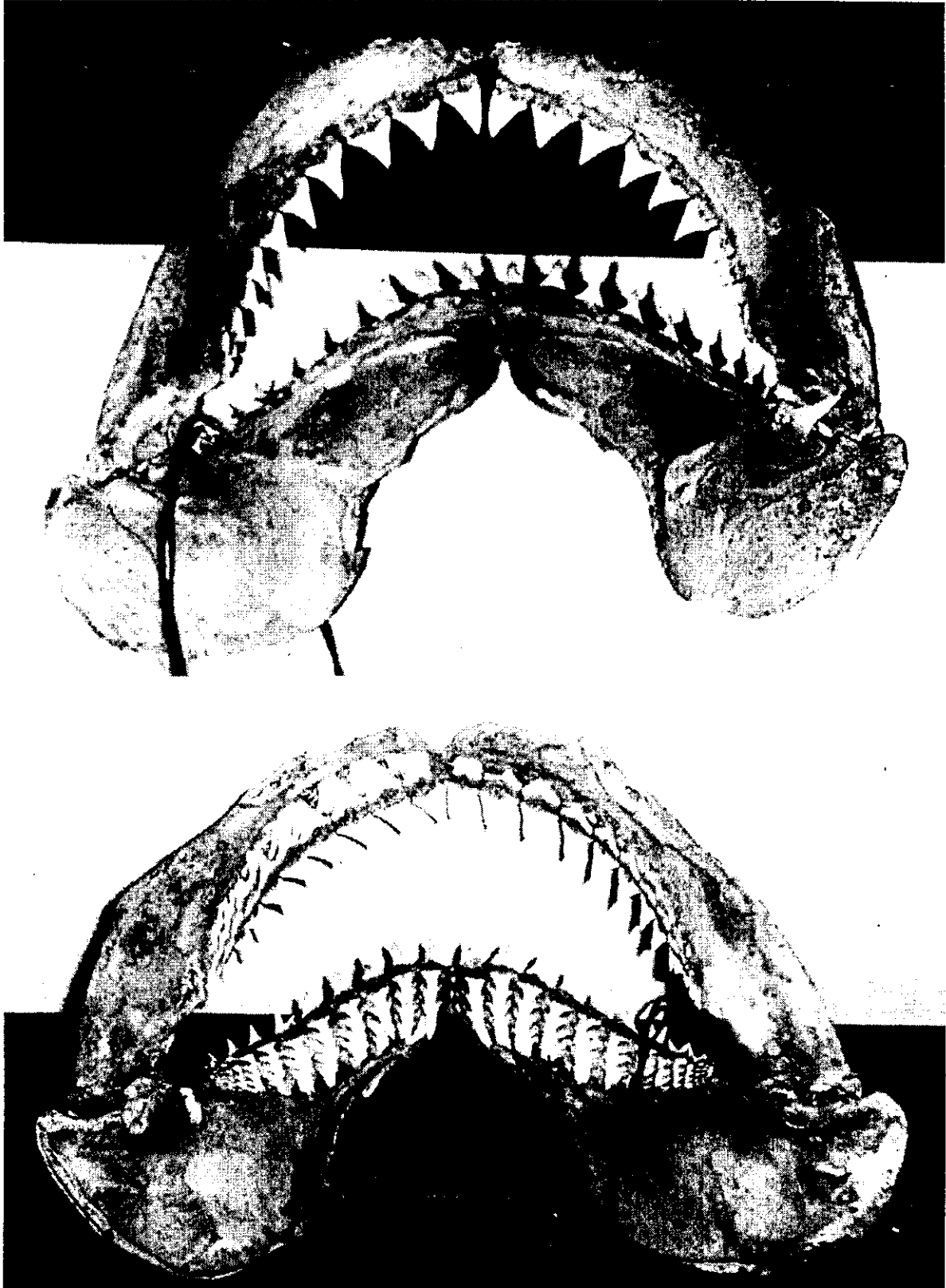


Fig 1. Glyphis Shark Jaw Collected at Office Kella (Caught at Location 1).
(labial view at top, lingual view at bottom)

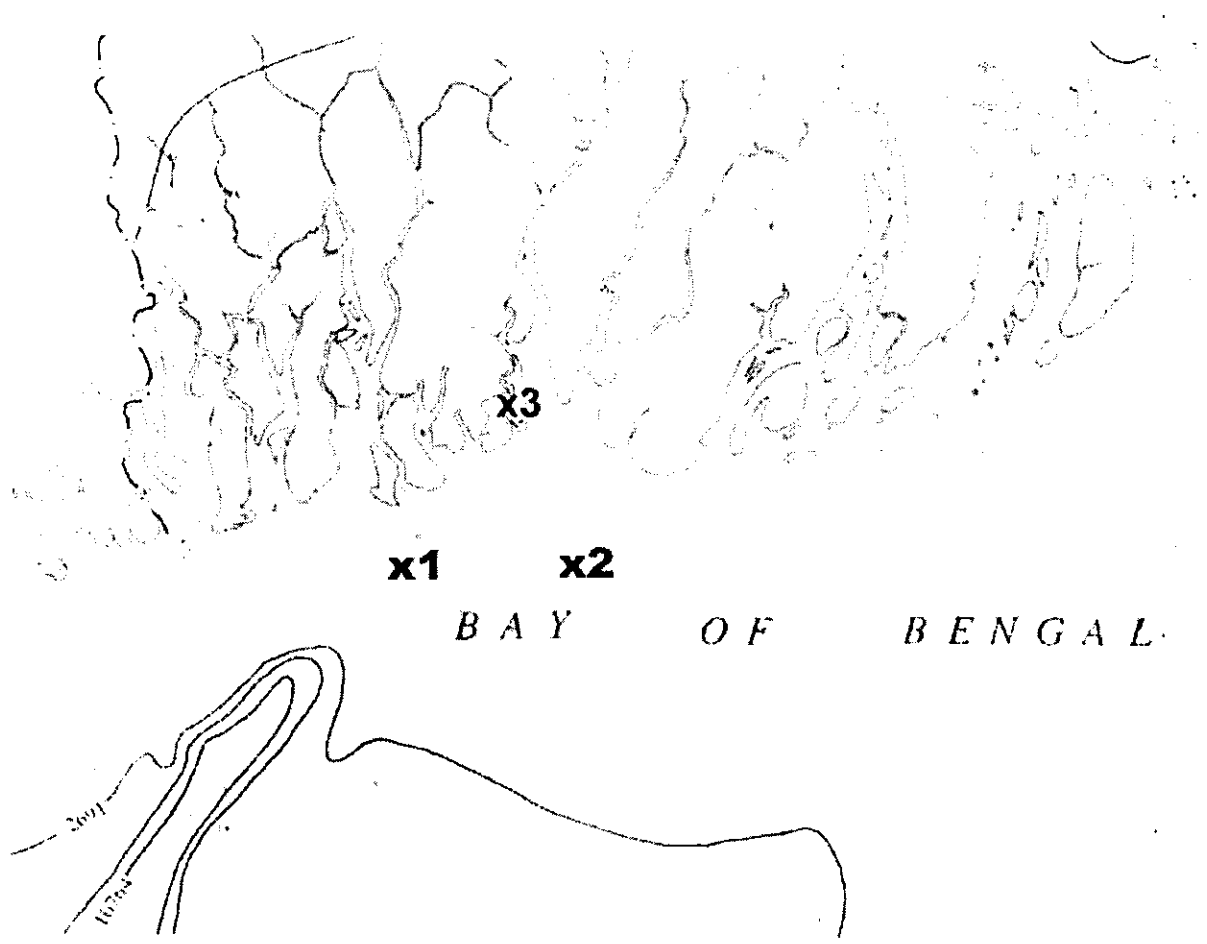


Fig 2. Map of Locations of Shark Specimens Referred to in Text.
x1 = Behundi net jaw; x2 = Shark gillnet whole specimen; x3 = Poacher's gillnet whole specimen



Fig 3. Replacement Tooth of Outer Tooth No 1 (Row 4) of Left Side of Upper Jaw.
(labial view at left; lingual view at right)

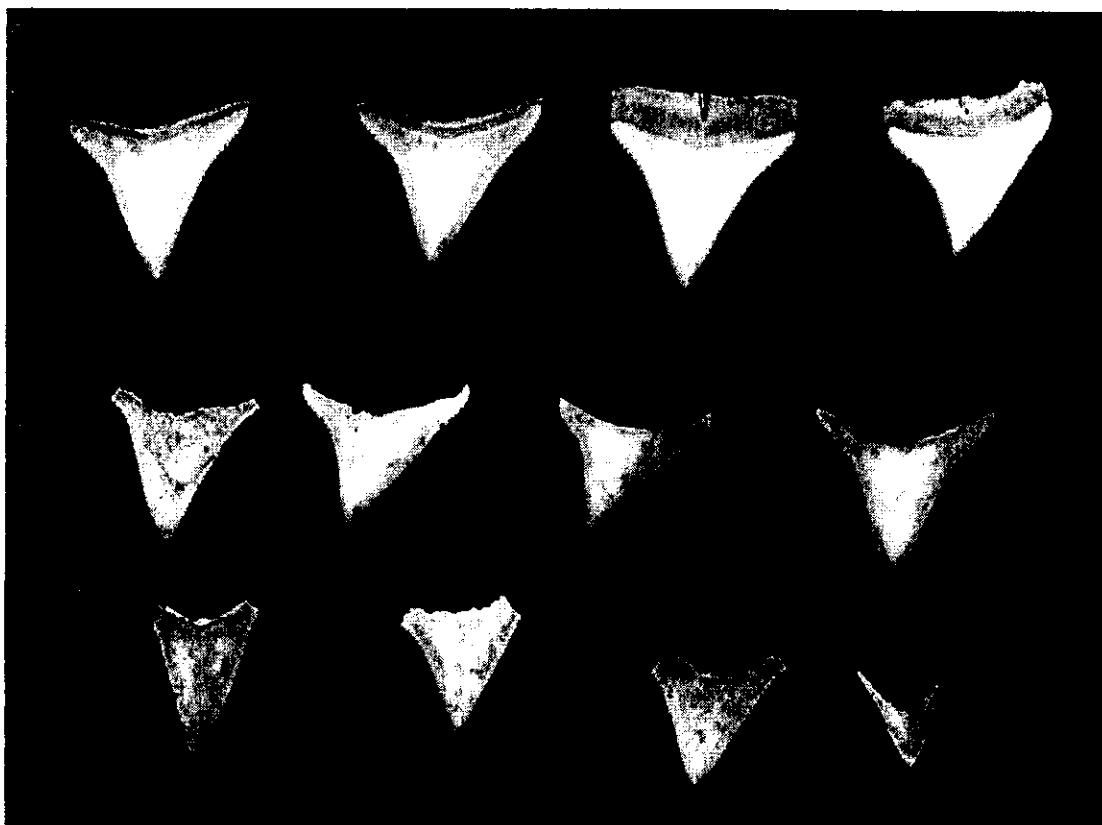


Fig 4. Replacement Teeth of Outer Teeth Nos 3, 4, 5 & 6 of Left Side of Upper Jaw.
(teeth are in labial view)



Fig 5. Replacement Tooth of Outer Tooth No 1 (Row 5) of Right Side of Lower Jaw.
(labial view at left, lateral view at centre, lingual view at right)

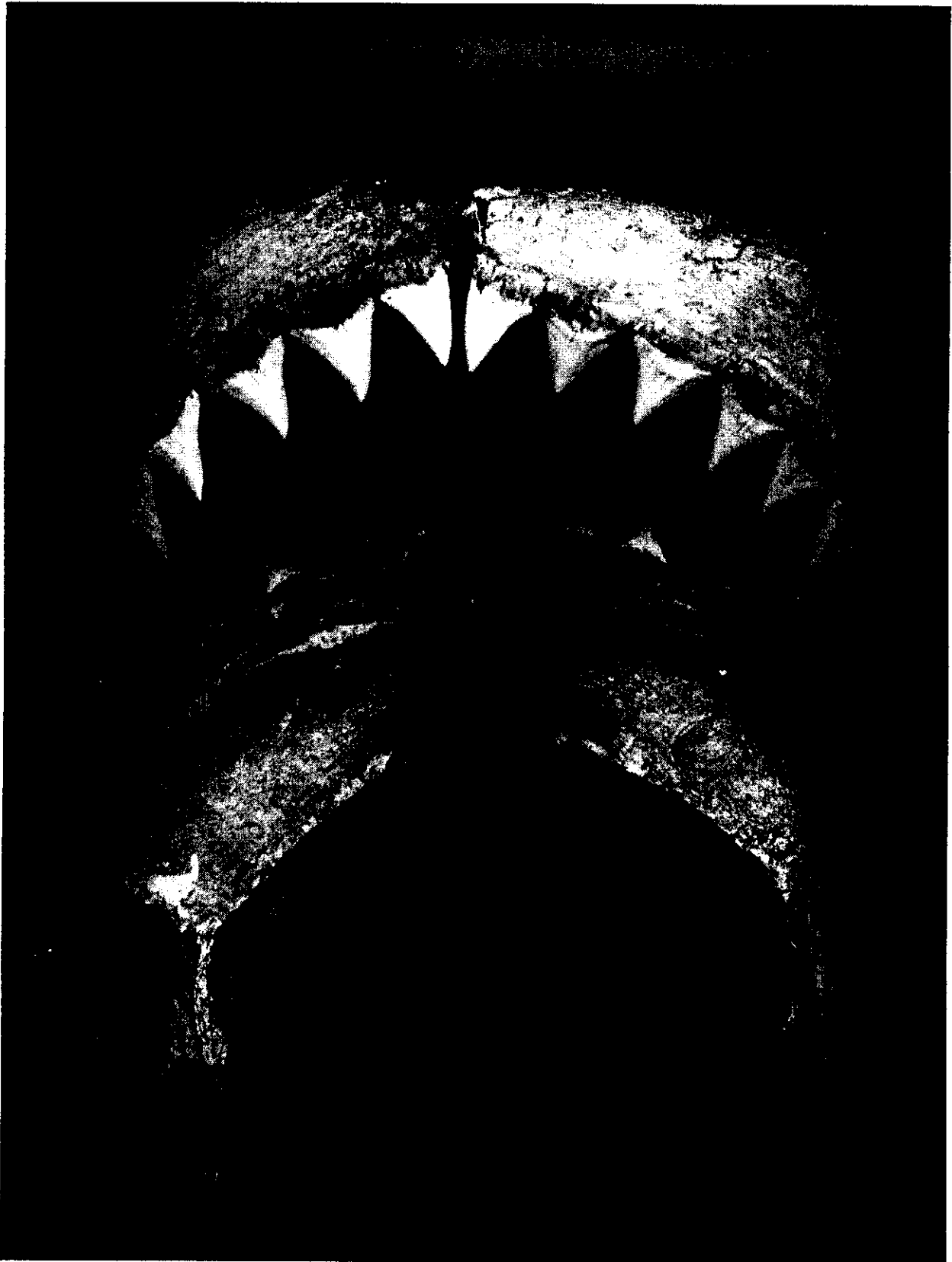


Fig 6. Digital Scan of Shark Jaws Collected at Office Kella (A).
(jaws are in closed position)

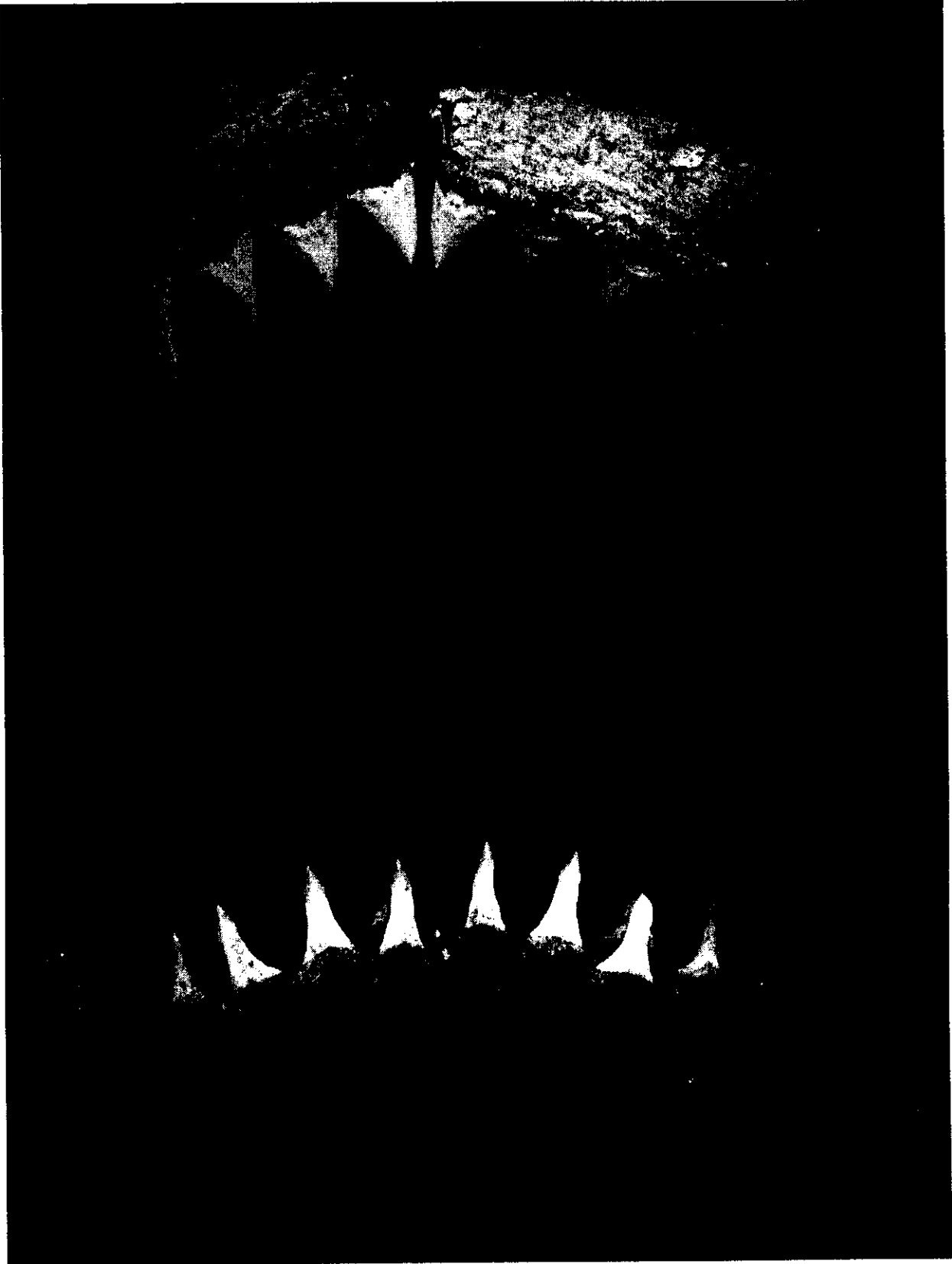


Fig 7. Digital Scan of Shark Jaws Collected at Office Kella (B).
(jaws are in open position)



Fig 8. Male Specimen of Glyphis Shark Caught with Shark Gillnet (Location 2).
(photographed on fishing boat at Meherali jetty)



Fig 9. Enlarged Views of Male Specimen of Glyphis Shark.

**Fig 10.
Possible
Female
Glyphis
Shark
Caught
in
Poacher's
Gillnet
(Location 3).**

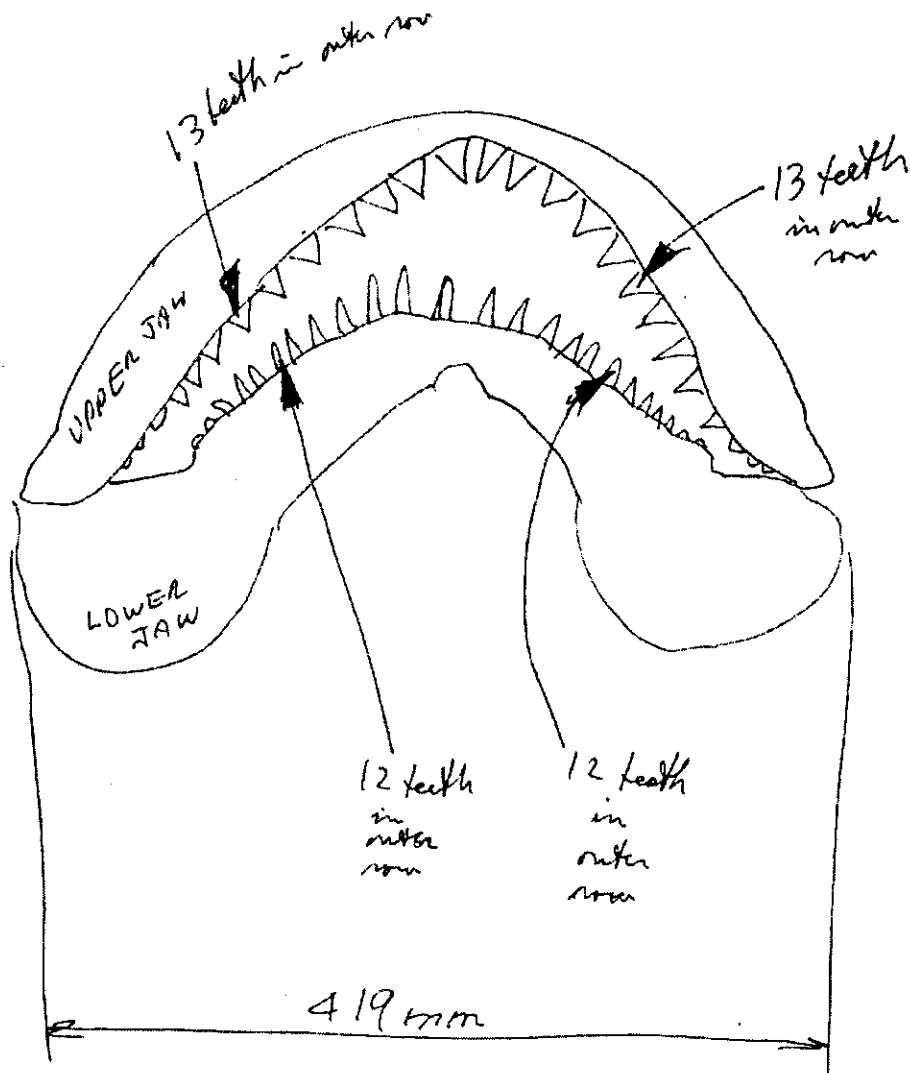
(gillnet
'noose'
marks
are
visible
around
the
head
and
trunk)



ATTACHMENTS

Attachment 1
Lab Notes on Glyphis Jaw

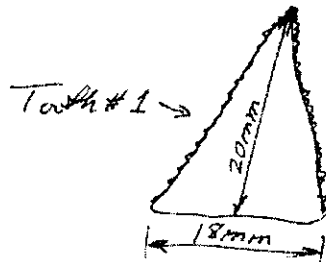
①



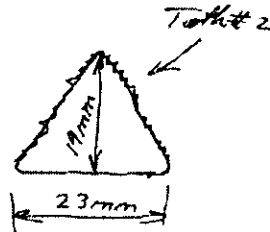
(2)

UPPER JAW

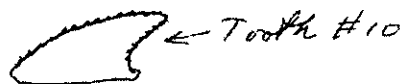
- 13 teeth in outer row on each side of symphysis (= total of 26 teeth). All teeth with fine serration on both edges.
- Tooth #1 (from symphysis) is slimmer than #2



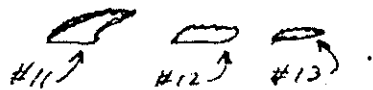
- Tooth #2 is more broad based



- Teeth #3 to #10. These are similar to tooth #2. They get progressively smaller, and the tips curve backward towards the jaw articulation.



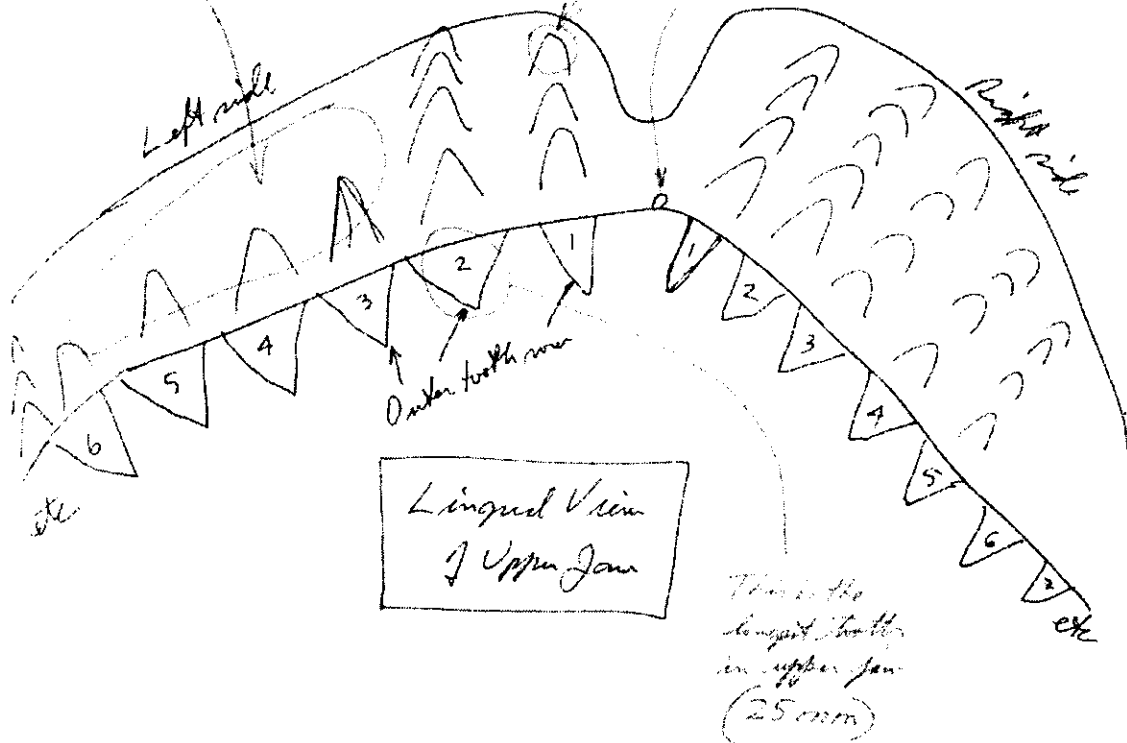
- Teeth #11 to #13 Very small and low

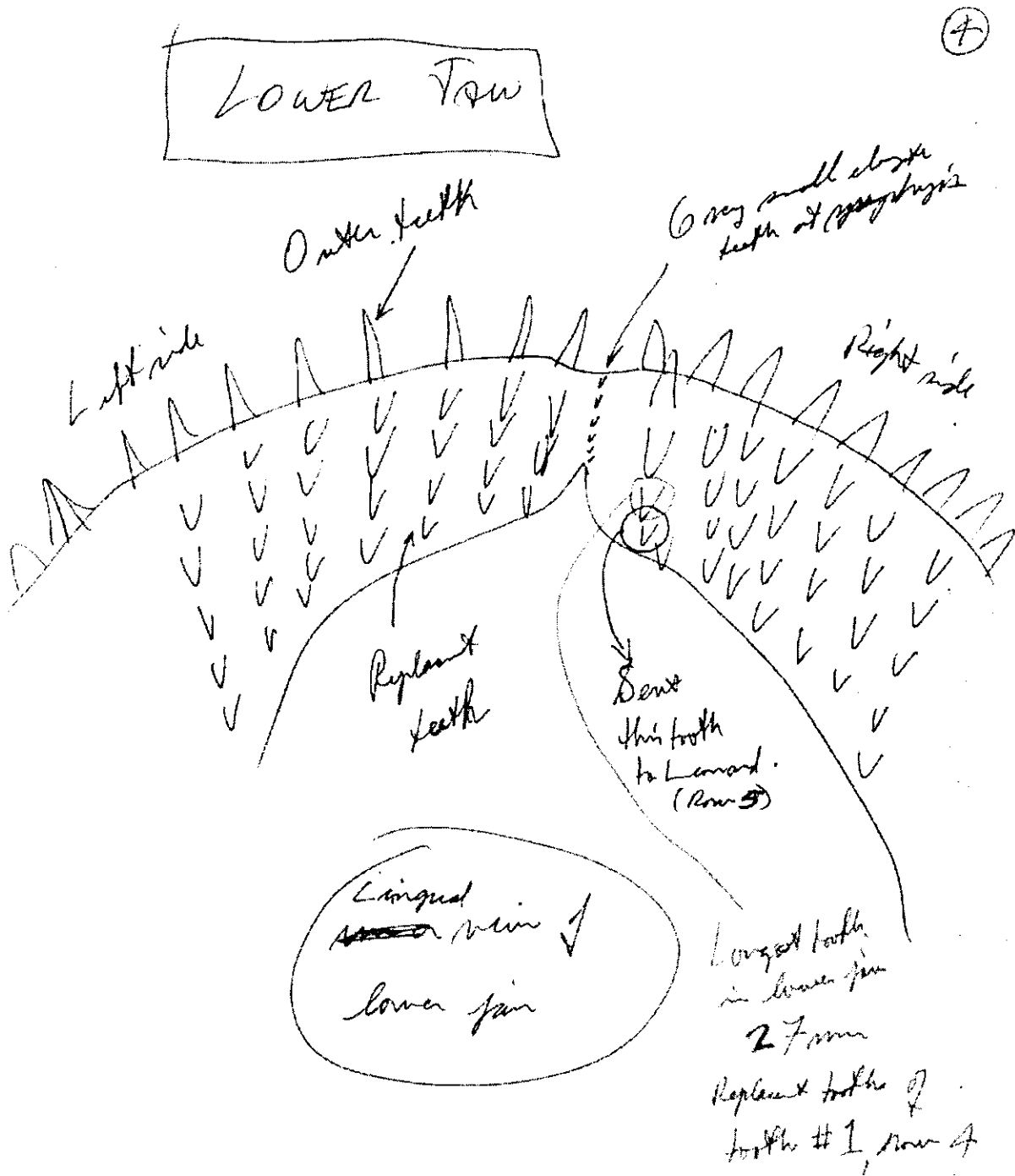


(3)

UPPER JAW

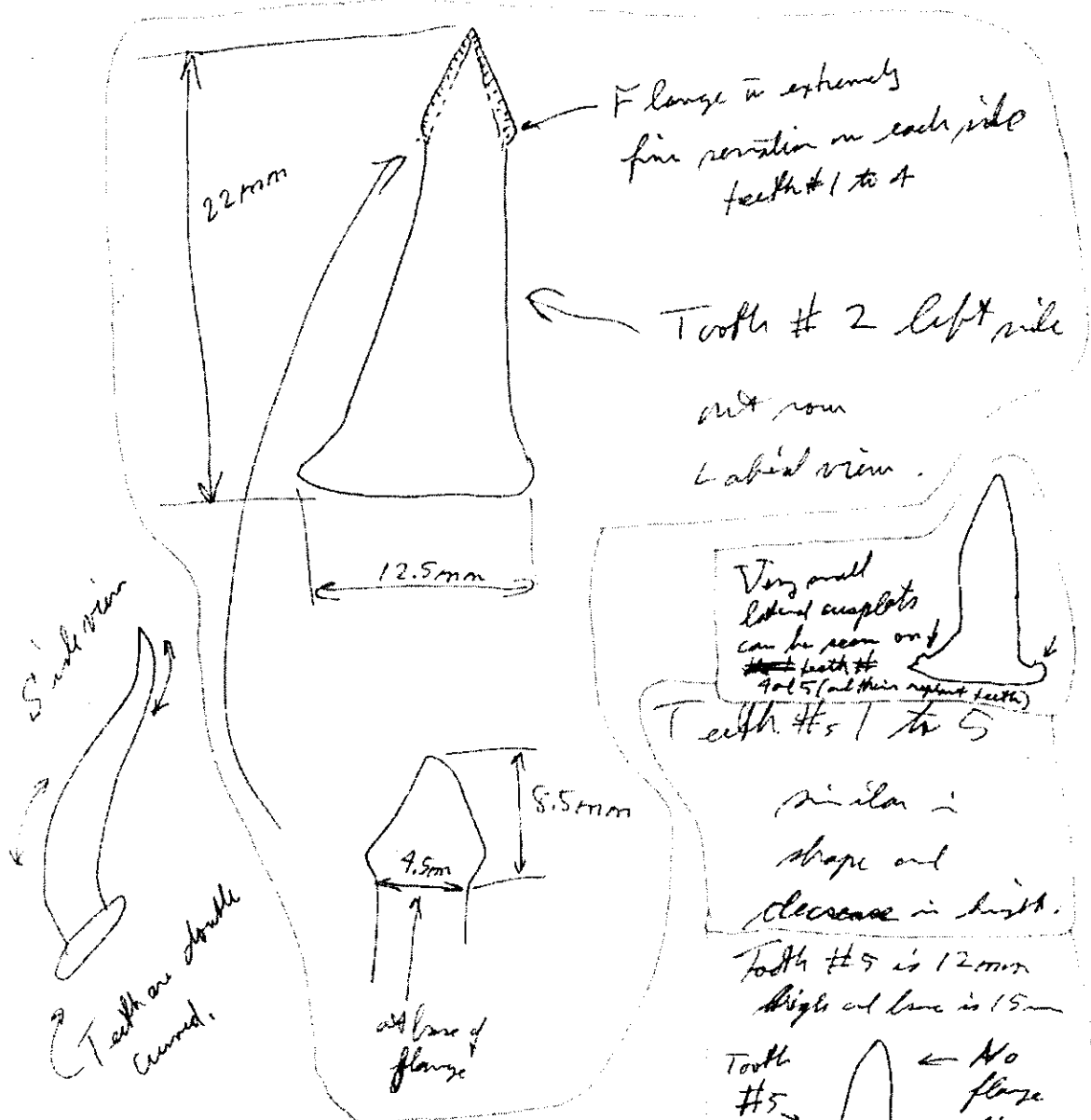
- 4 or 5 rows of replacement teeth behind outer tooth row.
- On the left side, ~~outer~~ ^{behind outer row} teeth # 3, 4, 5 & 6, most of the replacement teeth have fallen out of the specimens. Some of these I will send to you.
- I will send also a replacement tooth of tooth #1 Row 4, left side
- at the symphysis there is a small round blunt tooth.





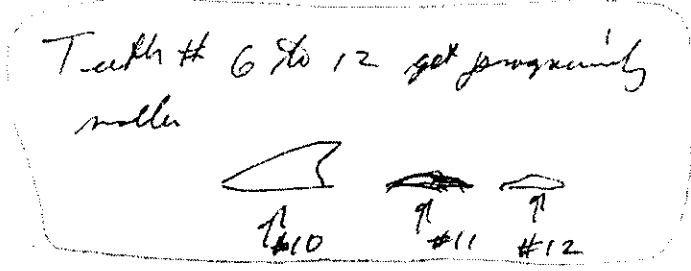
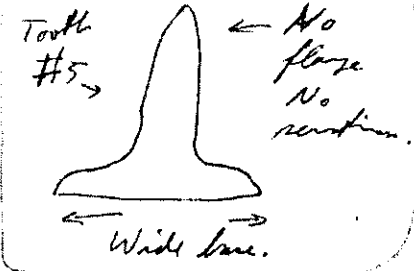
(5)

LOWER JAW



Similar in shape and decrease in height.

Tooth # 5 is 12mm high at base is 15mm



Attachment 2

**Emails from Dr Leonard Compagno,
dated 12, 23 & 26 February 2001 and 20 & 23 March 2001**

Garry Bernacsek

From: L.J.V. Compagno [lcompagno@samuseum.ac.za]
Sent: Monday, February 12, 2001 11:02 PM
To: Garry Bernacsek
Subject: Re: Greetings

Dear Garry

In response to your note:

I was surprised on that score, that you're doing work in the Sundarbans. It has rather an interesting reputation because of the large felines that inhabit it. It is the sort of environment that one would expect Glyphis, however, and not necessarily just Glyphis gangeticus, as well as Carcharhinus leucas. Although we don't know very much about the distribution of the various Glyphis species, they do turn up in the convoluted and extensive deltas of big tropical rivers as well as in smaller rivers in Australia and possibly New Guinea. I look forward to seeing photos of that big jaw, which could be G. gangeticus. It would be nice to obtain whole specimens of whatever Glyphis are present in the Sundarbans, as vertebral counts are critical, along with teeth and color patterns, in determining species. There is probably a second species of Glyphis in Burma, known from only one specimen from the Irrawaddy river delta

Best regards, Leonard

Leonard J.V. Compagno, Ph.D.
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eMail: lcompagno@samuseum.ac.za
alternate: lcompagno@yahoo.com
Web: <http://www.museums.org.za/sam/src/sharks.htm>

Garry Bernacsek

From: L.J.V. Compagno [lcompagno@samuseum.ac.za]
Sent: Friday, February 23, 2001 11:45 PM
To: Garry Bernacsek
Subject: Glyphis

Dear Garry

In response to your note:

----- Original Message -----

From: "Garry Bernacsek" <garry@bangla.net>
To: "L.J.V. Compagno" <lcompagno@samuseum.ac.za>
Sent: Monday, February 19, 2001 6:14 AM
Subject: RE: Greetings

> Hi Leonard
>
> Great to hear from you and that things are going good. I just may be down
> to
> CT for a visit some day. Was always interested to see it.
>
> Attached are photos of the Glyphis jaw (also a little Spadenose). I'm
> starting to get pretty sure we have a Glyphis and not something else. Big
> bugger, too. 42 cm across the symphysis. Could have come from a fish maybe
> 2
> m long.

LC [The photos came through fine, and the jaw photos are probably of a Glyphis
sp. and not Carcharhinus leucas.

> I was in the field a few days ago and talked to the people who acquired
the
> jaw in Jan 2000. I also saw a fresh specimen of Glyphis on a fishing boat.
> This thing was about 2m long and weighed maybe 80-100 kg. Caught in a 9
inch
> gillnet. The locals call it 'ILISHA HANGAR'. Hangar means shark in
Bengali.
> They say they catch 10-15 per year in the winter fishery in the sea off
the
> Sundarbans. I collected a bit of info on the species. And took video of
the
> fresh specimen. Also my colleague took photos (which I will try to get).
>
> Would you be interested to collaborate on a small technical note about the
> occurrence of Glyphis in Bangladesh. With the material and info we already
> have (which I will share with you in toto), and any additional info I can
> collect (I will do at least two more field trips in the coming months and
> will try to get a head, or maybe an entire specimen), I think we can tell
a
> reasonably worthwhile story. And tie it in to the Indian material. You of
> course would be senior author, with me as junior author. Maybe send it to
> Copeia or some other relevant journal. What do you say?

LC [That's fine by me. I'd be happy to collaborate on that. That *Glyphis*
occurs in the Bangladesh part of the Ganges delta is not entirely
surprising; the next problem is which species? I've looked at or otherwise
obtained information on the types of the two species that occur in the broad
area, *G. gangeticus* from the Ganges system and *G. siamensis* from the
Irrawaddy. It is not impossible that there might be more than one species in
the Ganges system. In Papua-New Guinea and in northern Australia, there are
two species, possibly both new, in various rivers.

> Best regards,
>
> Garry Bernacsek

Garry Bernacsek

From: L.J.V. Compagno [lcompagno@samuseum.ac.za]
Sent: Monday, February 26, 2001 10:53 PM
To: Garry Bernacsek
Subject: Re: Glyphis

Dear Garry

In response to your note:

----- Original Message -----

From: "Garry Bernacsek" <garry@bangla.net>
To: "L.J.V. Compagno" <lcompagno@samuseum.ac.za>
Sent: Saturday, February 24, 2001 1:01 PM
Subject: RE: Glyphis

> OK, great. I will be sending you various info over the next month. And maybe
> a tooth or two. And some video. I attach two more photos of the fish we saw
> (also, are you into rays???) . I intend to do another field trip in mid-March
> and will keep in mind that we may even have two species.

The additional pictures came through fine, with no problems. The photos obviously portray a big, lovely *Glyphis*, not *C. leucas*.

> The jaw is definitely not a leucas. I'm kinda surprised not to have come
> across leucas yet, since it's in the river next door in India. But the
> coastal zone in the Bangladesh Sundarbans is heavily fished, so leucas may
> be a rare beast over here. Also, leucas may stay in the river during the
> winter dry season (ie when the weather is calm and the winter behundi net
> fishery is full on), and only go to sea during the hot wet monsoon season
> (when no one is fishing off the Sundarbans cause of cyclone danger, and
> generally bad weather and heavy seas - so no leucas are caught then).

LC There are few records of *C. leucas* around Indian waters, to my knowledge anyway, and the only freshwater record I know of was a newborn specimen from the Hooghli River, apparently collected alongside a newborn *Glyphis gangeticus*. I suspect that heavy inshore and riverine fishing and development may have thinned *C. leucas* out, to say the least, but a baseline indicator of abundance is hard to come by. I saw a few recently caught *C. leucas* in Cochin in 1982, plus Day's pictured specimen in his Fishes of India (as *Carcharias gangeticus*). P.K. Talwar of the Zoological Survey of India suggested, when I visited Calcutta in 1982, that apparently ichthyologists in India have been misidentifying *Carcharhinus leucas* as *G. gangeticus*, following Day, which makes it difficult to sort out the older literature.

> Oh, by the way. I would like to include a third author - Emdadul Haque. He
> is my counterpart in the government and is the head of the aquatic
resources
> division. I am training him, and he has helped me a lot with the work in
the
> field. And he is starting an MSc in mangrove fisheries and fish
biodiversity
> in the fall (either at UBC or Hull), so he needs a publication or two to
> have some street cred (his background is forestry and he is switching over
> to fisheries). I hope you don't mind. It would be: Compagno, Bernacsek and
> Haque. Rest assured his name is not just there for cosmetics, but he is
> actually making a substantial and, I can assure you, vital contribution.

LC [Not a problem. Involvement by local researchers is essential here. The more both of you can find out about the biology of *Glyphis*, the better, including habitat preferences, which will help to shape a conservation strategy for this animal and other freshwater elasmobranchs. Particularly if

Garry Bernacsek

From: L.J.V. Compagno [lcompagno@samuseum.ac.za]
Sent: Tuesday, March 20, 2001 8:13 PM
To: Garry Bernacsek
Cc: Leonard J.V. Compagno
Subject: Glyphis again, what else?



GLY1984-1.ZIP

To:
Garry Bernacsek
Fisheries Specialist
Sundarbans Biodiversity Conservation Project
House 80, Road 23
Gulshan 1
Dhaka 1212, Bangladesh
tel and fax: 880-2-8823244

email only up to 28 March 2001: garry@bangla.net

email from 29 March 2001 onward: globalaquatic@ozemail.com.au

Khulna field office, tel: 880-41-763095 and 761865

Dear Garry

This is a note in response to several of yours about the Glyphis, which are very exciting:

Hi Leonard

Here is the information on the Glyphis material from Bangladesh. I have not been able to go to the forest again, and I will not be able to go before I leave Bangladesh on 30 March. However, I will be back again, not exactly sure when. But I think we should go ahead with a published note on what we have.

LC [>Agreed.

Wednesday 24 January 2001: I was at Office Kella on Dubla Island (see attached map). This is the Forestry Department (FD) office for the Dubla Island winter fishery. I was presented with the Glyphis jaw by a FD officer.

Monday 12 February 2001: I was at Meherali fishing camp on Dubla Island having a meeting with fishermen and fish traders. I met the FD officer (Anwar Hussain) who first obtained the jaw (it was another FD officer who gave me the jaw on 24 Jan). He obtained it from a fish trader (Mr Butaburua) from Chittagong. Butaburua was at the meeting and he gave me the following information:

- The shark was caught in January 2000 by a fishing boat using a large behundi net (set bagnet) in the sea.
- The approximate location was about 20 km south of Alokor (Dubla Island) in the Bay of Bengal. This is marked as x1 (x marks the spot) on the second attached map.
- The shark had a big head. It was about 10 ft long and weighed about 100 kg.
- Butaburua saw the shark and cut out the jaw because he thought the shark was peculiar.
- Anwar obtained the jaw from Butaburua in February or March 2000, and kept it because he thought it was special.
- Butaburua says that 10-15 specimens are caught of this special shark each year. It is called 'ILISHA HANGAR' (in Bangla, 'HANGAR' means shark, and the important river shad Hilsa ilisha [= Tenualosa ilisha] is called 'ILISH').

The implication is that the shark eats hilsa, but I don't know if this is true.

LC > From its jaws and teeth, this specimen (represented by the set of jaws) is apparently NOT *Glyphis gangeticus*, but instead is most likely *Glyphis glyphis* or something very close to it. *Glyphis* sp. A, from Queensland and Northern Territory (the tentative name from Last & Stevens, 1994, and Compagno & Niem in the 1998 FAO Western Central Pacific species sheets), and likely Papua-New Guinea, may be the same species, that is, *G. glyphis*. All of these have big jaws and teeth even for a *Glyphis*, fewer tooth rows compared to other species, hastate lower teeth with spearlike cusps, very large second dorsal fins even for a *Glyphis*, and, in two Australian specimens, much higher precaudal vertebral counts than any other *Glyphis*. The holotype of *G. glyphis* is an old stuffed specimen with its precaudal vertebrae absent, but its caudal counts agree with the Australian specimens of *G.* sp. A (as well as certain other species except *G.* sp. C from Australia and Papua-New Guinea, which has much lower vertebral counts).

After finishing our discussion I was called to the nearby jetty to look at the catch of a fishing boat that had just pulled in. There was the specimen of *Glyphis* that I have earlier sent you photos of. Here is the info on the specimen:

- It was caught using a 9 inch stretch mesh gillnet.
- The capture location was about 40 km south from the mouth of the Baleswar River, marked as x2 on the map.
- It had been caught one week ago and had been kept on ice in the hold of the boat.
- The specimen had very small eyes and large pectoral fins. You can see various features from the photos. When I first saw the specimen the upper and lower jaws were quite protruded. The crew then turned the fish over, and the jaws became retracted somewhat. The two photos show the jaws in the retracted position.
- Other large fish in the catch included a large silver croaker, a large Indian salmon and a Spanish mackerel. However I don't know if these were caught at the same place and time as the *Glyphis*, as the boat had been out for a week.

LC > Did you get a look at the jaws and teeth of this specimen? It looks like it has a large second dorsal fin and heavy jaws as with *G. glyphis* - *G.* sp. A.

Some more ideas about the jaw, feeding and other things:

With the jaw closed, there is a very large gap of 6.5 cm between the upper jaw and lower jaw (symphysis to symphysis). This means *Glyph* would swim around with its mouth partly open all the time, as in the specimen photos. All the better to breathe with, I guess.

LC > Not unlike makos, *Hemipristis elongatus*, crocodile sharks, and other big-tooth fish-grabbers. The offset produces a nice space filled with spikes and saws, that neatly impales the victim and kills it without necessarily severing it (although that is possible with shaking). It also allows dismembering of bigger prey, and chopping out of chunks of flesh from a carcass.

The strongly differentiated dentition in the upper and lower jaw suggests differences in function. The lower teeth are clearly for grasping and holding on to prey - such as slippery fish. The teeth puncture the prey and prevent it from escaping. The lower teeth are definitively not for cutting. This is what the upper teeth clearly are for - to cut off a bite-size chunk of the prey. [That'll kill it and stop it from thrashing about.]

LC > Alternatively, the dentition can kill a whole large prey fish and then allow the shark to swallow it without letting it go. With these sharks, living in turbid rivers and muddy inshore waters, this may be important to cut down loss of prey to other fishes?

The eye is very small. This suggests that *Glyph* doesn't need to worry about

seeing its prey, and may be practically blind, seeing only luminescence levels and perhaps direction. The Ganga-Hooghly River and other rivers emptying into the northern Bay of Bengal are very silty and turbid, so visibility is very low. [The local river dolphin *Platanista gangetica* is practically blind.] The northern Bay of Bengal is pretty muddy too (no blue water here). So prey detection is probably via pits of Lorenzini or other tactical means (like brushing up against something). Whatever the case, Glyph probably has to make a very quick snap at any passing meals if it wants to eat. So job 1 is to grab hold of whatever prey comes close enough and not let it escape (ie the job of the lower teeth). Job 2 is to bite off a chunk (ie the job of the upper teeth). By having the mouth permanently open, Glyph has a faster reaction time and a bit of extra edge. The strong protrudibility of the jaws allows Glyph to get that little bit closer for the bite. [Get past the long snout, too].

LC >Could be. We can throw these ideas about in the paper. The Kinabatangan River in Sabah is extremely silty also, where *Glyphis* sp. B was caught. This has weaker jaws and smaller teeth than *G.* sp. A.

Glyph has a nice hydrodynamic shape and large pectorals for gliding. Hence, Glyph is probably a pretty active swimmer and prey hunter. Maybe it needs more oxygen and so has evolved the permanently open jaw configuration.

The interesting thing about our new records is that Glyph goes far out to sea. Maybe it only comes into rivers to give birth (assuming it is viviparous). Or it gives birth at sea and the pups swim into the rivers and use them as nursery grounds. When they get big enough, they swim back out to sea. [This is what most fish species do in the area.] So many unknowns.

LC > To my knowledge this is the first hard data catch of *Glyphis* in marine waters, although some caught in Papua-New Guinea may be from marine waters: locality data wasn't very good, which is a continuing problem with **Glyphis** records. We got newborn young and some larger specimens of *G.* sp. B in the lower Kinabatangan in Sabah, with the locals noting that they occasionally get big, adult specimens of this species in the river. The local fish fauna where the sharks are caught consists of primary freshwater fishes, and the **Glyphis** apparently eat them. It is apparent that this **Glyphis** may be coming into freshwater to drop its young, but we don't know what the adults do otherwise. We have no marine records for this species. They don't seem to venture into inshore clear-water marine environments that are heavily fished near the Kinabatangan delta, as shown by lack of market catches, but they could stick to turbid areas near the river. People who fish in the lower river do get them, however.

All for now. The teeth are on the way by courier. I will send you the video when I get back to Sydney in early April.

LC >Great. The scanner shots show a nice likeness to the teeth of large specimens of possible *G.* sp. A from Papua-New Guinea, as well as the holotype of *G. glyphis

My video shows that the specimen is a large male. Body is gray-green above and white below. Fairly deep bodied in profile. Very small eyes. The first gill flap is fairly large and the others smaller. Hence fishermen say it has 'ears'.

I have your FAO guide in Sydney, but not here. I would be very grateful if you scan the pages on *Glyphis gangeticus* and email them to me ASAP. I have to write up a small internal report on glyph for the project and want to refer to what you wrote about the species, and the other known specimens. Have you written anything else about *G. gangeticus*?

LC >I'll send you scanned-in text of the 1984 catalog with both species, and also my 1988 book. Sid Cook and I wrote the following about *Glyphis* (from Compagno & Cook, 1995. The exploitation and conservation of freshwater elasmobranchs: Status of taxa and prospects for the future. In: Oetinger, M.I. and G.D. Zorzi, eds., The biology of freshwater elasmobranchs. A symposium to honor Thomas B. Thorson. Journal of Aquaculture and Aquatic Sciences, 1995, 7: 62-90, figs. 1-5.):

"*Glyphis gangeticus* (Mueller and Henle, 1839). Ganges shark. This rare large shark has valid records based on only three specimens, all apparently collected in fresh water in the Ganges-Hooghly river system, India during the last century (Compagno, 1984, 1988). Numerous records of the Ganges shark from marine and fresh waters of the tropical Indo-West Pacific are mostly based on *Carcharhinus leucas* and *C. amboinensis* when verifiable (Boeseman, 1964, Garrick, 1982, Compagno, 1984, 1988). The biology of the Ganges shark is poorly known, and there is an urgent need to study freshwater sharks in the Ganges-Hooghly system and other Indian rivers and to determine if the Ganges shark is still extant. If so, it should be the subject of a detailed biological study that would among other things determine its conservation status.

"*Glyphis* sp. 1. Bizant river shark. This is an apparently undescribed shark that is known from two specimens collected from the Bizant River 17 km upstream from its mouth, Queensland Australia, possibly in brackish water (Compagno, 1988), where it occurs along with *Carcharhinus leucas*.

"*Glyphis* sp. 2. Adelaide river shark. This is a possibly undescribed shark known from specimens collected in the Adelaide River, Northern Territory, Australia (Taniuchi and Shimizu, 1991, Taniuchi et al., 1991b) and apparently not conspecific with the Bizant river shark. It may be conspecific with an undescribed species of *Glyphis* from Papua New Guinea (Compagno, 1988)."

>I also wrote the following (Compagno, 1997. Threatened fishes of the world: *Glyphis gangeticus* (Müller & Henle, 1839) (Carcharhinidae). Environmental Biology of Fishes 49: 400, ill.):

"Threatened fishes of the world: *Glyphis gangeticus* (Müller & Henle, 1839) (Carcharhinidae).

L.J.V. Compagno
Shark Research Center, South African Museum, P.O. Box 61, Cape Town 8000, South Africa

"Common names: Ganges shark (E), Requin du Ganges (Fr), Tiburon del Ganges (Sp).

"Conservation status: Possibly extinct.

"Identification: A large stocky shark reaching at least 178 cm (adult male) with two spineless dorsal fins and an anal fin, a broadly rounded, short snout much less than mouth width, minute eyes with internal nictating eyelids dorsolateral on head, no spiracles, five moderately long gill slits on sides of head, no nasoral grooves or barbels on nostrils, mouth long, broad, and extending anterior to eyes, labial furrows very short, upper teeth with high, broad serrated triangular cusps, lower anterior teeth with long, hooked, protruding cusps with unserrated cutting edges along entire cusp, without spearlike tips, and with low cusplets on feet of crowns, tooth row counts 32-37/31-34, origin of first dorsal fin over rear ends of pectoral fin bases, second dorsal fin about half height of first dorsal, caudal fin with a strong ventral lobe and lateral undulations on its dorsal margin, no interdorsal ridge, upper precaudal pit longitudinal, no conspicuous markings on body and fins, intestine with a scroll valve, 160 total vertebral centra, 50 monospondylous precaudal, 30 diplospondylous precaudal, and 80 diplospondylous caudal centra.

"Drawing by L.J.V. Compagno of Paris syntype (MNHN-1141).

"Distribution: Lower reaches of the Ganges-Hooghly river system, West Bengal, India; possibly from off Karachi, Pakistan if *Carcharias murrayi* Günther, 1887 is a junior synonym of this species but this is uncertain because the holotype and only known specimen (in the British Museum [Natural History]) is apparently lost. Abundance: Uncertain; only three museum specimens of the Ganges shark are currently known in fish collections (one each in the Museum National d'Histoire Naturelle, Paris, Humboldt Museum, Berlin, and Zoological Survey of India, Calcutta), all of which were collected in the 19th century and with no confirmed records after 1867. Most literature records and specimens labelled as this

species are bull sharks, *Carcharhinus leucas* (Valenciennes in Müller & Henle, 1839) or other species of *Carcharhinus* Blainville, 1816. Habitat and ecology: Fresh water in the lower reaches of the Ganges-Hooghly river system, possibly also shallow marine estuaries but there are no verified marine records of this species. The small eyes and slender teeth of this shark suggest that it is primarily a fish-eater and is adapted to turbid water such as occurs in the Ganges River and the Bay of Bengal. It has been nominally implicated in numerous attacks on humans in the Ganges but since *C. leucas* occurs in the same river system this cannot be proven at present and it is possible that *C. leucas* was involved in most if not all of the attacks. Reproduction: Live-bearing and probably with a yolk-sac placenta by analogy to related genera, late fetuses and newborn specimens 56-61 cm long, litter size and gestation period unknown. Threats: Overfishing, habitat degradation from pollution, increasing river utilization and management including construction of dams and barrages. Conservation action: An in-depth survey of fishing camps and landing sites and, if necessary, a sampling program in the Ganges system to determine the current status of this shark along with other gangetic elasmobranchs (sharks, stingrays and sawfish). Conservation recommendations: Provided the species is still extant, placement on the IUCN International Red List and CITES listing of this species would be in order.

VC Boeseman, M. 1964. Notes on the fishes of Western New Guinea III. The fresh-water shark of Jamoer Lake. Zool. Meded. 40: 9-22.
Compagno, L.J.V. 1984. FAO Species Catalogue. Vol. 4, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis No. 125. vol. 4, pt. 1: viii, 1-250; pt. 2: x, 251-655.
Compagno, L.J.V. 1984. Chimaeras. Sharks. In W. Fischer, & G. Bianchi, eds. FAO species identification sheets for fisheries purposes. Western Indian Ocean. Fishing Area 51. Food and Agriculture Organization of the United Nations, Rome, vol. 5, 272 pp. (not numbered).
Compagno, L.J.V. 1984. The mysterious Ganges shark. Ichthos 7: 25-26.
Compagno, L.J.V. 1987. The French connection: return of the Ganges shark. Ichthos (13): 8.
Compagno, L.J.V. 1988. Sharks of the Order Carcharhiniformes. Princeton University Press, Princeton, New Jersey, pp. i-xxii, 1-572, 158 figs, Pls. 1-35.
Compagno, L.J.V., & S. F. Cook. 1995. The exploitation and conservation of freshwater elasmobranchs: Status of taxa and prospects for the future. In: Volume VII: The biology of freshwater elasmobranchs (Eds. M.I. Oettinger and G.D. Zorzi). Journal of Aquaculture and Aquatic Sciences: 62-90, figs.
Garrick, J.A.F. 1982. Sharks of the genus *Carcharhinus*. Nat. Ocean. Atmosph. Adm. USA, Tech. Rep., Nat. Mar. Fish. Serv. Circ. (445), viii + 194 p."

What about the fresh 280 cm female, and the two new jaws? Has that been written up by you? If so, I would very much like to have a copy. (I've got your short note in IUCN/SSG Shark News 9 from the SSG website.)

VC > I'd seen photographs, but not the specimens themselves in the flesh. Sid Cook had one of its teeth. Tyson Roberts got the records in India, just after I published the above (I'm very happy to be proven wrong on this beast being extinct), except that I'd like confirmation that this shark was actually **G. gangeticus** and not another species of **Glyphis**. Tyson thinks that **G. siamensis** is conspecific with **G. gangeticus** but I disagree. I haven't seen his write-up if he's done one yet.

Two days ago our wildlife specialist caught a poacher with a 6 inch gillnet inside the forest sanctuary area. In the net was a 70-80 cm female *Scoliodon laticaudus* (j attached). Interesting that such a large adult should be wandering about in the forest.

VC > I assumed it was **S. laticaudus** also at first glance, until I started to look at it in detail. Maybe I'm hallucinating, and have contracted

VC
Glyphis-fever, but it apparently isn't *Scoliodon* (which your first picture certainly was). The relatively large, falcate narrow pectoral fin, big second dorsal fin relative to the anal fin, first dorsal fin far anterior with its origin over the pectoral bases suggest instead yet another *Glyphis* (if not *Lamiopsis temmincki*, which has the first dorsal fin somewhat more posteriorly situated and the second dorsal fin about as large as the first, also a broader pectoral fin). There is an Australian-Papuan species, *Glyphis* C, which has a flat broad head also; the holotype of *G. siamensis* looks like a road-kill, but may have a flatter head than *G. gangeticus* and certainly *G. glyphis*. Whatever it is, I'd like to see more pictures and material.

> We should talk about getting a project going on investigating these beasties more closely. Not that I need any more work.

Attached to this note is the relevant parts of the FAO shark catalog. I'll send the 1988 book sections in two installments. I hope these get through; if not, I may have to send these separately, shrink the individual JPG files, or send you text files from the relevant sections.

Best regards,

Leonard

Garry Bernacsek

From: L.J.V. Compagno [lcompagno@samuseum.ac.za]
Sent: Friday, March 23, 2001 8:36 PM
To: Garry Bernacsek
Subject: Glyphis teeth arrived safely

Dear Garry

This is to confirm that the teeth arrived safely here. I compared with them with the material on hand, and they look especially like the *G.* sp. A from Papua-New Guinea, only more robust (presumably due to their larger size).

Best regards, Leonard

Leonard J.V. Compagno, Ph.D.
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alternate: lcompagno@yahoo.com
Web: <http://www.museums.org.za/sam/src/sharks.htm>

Attachment 3

Reproduced Text on Glyphis from Compagno (1984)

From Compagno, 1984. FAO Fish. Synop. (125) 4(2)

oil. This shark is fished by sports anglers and caught with rod and reel; it is one of the sharks recognized as a big-game fish by the International Game Fish Association and is currently the second largest all-tackle record fish taken by rod and reel after the great white shark.

Literature : Beebe & Tee-Van (1941), Fowler (1941), Bigelow & Schroeder (1948), Gudger (1949), Baughman & Springer (1950), Kauffman (1950), Cadenat (1957), Fourmanoir (1961), Garrick & Schultz (1963), Randall (1963), Cohar & Muzhar (1964), Springer (1960, 1963), Clark & von Schmidt (1965), Bass, D'Aubrey & Kistnasamy (1975b), Johnson (1978), Compagno & Vergara (1978), Compagno (1979, 1981), Cadenat & Blache (1981), Van der Elst (1981).

Glyphis Agassiz, 1843

CARCH: Glyph

Genus : Glyphis Agassiz, 1843, Poiss.Foss., 3:243.

Type Species : Carcharias (Prionodon) glyphis Müller & Henle, 1839, by absolute tautonymy (see discussion below).

Synonymy : None.

Field Marks : Requiem sharks with short, broadly rounded snouts, small, wide-spaced nostrils, no spiracles, labial furrows confined to mouth corners, extremely small eyes, serrated triangular, broad-cusped upper teeth, no cusplets on lower teeth (except for first few anterolaterals in G. gangeticus), no keels on caudal peduncle, conspicuously protruding cusps on lower teeth, longitudinal precaudal pits, first dorsal midbase much closer to pectoral bases than pelvics, second dorsal fin half to 3/5 height of first, second dorsal origin slightly in front of anal origin, anal fin with preanal ridges virtually absent and with a deeply notched posterior margin.

Diagnostic Features : Body fairly stout. Head broad and flattened but not trowel-shaped; snout broadly parabolic or rounded in dorsoventral view and short, with the preanal length varying from about equal or somewhat less than internarial space but much less than mouth width; eyes extremely small, without posterior notches; spiracles absent; no papillose gillrakers on internal gill openings; nostrils small, internarial space 3 to 6 times the nostril width; anterior nasal flaps short, broadly to narrowly triangular, but not tubular; labial furrows short, essentially confined to mouth corners, with uppers shorter than lowers and falling far behind eyes; teeth strongly differentiated in upper and lower jaws; upper anteroposteriors with more or less erect, broad, triangular cusps, no cusplets or blades, and fine serrations; lowers with or without cusplets (on first few anterior teeth) or blades but with variably oblique to erect, long cusps and with serrations generally absent; cusps of lower teeth prominently protruding when mouth is closed; 29 to 37/28 to 34 rows of teeth. Interdorsal ridge absent; no lateral keels on caudal peduncle; upper precaudal pit longitudinal and not crescentic. First dorsal origin far anterior, over last third of pectoral bases, midbase much closer to pectoral bases than to pelvics and free rear tip well in front of pelvic fins; second dorsal fin much smaller than first but relatively large, its height 1/2 to 3/5 of first dorsal height or less, its origin slightly anterior to anal origin; pectoral fins moderately broad and falcate or semifalcate, their lengths from origin to free rear tip about 3/5 to nearly 3/4 of pectoral anterior margins; pectoral origins varying from about under interspace between third and fourth gill slits to under fourth gill slits; anal fin slightly smaller than second dorsal, with preanal ridges very short or absent and a deeply notched posterior margin. Colour grey or brownish above, without a colour pattern. Large sharks, to at least 2 m.

Remarks : The genus Glyphis is used here for the 'river sharks', two and possibly three or more species of poorly known, freshwater and estuarine sharks of the Indian Ocean and Western Pacific. This includes the famous, notorious, and elusive Ganges shark (G. gangeticus) of Indian waters.

The nomenclatural history of the genus Glyphis is somewhat checkered. Agassiz (1843) based his description of the genus primarily on a living species, Carcharias (Prionodon) glyphis Müller & Henle, 1839, which he mentioned in its text, but also named a new fossil species, G. hastalis. Elsewhere in the Poissons Fossils Agassiz (vol. 3, 1845, tab.mat.3c: 7) noted that Glyphis included "une espèce vivante et une fossil de l'Argile de Londres, le G. hastalis". Agassiz did not designate a type for Glyphis, but this must be C. (P.) glyphis by absolute tautonymy.

Fowler (1941) and Bigelow & Schroeder (1948) assumed that Glyphis as originally described by Agassiz included only a single species, G. hastalis, which they erroneously assumed was the type species by monotypy. Bigelow & Schroeder (1948) cited 1838 as the earliest date for Glyphis, on a plate caption for G. hastalis (Agassiz, Poissons Fossils, Atlas, vol. 3, pl. 36). However, according to Woodward & Sherborn (1890) the plate in question was apparently published in 1845 and hence postdates the text description of Glyphis.

Fowler (1928, 1941) erroneously used Glyphis to replace Prionace Cantor, 1849, as a generic name for the blue shark, P. glauca (Linnaeus, 1758). Apart from the subsequent stabilization of Prionace as the generic name of the blue shark by the International Commission on Zoological Nomenclature (Opinion 723, 1965) and confusion on the type species of Glyphis, this action is unwarranted because neither the living type species of Glyphis or the fossil G. hastalis are congeneric with the blue shark.

- 509 -

From Compagno, 1984. FAO Fish. Synop. (125) 4(2)

Geographical Distribution: Indo-West Pacific: Definitely known from the Hooghly River, Ganges system, West Bengal, India, and likely from the vicinity of Karachi, Pakistan (see remarks below).

Habitat and Biology: A poorly known freshwater riverine and possibly inshore marine and estuarine shark. Probably viviparous. The Ganges shark has a horrific reputation as a man-eater in the Ganges-Hooghly system, but this is unproven (see remarks below).

Size: Maximum possibly to at least 204 cm (type of *Carcharias murrayi*); adult or adolescent male 178 cm (stuffed syntype); newborn specimens 56 to 61 cm.

Interest to Fisheries: Probably fished in the Ganges-Hooghly system, but details unknown.

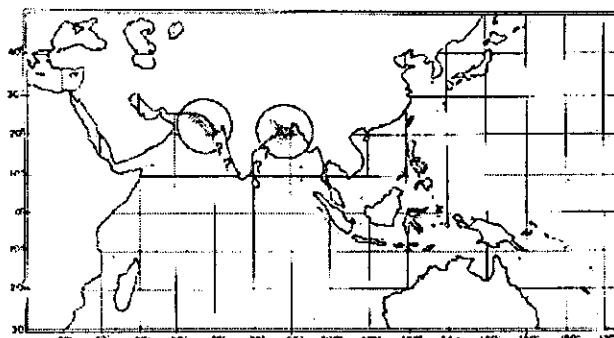
Literature: Fowler (1941); Garrick & Schultz (1963); Boeseman (1964); Garrick (1967, 1982, pers. comm.); Budker & Whitehead (1972); Bass, D'Aubrey & Kistnasamy (1973).

Remarks: The elusive Ganges shark has been famed and fabled for its occurrence in fresh water as well as for its bloody reputation as a man-eater there. Originally known only from the type locality, it was gradually recorded from the entire span of the Indo-West Pacific until Fowler (1941), in a masterpiece of compilation bearing little relationship to reality, recorded the species from Arabia and India to Borneo, Viet Nam, China, Japan, Australia, the Philippines, and Fiji and the Hawaiian Islands. However, with the critical survey of carcharhinids begun in the early 1960s, most of the marine and freshwater records of the Ganges shark could not be substantiated and many were found to be based on *Carcharhinus leucas*, *C. amboinensis* and other species (see Garrick & Schultz, 1963; Boeseman, 1964; Garrick, 1967, 1982; Bass, D'Aubrey & Kistnasamy (1973)). Boeseman (1964) noted that "most of the recorded *C. gangeticus* from outside the Indo-Pakistan Peninsula (excepting those from Japan and possibly, from Viti-Levu, Fiji Islands), are identical with *C. leucas* Müller & Henle.", and since then confirmation of records of the species from Japan and Fiji has not been forthcoming. Lineaweaver & Backus (1970) and Ellis (1975, 1983) even considered the Ganges shark a synonym of *Carcharhinus leucas*, although Garrick (1982) recognized it as distinct.

During a trip to India in 1982 the writer discovered an additional specimen of *C. gangeticus* in the fish collection of the Zoological Survey of India in Calcutta (ZSI 8067, 61 cm newborn female, misidentified as *Carcharhinus termincki*), collected by Dr J. Anderson from the Hooghly River on 4 April 1867. This confirmed Garrick's recognition of the species, but sheds little additional light on its biology. It is apparently only the fourth verified specimen of this rare shark, including the two syntypes (one lost) and possibly the holotype of *Carcharias murrayi* (also lost), and hence is one of two extant specimens in museum collections. Garrick (1982) suggested that *Carcharias murrayi* is a possible synonym of this species, with which the writer concurs.

The writer examined another specimen in the Zoological Survey collections labelled *Squalus gangeticus* (ZSI 10250, 65 cm newborn male) but bearing the same data (Hooghly River, collected by Dr J. Anderson, 4 April 1867) as the true *gangeticus* specimen; but this turned out to be the circumtropical bull shark, *Carcharhinus leucas*. Although Garrick (1982) had not examined specimens of *leucas* from the Indian subcontinent, the writer found *leucas* material from Cochin and Bombay as well as the Hooghly specimen.

Thus there are two species of sharks in the Hooghly River, and, with the well-known affinities of *C. leucas* for fresh water, probably two Ganges River sharks as well. The hideous reputation of the true Ganges shark grew on the assumption that there was only one species of shark in fresh water in the Hooghly-Ganges system, which was responsible for the numerous attacks on people reported by Day (1878) and other writers. However, the Ganges shark may eventually have to pass on much or all of its notoriety to the more prosaic but perhaps more dangerous and formidable bull shark. In comparison with *Carcharhinus leucas*, *Glyptis gangeticus* has much narrower, higher, upper teeth and slender-cusped, less heavily built lower teeth. The teeth of the Ganges shark appear more suitable for fish-impaling and less useful for dismembering tough mammalian prey than the very stout teeth of the bull shark. The presence of the bull shark (one of the most dangerous living species) in the Hooghly and perhaps the Ganges along with readily available human prey and mammalian carrion suggests that with widespread confusion of this shark and *C. leucas* in India and elsewhere its bad reputation must be considered uncertain at best. The Ganges shark is potentially dangerous because of its size and large teeth, but at present its relation to humans is a mystery, along with almost all other aspects of its biology. Although sharks are currently caught in the Ganges system (P.K. Talwar, pers. comm.), it is not known how common the true Ganges shark is relative to the bull shark. It is also quite uncertain how well the Ganges shark is adapted to fresh water, or for that matter, how well it can live in sea water. The presence of newborn individuals in the Hooghly River suggests that at least the young may be born in fresh water. The minute eyes of the Ganges shark, along with other *Glyptis* sharks, suggests that the entire group may be adapted to turbid water with poor visibility, as in large tropical rivers and muddy estuaries.



From Compagno, 1984. FAO Fish. Synop. (125) 4(2)

Glyphis glyphis (Müller & Henle, 1839)

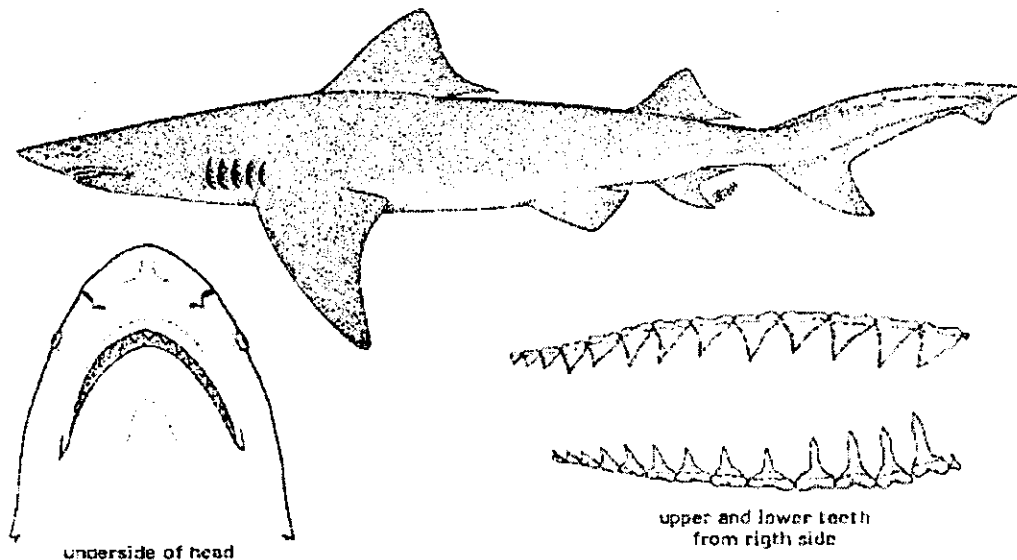
CARCH Glyph 2

Carcharias (Prionodon) glyphis Müller & Henle, 1839, *Syst. Besch. Plagiost.*, (2):40, pl. 14. Holotype: About 1 m long, stuffed specimen in Zoologisches Museum, Humboldt Universität, Berlin. Type Locality: Unknown.

Synonymy : None.

Other Scientific Names Recently in Use : *Carcharhinus glyphis* (Müller & Henle, 1839).

FAO Names : En - Speartooth shark; Fr - Requin lancette; Sp - Tiburdín lanza.



Field Marks : A stocky requiem shark with a broadly rounded short snout, preoral snout much shorter than mouth width but preorbital snout rather long, minute eyes, first dorsal origin over rear ends of pectoral bases, second dorsal rather large, about 3/5 height of first dorsal, upper teeth with high, broad, serrated triangular cusps, lower anterior teeth with long, hooked, protruding cusps with unserrated cutting edges confined to slightly expanded spearlike tips, no interdorsal ridge, upper precaudal pit longitudinal, no conspicuous markings.

Diagnostic Features : First few anterior teeth in lower jaw with cutting edges confined to tips of cusps, giving the cusps a spearlike shape, and no cusplets. Second dorsal higher, about 3/5 height of first dorsal.

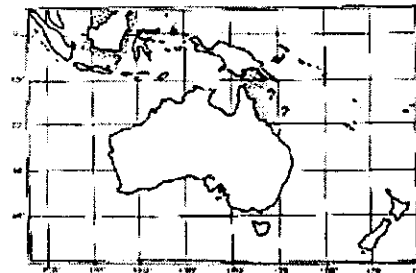
Geographical Distribution : Uncertain. *G. glyphis*-like sharks occur in Borneo, New Guinea, and Queensland, Australia, but it is uncertain at present if any of these are the true *G. glyphis* (see remarks below).

Habitat and Biology : Presumably inshore and possibly in fresh water. Biology unknown.

Size : Maximum at least 1 m; this or a related species in New Guinea may reach 2 to 3 m.

Interest to Fisheries : Unknown.

Literature : Garrick (1982, and pers. comm.).



Remarks : This mysterious, apparently rare shark was long known only from Müller & Henle's (1839) original account. Prof. J.A.F. Garrick (pers. comm.) has obtained additional specimens of *glyphis*-like sharks from New Guinea, Borneo and Queensland, Australia. However, these may represent more than one species, as the Borneo and New Guinean specimens differ significantly in vertebral counts, and it is uncertain at present which of these (if any) represent the true *G. glyphis*. This problem is under study by Prof Garrick and the writer.

Attachment 4

Reproduced Text on Glyphis from Compagno (1988)

GENUS *GLYPHIS* AGASSIZ, 1843:
RIVER SHARKS

Genus *Glyphis* Agassiz, 1843, vol. 3, p. 243. Type species, *Carcharius (Prionodon) glyphis* Müller & Henle, 1839 by absolute tautonymy.

Illustrations

FIGURE 3.1J (tooth), 19.11, 19.12A (lateral views), 19.13 (cranium).

Introduction

Included here are perhaps some of the most mysterious and poorly known carcharhinids, the "river sharks," named for the habitats at least two of the species have been collected in. The notorious and elusive Ganges shark from India has a fearsome reputation as a man-eater but this may be based in whole or part on the more formidable bull shark, *Carcharhinus leucas*, which also occurs in the Ganges river system in India. Species related to the little-known spear-tooth shark occur in brackish waters in the lower reaches of rivers and apparently inshore marine waters of the Western Pacific. The Ganges shark at least may bear young in fresh water. All the river sharks have minute eyes, possibly an adaptation to turbid water with poor visibility, as in large tropical rivers and muddy estuaries. Some species of river sharks reach at least 2 m. length.

Definition

Stout carcharhinine sharks with broad and moderately depressed heads and snouts. SNOUT broadly parabolic, wedge-shaped or rounded in dorsoventral view. PREORAL LENGTH equal to or less than internarial width and much less than mouth width. Ventral edges of EYES about opposite or somewhat above level of nostrils, the midheights of eyes well above the incurrent apertures. No brow ridge above eyes. Eyes circular. No GILL RAKERS. Internarial width about 3.8–5.8 times NOSTRIL width.

Dignathic heterodonty strongly developed. Single row of lower MEDIALS about as large or much larger than upper medials but much smaller than adjacent ANTEROLATERALS. Upper anteriors broad, high-crowned, triangular, highly compressed and finely serrated, with straight cutting edges and nearly straight root edges. Lower ANTERIORS differentiated, very high, narrow, deep, smooth-edged, or finely serrated, and hook-cusped, with deeply concave crown edges and deeply arched roots; CUSPS either have an entire cutting edge, or have it confined to the cusp tip (hastate teeth), and crown FEET have either CUSPLETS or smooth SHOULDERS. POSTERIOR teeth well differentiated and in several rows and series in both jaws, mostly cuspidate but semi-carinate in the distalmost rows. TOOTH ROW COUNTS 27–37/26–34. TOOTH SERIES 1–3/1–4, with posteriors in more functional series than anteriors and laterals. Primary CUSPS broad-based in upper anterolaterals, narrow-based in lower laterals and in some posteriors.

No lateral dermal KEELS on CAUDAL PEDUNCLE. PRECAUDAL PITS fossate and longitudinally elongated on upper and lower caudal origins.

PECTORAL FINS broad, their lengths 0.6–0.7 of their anterior margin lengths. PELVICS moderately large, their anterior margins 0.25–0.44 of pectoral anterior margins. FIRST DORSAL origin far anterior, over last half of pectoral bases. Midpoint of first dorsal base much closer to pectoral bases than pelvic bases. SECOND DORSAL rather large but noticeably smaller than first, height 0.5–0.7 of first dorsal height, base length 0.5–0.6 of first dorsal base. ANAL FIN distinctly smaller than second dorsal, height about 0.76–0.9 of second dorsal height, base length 0.7–1.0 of second dorsal base. Anal origin usually under first third of second dorsal base, sometimes nearly opposite its origin. Anal posterior margin deeply or broadly concave.

CRANIAL morphology little-known, here derived from radiographs of Indian, New Guinean and Australian species. ROSTRAL CARILLAGES moderately long and slender, length of medial about 2.4 in nasobasal length or greater. Distance between bases of LATERAL ROSTRALS about 1.1–1.7

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Sharks of the Order Carcharhiniformes
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in length of MEDIAL ROSTRAL. ROSTRAL NODE probably with a broad fenestra. NASAL CAPSULES broad, depressed, and transversely expanded, with their widths about 1.8 times their lengths. Anterior margin of nasal capsules slightly undulated and medially concave, convex laterally. Width across nasal capsules about 1.1–1.2 times nasobasal length. Shape of NASAL APERTURES uncertain, confined to anteroventrolateral surfaces of nasal capsules. ECTETHMOID CONDYLES low. ORBITONASAL FORAMINA visible in dorsal view of cranium. SUBETHMOID FOSSA broad and short. ANTERIOR FONTANELLE without an EPIPHYSIAL FORAMEN or an anteriorly expanded dorsal edge. BASAL PLATE very broad at orbital notches, its width greater than distance across the orbital walls above it and about 1.8–2.1 in nasobasal length. Nature of stapedia and internal carotid foramina uncertain, BASAL PLATE strongly arched. PREORBITAL PROCESSES small, probably reduced distally. POSTORBITAL PROCESSES very long and slender, with lengths about 3.8–4.2 in nasobasal length. SUBORBITAL SHELVES narrow, edges probably nearly parallel to each other and only slightly wider than basal plate at orbital notches. A broad SUBORBITAL LEDGE present between suborbital shelf and nasal capsule on each side of cranium. Shape of ORBITS probably elongated, wedge-shaped, and anteriorly depressed. Lateral profiles of OTIC CAPSULES abruptly delimited anteriorly at their junction with the orbital walls in dorsal view of cranium.

TOTAL VERTEBRAL COUNTS 149 to at least 217. The surviving syntype of *G. gangeticus* (MNHN 1141) has 160 total centra, with 31.2% MP, 18.7% DP, and 50.0% DC centra, DP/MP ratio of 0.8, DC/MP ratio of 1.3, *A* ratio of 159.5, and *B* ratio of 100; in two New Guinea *Glyphis* sp. with 149 total centra there are 31.1% MP, 22.3% DP and 46.6% DC centra, DP/MP ratio of 0.7, DC/MP ratio of 1.5, *A* ratio of 132, and *B* ratio of 100; in one Australian *Glyphis* with 217 total centra there are 32.3% MP, 24.9% DP, and 42.9% DC centra, DP/MP ratio 0.8, DC/MP ratio 1.3, *A* ratio 128, and *B* ratio 60. Last few MP centra somewhat enlarged before MP-DP transition in New Guinea *Glyphis* but not in Australian species. SIZE at maturity uncertain but probably rather large, approximately 2 m. COLOR light brown or gray dorsally, ventral surface white, no prominent markings but fins dusky in some species.

Additional Descriptive Data

EYES very small, their lengths about 0.3 to 0.4 in length of third gill opening, without notches. SPIRACLES absent. ANTERIOR NASAL FLAPS moderately long, triangular, broad to narrow, nipple-shaped or not. NOSTRILS about 1.0 to 3 times as far from snout tip as from mouth. PRENARIAL GROOVES absent. LABIAL FURROWS very short, length of uppers much less than nostril width, lower labial furrows hidden when mouth is closed, presence of LABIAL CARTILAGES uncertain.

TOOTH ROW GROUPS include upper MEDIALS or ALTERNATES, lower MEDIALS, and ANTERIORS, LATERALS, and POSTERIORS in both jaws; SYMPHYSIALS variably present or absent in lower jaw. TOOTH ROW FORMULA $A1$ or $M1/M1$, $S0/0$ or 1 ; $A2/2$, $L8-9/6-9$, $P3-4/3-6$. TOOTH CUSPS erect on anteriors, erect to moderately oblique on laterals, strongly oblique to obsolete on posteriors. CUSPLETS absent on all teeth, except symphysials and anteriors in at least the young of some species. TOOTH CROWNS vary from very high in anteriors to low in posteriors. BASAL LEDGES and GROOVES absent from teeth.

No INTERDORSAL RIDGE. CAUDAL PEDUNCLE not compressed or slightly compressed. Crowns of LATERAL TRUNK DENTICLES transversely oval in young, with three strong ridges and short and stout to weak cusps.

Posterior margin of PECTORAL FIN nearly straight to moderately concave. Pectoral origins below fourth gill openings or interspace between third and fourth gill openings. FIRST DORSAL insertion well anterior to pelvic origins, free rear tip well anterior or about over pelvic origins. Posterior margin of SECOND DORSAL weakly to moderately concave in young, its inner margin short and less than fin height. ANAL insertion opposite, slightly anterior or slightly posterior to second dorsal insertion, by 0.25 of second dorsal base or less. Postventral CAUDAL margin deeply notched, with the lower postventral margin inclined posteroventrally to the tip of the ventral caudal lobe. Lateral undulations well-developed in dorsal caudal margin.

ROSTRAL CARTILAGES not hypercalcified in young. Dorsal edges of LATERAL ROSTRAL CARTILAGES ending before anterior fontanelle. Base of MEDIAL ROSTRAL CARTILAGE slightly expanded.

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ANTERIOR FONTANELLE width 2.6–3.1 in nasobasal length. Distance from base of medial rostral cartilage to dorsal lip of anterior fontanelle about 4.2–5.7 in nasobasal length. Length of OTIC CAPSULES about 1.8 in nasobasal length, width across them 1.4 in nasobasal length. HYOMANDIBULAR FACETS large, triangular, and somewhat exerted from the occiput. VERTEBRAL COLUMN without a stutter zone of alternating long and short centra. REPRODUCTION probably viviparous, due to the large size of the umbilical scar in newborn individuals.

Nomenclature

Fowler (1941) and Bigelow & Schroeder (1948) assumed that Agassiz's (1843) description of *Glyphis* included only a single species, the fossil *G. hastalis*, which they erroneously considered the type by monotypy. However, Agassiz (1843) based his description of *Glyphis* primarily on a living species, *Carcharias (Prionodon) glyphis* Müller & Henle, 1839, which he mentioned in its text, but also proposed *G. hastalis* as a new fossil species. Elsewhere in the same work Agassiz (1845, tab. mal. 3c: 7) stated that *Glyphis* included "une espece vivante et une fossil de l'Argile de Londres, le *Gl. hastalis*." Agassiz did not designate a type for *Glyphis*, but this must be *C. (P.) glyphis* by absolute tautonymy under the International Code of Zoological Nomenclature.

Bigelow & Schroeder (1948) indicated 1838 as the earliest citation for *Glyphis*, on a plate caption for *G. hastalis*. However, according to Woodward & Sherborn's (1890) account of the publication dates of Agassiz's *Poissons Fossils*, the plate in question (Atlas, vol. 3, pl. 36) was published in 1845 and hence postdates the detailed text description of *Glyphis*.

Fowler (1928, 1941) used *Glyphis* to replace *Prionace* Cantor, 1849 as a generic name for the blue shark, *P. glauca* (Linnaeus, 1758). Apart from the subsequent designation of *Prionace* as the generic name of the blue shark by the International Commission on Zoological Nomenclature (Opinion 723, 1965), Fowler's proposition is erroneous because neither the living type species of *Glyphis* nor the fossil *G. hastalis* is congeneric with the blue shark.

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Classification

Two little-known carcharhinid species, *Carcharias (Prionodon) glyphis* Müller & Henle, 1839 and *C. (P.) gangeticus* Müller & Henle, 1839 have been generally included in the genus *Carcharhinus* Blainville, 1816 or its synonyms *Carcharias* Cuvier, 1816, *Galeolamna* Owen, 1853, and *Eulamia* Gill, 1862. However, Garrick (1982 and *pers. comm.*) removed both species from *Carcharhinus*, without placing them in a genus, but suggested that the two were related.

Previously Compagno (1979) hesitated to exclude these species from *Carcharhinus*, but at the time had only seen a pair of jaws and some photos and radiographs of a New Guinean shark then referred to *C. glyphis* but now considered *Glyphis* sp. indet., near *G. glyphis*. Compagno (1979) noted: "In the absence of adequate study material I prefer to submerge them in *Carcharhinus* in a group along with *C. leucas* and *C. amboinensis*, which apparently are their closest relatives in the genus. *C. amboinensis* and *C. leucas* agree in all the characters uniting *glyphis* and *gangeticus* except for their smaller second dorsal fins (in *C. leucas* approaching *C. gangeticus* in size), transverse, crescentic precaudal pits, and lower-crowned teeth. *C. sealei* from the western Indian Ocean and *C. melanopterus* also approach *C. gangeticus* in second dorsal size, and *C. altimus* and *C. plumbeus* in the height and shape of their upper anterior teeth." Also, the chondrocranium of three species of *Glyphis* (as reconstructed from radiographs) agrees with that of *C. leucas* and *C. amboinensis* in having strong sub-orbital ledges in the orbital notches and with *C. leucas* in having reduced, striplike preorbital processes.

Since writing the account quoted above, I examined a specimen of *C. gangeticus* in the Zoological Survey of India, Calcutta, in 1982 and was able to directly compare it with specimens of *C. leucas* and *C. amboinensis*. This convinced me that Garrick (1982 and *pers. comm.*) was correct in removing this species and *C. glyphis* from *Carcharhinus*. As Garrick had left the two species as "orphans" in the Carcharhinidae, I resurrected the genus *Glyphis* for *C. glyphis* and *C. gangeticus* (Compagno, 1984b, c). Through the agency of Mr. Jeff Johnson of the Queensland Museum, I was able to examine a specimen of *Glyphis* sp. from the Bizant River, Queens-

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land in 1985 and found it to be remarkably similar to the Calcutta specimen of *G. gangeticus* in many details, although it has a larger second dorsal fin as in *Glyphis glyphis* and differs in other details. Subsequently, through the agency of Dr. B. Seret of the Museum National d'Histoire Naturelle, Paris, I examined the syntype of *C. gangeticus* in 1986, which further confirmed the validity of this genus. A detailed account of these specimens will be published elsewhere.

Glyphis species resemble *C. leucas* and *C. amboinensis* in their relatively short, blunt, broadly rounded snouts, small eyes, broadly triangular upper teeth, heavy bodies, no interdorsal ridges, first dorsal origin over the pectoral bases, second dorsal origin often somewhat anterior to anal origin, and lack of conspicuous color pattern. However, *Glyphis* is readily separable from *Carcharhinus* by a number of characters apart from fossate precaudal pits. *Glyphis* species have anterior teeth with elongated strongly curved, hooked cusps which usually protrude from the mouth even when closed, but in *Carcharhinus* the lower cusps are shorter, straighter, and do not protrude when the mouth is closed. Also, the eyes of *Glyphis* species are smaller than in *Carcharhinus*, although, with negative allometry of eye diameter with growth, large individuals of small-eyed *Carcharhinus* species such as *C. leucas* overlap small *Glyphis* in eye diameter. *Glyphis* species have their eyes uniquely elevated on the dorsal surface of the horizontal head rim, with ventral eye margins opposite or above the nostrils, which gives a more dorsolateral visual field. *Carcharhinus* species have their eyes on the horizontal head rim, with their ventral edges below or exceptionally opposite the incurrent apertures of the nostrils; most species have a lateral or ventrolateral visual field (*C. melanopterus*). The gill openings of *Glyphis* species decrease in size from first to fifth, while the third or fourth gill openings are larger than the first in *Carcharhinus*. The second dorsal fin of *Glyphis* species is relatively larger, with height 0.5–0.7 of the first dorsal height, but usually below 40% in *Carcharhinus* species; as noted above, *C. melanopterus* and *C. sealei* approach *Glyphis* in this ratio but do not overlap it (between 40 and 50%).

Lamiopsis is closest to *Glyphis* in dentition, general body form and fossate precaudal pits, and in the previous version of this work (Compagno, 1979) an alternative arrangement suggested by Prof. J. A. F. Garrick (*pers. comm.*) was noted, that

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would include *Glyphis* and *Lamiopsis* species in a single genus, separate from *Carcharhinus*. The two genera are retained here because the lack of knowledge on certain character systems in *Glyphis* (particularly the cranium) and several obvious differences between these genera. *Lamiopsis* differs from *Glyphis* most notably in having a longer, more broadly parabolic snout, with the preoral length nearly equal to mouth width and 1.6–1.8 times interalarial width; larger eyes, situated on the horizontal head rim and with their ventral edges depressed below the level of the horizontal head rim; better differentiated, carinate posterior teeth, in slightly more rows and series; pectoral fins slightly broader, their lengths 0.8–0.9 of their anterior margin lengths; slightly larger pelvises, their anterior margins nearly or quite half (45–51%) of pectoral anterior margin lengths; more posterior first dorsal, with origin over pectoral inner margins and base midpoint only slightly closer to pectoral bases than to pelvic bases; second dorsal nearly as large as first, height 0.75–0.88 of first dorsal height and base length 0.75–0.80 of second dorsal base; and anal posterior margin nearly straight to shallowly concave.

Species

At least two described species definitely fall in this genus, the GANGES SHARK, *Glyphis gangeticus* (MÜLLER & HENLE, 1839) and the SPEARTOOTH SHARK, *Glyphis glyphis* (MÜLLER & HENLE, 1839). A third species, *Carcharias murrayi* Günther, 1883 may belong to this genus and possibly is a synonym of the Ganges shark, and a fourth species, *Carcharias (Prionodon) siamensis* Steindachner, 1896 may be either a *Glyphis* or a synonym of *Carcharhinus leucas*. Material from the Western Pacific under study by Prof. J. A. F. Garrick suggests that there are three species of *Glyphis* respectively from Queensland, Australia, New Guinea, and Borneo, but their identity with described species is uncertain at present (J. A. F. Garrick, *pers. comm.*).

Müller & Henle (1839) described *Carcharias (Prionodon) gangeticus* from two specimens: a large, stuffed adult or adolescent male "5 1/2 Fuß" or an estimated 178 cm. long, (assuming the use of a 27 mm. inch in Germany at the time according to R. Rosa, *pers. comm.*), in the Zoologisches Museum, Humboldt Universität, Berlin; and a 564 mm. newborn male preserved in alco-

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hol, MNHN 1141. The Berlin specimen was apparently lost but MNHN 1141 is still in existence (J. A. F. Garrick, M.-L. Bauchot, *pers. comm.*) and was examined by me. As Müller & Henle did not designate either of the *C. (P.) gangeticus* specimens as types, they should be considered syntypes. According to Müller & Henle (1839) the type locality is "Im Ganges, 60 Stunden oberhalb des Meers bei Hougly gefangen." (In the Ganges, captured in the Hooghly River 60 leagues above the sea). Dumcnil (1865) expanded on this and noted that only the Berlin syntype had been collected from the Hooghly River, but that the Paris syntype was known only from a vague "Bengale." The place where the Berlin syntype was collected, although difficult to determine accurately without place-names, would be 240 km (150 mi) up the Hooghly River in West Bengal, well upriver from Calcutta and possibly near the city of Nabadwip.

Günther (1870) suggested that *Carcharias leucas* was doubtfully distinct from *Carcharias gangeticus*, while Lineaweaver & Backus (1969) and Ellis (1975, 1983) considered the Ganges shark a synonym of the bull shark, *Carcharhinus leucas*. However, Garrick & Schultz (1963), Boesman (1964), and Garrick (1967, 1982) recognized both as valid species, which was confirmed by my direct comparison of Indian specimens of *Carcharhinus leucas* and *Glyphis gangeticus*.

Günther (1883) described *Carcharias murrayi* from another stuffed specimen, 6 ft 8 in 6 lines (about 2044 mm.) long, from "Kurrachce, India" (= Karachi, Pakistan), which is also lost (Garrick, 1982). Garrick (1982) noted that *C. murrayi* was like *Carcharhinus leucas* in several details, but had *gangeticus*-like lower teeth with small cusplets (illustrated in Günther's description) and a second dorsal considerably larger than the anal fin. Fowler (1941) synonymized *C. murrayi* with *Carcharias ellioti* Day, 1878, but this is erroneous because the latter is clearly a synonym of *Hemipristis elongatus*. Compagno (1984b, c) listed *Carcharias murrayi* as a tentative junior synonym of *C. (Prionodon) gangeticus* on the evidence of its tooth morphology and type locality on the Indian subcontinent, but its identity must remain uncertain due to the sketchiness of Günther's (1883) description of the species and the loss of its holotype. Garrick (1982) noted that its type locality, Karachi, is situated on the Indus river delta, making a freshwater locality for *murrayi* possible.

Another possible *Glyphis* is *Carcharias (Prion-*

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odon) siamensis, described by Steindachner (1896) from a 630 mm. long specimen from the mouths of the Irrawaddy River near Rangoon, Burma, and possibly in fresh or brackish water. Garrick (1982) suggested similarities of this species with *Carcharhinus leucas* on its short, broad, blunt snout, small eye, second dorsal fin slightly larger than the anal fin and originating in front of it, and interdorsal space 3.25 times the second dorsal base (in comparison, this is only 2.7 in the two young *gangeticus* examined here). Although *siamensis* may be based on *leucas* the species is *Glyphis*-like in its smaller eye, said to be only 4.4 mm. long (0.7% of total length), and slightly higher tooth row count, 29/29. Determination of the identity of *siamensis* will require reexamination of its holotype, which may be in the Naturhistorisches Museum, Vienna; however Garrick (1982) had not examined the holotype and did not know if it still existed. Following Garrick (1982), I consider *C. (P.) siamensis* a species *dubium*, in *Carcharhinus* or possibly *Glyphis*.

Müller & Henle (1839) described *C. (P.) glyphis* from a stuffed specimen about 948 mm. long without locality (J. A. F. Garrick, *pers. comm.*) in the Zoologisches Museum, Humboldt Universität, which may no longer exist. From Müller & Henle's account *G. glyphis* differs from the similar *G. gangeticus* in its hastate-cusped lower anterior teeth, without cusplets on the crown feet, fewer anteroposterior tooth rows (13/13 vs 14-18/16-17), and a higher second dorsal fin (5.4% of total length, vs 4.4-4.7%). Prof. J. A. F. Garrick (*pers. comm.*) has obtained additional specimens of *Glyphis* sharks from New Guinea, Borneo, and Queensland, Australia with higher second dorsal fins as in *G. glyphis*. However, these may represent two or even three species, as the sharks from each locality differ considerably from one another in vertebral counts (J. A. F. Garrick, unpub. data) and partially in tooth row counts and tooth morphology. Specimens from New Guinea and Borneo approach *G. gangeticus* in their anteroposterior tooth counts (14-16/13-16 on each side) but have either hastate or nonhastate lower anterior teeth and either somewhat lower (147) or higher (203) total vertebral counts (160 in Paris syntype of *G. gangeticus*). A specimen from Queensland has nonhastate lower anterior teeth with basal cusplets as in *G. gangeticus*, but only 13/12-13 rows of anteroposterior teeth and a much higher vertebral count (217) and larger second dorsal fin. At present it is uncertain which of these specimens, if

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Glyphis gangeticus (Fig. 19.12). The presence of the bull shark, one of the three most dangerous living species (Compagno, 1984b), in the Hooghly River suggests that shark attacks attributed to the Ganges shark must be considered uncertain at best, and their frequency no indication of its abundance. *Glyphis gangeticus* has much narrower, higher upper teeth and slender-cusped, less heavily built lower teeth, that appear more suitable for fish-impaling and less useful for dismembering tough mammalian prey than the stout, massive teeth of *Carcharhinus leucas*. The true Ganges shark may very well be less inclined to attack people than the bull shark.

Sharks are currently caught in the Ganges system (P. K. Talwar, *pers. comm.*, 1982), but it is uncertain as to what proportion of the catch is Ganges sharks as opposed to bull sharks. Unfortunately, because of political unrest in West Bengal and limited time on my visit to India in 1982, I was unable to accomplish any fisheries surveys along the Hooghly River or collect more Ganges sharks and bull sharks.

It is not possible at present to confirm or deny that the Ganges shark is confined to fresh water or fresh and brackish water, although so far no *Glyphis gangeticus* have been reported from undoubted salt water. If confined to fresh water, *G. gangeticus* would be unique among living sharks.

Glyphis glyphis is without locality, although, as

From Compagno, 1988
Sharks of the Order Carcharhiniformes
Princeton U. Press

noted above, similar *Glyphis* sharks occur on Borneo and New Guinea, and in Australia. The Australian shark was caught a short distance up the Bizant River, Queensland, possibly in fresh water but more likely in brackish or salt water because of the mangrove habitat of the river where it was captured (J. A. F. Garrick, *pers. comm.*, J. Johnson, *pers. comm.*).

Study Material

Glyphis gangeticus: ZSI 8067, 610 mm. newborn female, Hooghly River, West Bengal, India; MNHN 1141, 561 mm. immature free-living male, SYNTYPE of *Carcharias (Prionodon) gangeticus* Müller & Henle, 1839, "Bengal" (also morphometric data, tooth and vertebral counts on the same specimen provided by Prof. J. A. F. Garrick).

Glyphis sp.: LWF-E-218, immature female est. 1.6–1.8 m., Port Romilly, New Guinea (jaws only). Also radiographs and photos of LWF-E-227 and E-294, both 720 mm. immature males from New Guinea (from J. A. F. Garrick).

Glyphis sp.: QM 1.19719, 745 mm. immature male, 17 km. upstream from river mouth at 2 m. depth, March 23, 1982, Bizant River, between Kennedy and Normanby Rivers, Princess Charlotte Bay, Queensland, Australia.

GENUS *LAMIOPSIS* GILL, 1862: BROADFIN SHARK

Genus *Lamiopsis* Gill, 1862b, pp. 401, 410. Type species: *Carcharias (Prionodon) temmincki* Müller & Henle, 1839 by original designation.

Illustrations

FIGURES 19.14 (cranium); PLATES 14B (lateral view), 19:48–49 (teeth), 27C (denticles),

Introduction

Lamiopsis includes a single species of locally common, moderate-sized inshore sharks of the Indo-West Pacific, closely related to the river sharks

(*Glyphis*) and occasionally confused with them. The large second dorsal fin and dentition distinguishes it from other similar sharks.

Definition

Stout carcharhinine sharks with broad and moderately depressed heads and snouts. SNOUT broadly parabolic or subangular in dorsoventral view. PREORAL LENGTH nearly equal to mouth width and 1.6–1.8 times interocular width. Ventral edges of EYES below level of nostrils, the midheights of eyes about opposite the incurrent apertures. No brow ridge above eyes. Eyes circular. No GILL RAKERS.

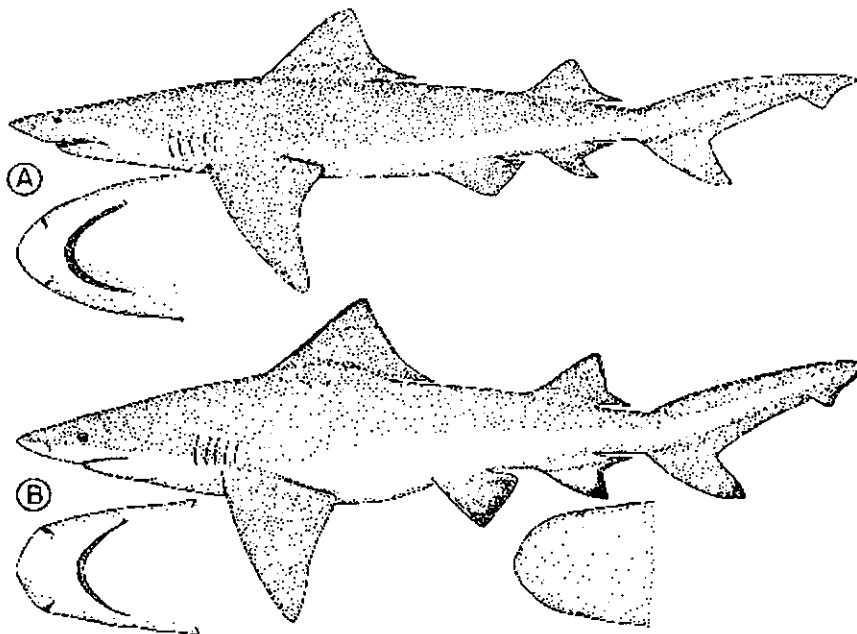


FIGURE 19.11. Lateral views of A. *Glyphis glyphis*, based on Müller & Henle's (1839-1841, pl. 14) illustration of the stuffed holotype, about 90 cm. long, snout restored from other *Glyphis* material. B. *Glyphis* sp., QM-I.19719, 745 mm. immature male, Bizant River, Queensland, Australia.

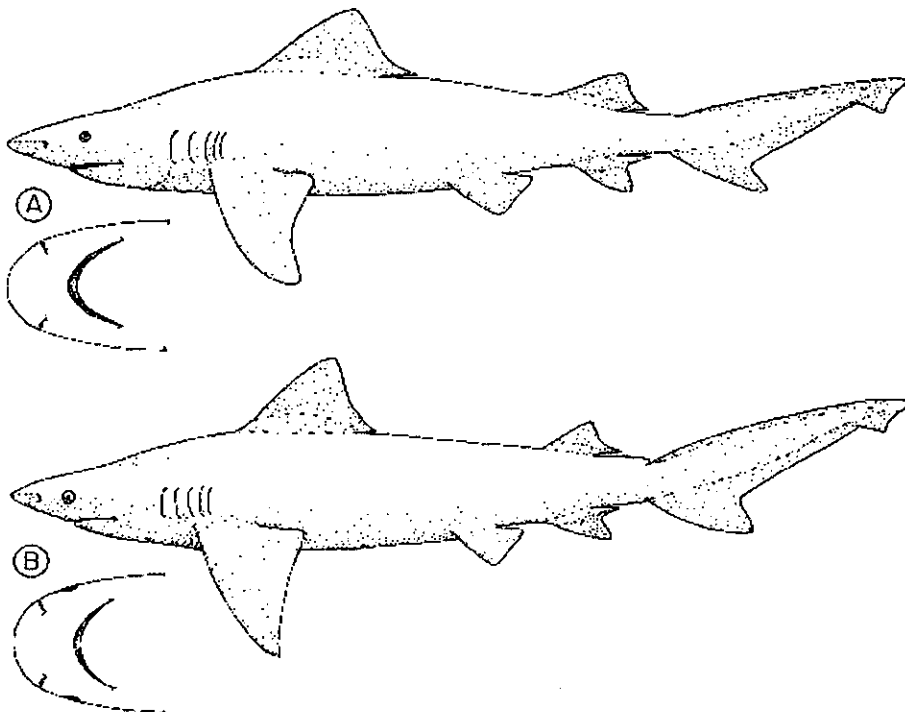


FIGURE 19.12. Freshwater sharks from the Hooghly River, West Bengal. A. The true Ganges shark, *Glyphis gangeticus*, ZSI-8067, 610 mm. newborn female. B. The bull shark, *Carcharhinus leucas*, ZSI-10250, 650 mm. newborn male. Both specimens collected by Dr. J. Anderson on April 4, 1867.

Attachment 5

Reproduced Text on Glyphis from Talwar and Jhingran (1991)

Colour: in life, slaty-grey, paler below, with numerous dark or brown variegated spots, or vertical bars on body, and also on pectoral, dorsal and caudal fins, faded or obsolete in adults.

Geographical Distribution: All tropical Oceans.

Inhabits inshore coastal waters to offshore waters, sometimes entering brackish waters and river mouths.

Fishery Information: A good fishery of the tiger shark exists on the east coast of India from June to March, but reports of this species from our inland waters are scanty. Considered as one of the most dangerous sharks because of its occurrence in shallow waters, its large teeth and size, and its indiscriminate appetite. This is the only ovoviviparous carcharhinid.

Genus *Glyphis* Agassiz

Glyphis Agassiz, 1843, *Poiss. Foss.*, 3: 243 (type-species: *Carcharias glyphis* Muller & Henle); Compagno, 1984, *FAO Fish. Synop.*, (125) 4(2): 506–509 (Review).

Diagnosis:

Body fairly stout. Head broad and flattened; snout short and broadly rounded in dorsoventral view. Eyes extremely small. Spiracles absent; nostrils small, widely spaced; internarial space 3 to 6 times the nostril width. Labial furrows short, essentially confined to mouth corners. Teeth strongly differentiated in both jaws; upper anteroposteriors with more or less erect, broad, triangular cusps, no cusplets or blades, and fine serrations; lower with or without cusplets (on first few anterior teeth) or blades but with variably oblique to erect, long cusps and with serrations generally absent; cusps of lower teeth prominently protruding when mouth is closed. First dorsal fin inserted far anterior, over last thirds of pectoral bases, midbase much closer to pectoral bases than to pelvic fins; second dorsal fin much smaller than first fin, its height about half as high as first, its origin slightly anterior to anal fin. Anal fin with preanal ridges virtually absent and with a deeply notched posterior margin. Colour grey or brown above, without a colour pattern. Large sharks to at least 2 m.

This genus includes the poorly known freshwater and estuarine sharks of the Indian Ocean and Western Pacific. Two species; one in the Indian area.

Glyphis gangeticus (Muller & Henle)

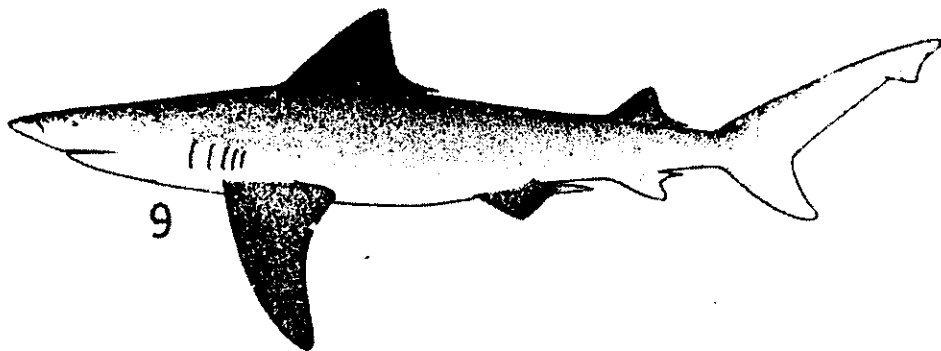
(fig. 9)

Carcharias (Prionodon) gangeticus Muller & Henle, 1839, *Syst. Besch. Plagiost.*, (2): pl. 13 (type-locality: Ganges R.).

Carcharias gangeticus: Day, 1878, *Fishes of India*: 715, pl. 187, fig. 1; Day, 1889, *Fauna Br. India, Fishes*, 1: 13.

? *Carcharias murrayi* Gunther, 1887, *Ann. Mag. nat. Hist.*, (5)11: 137 (type-locality: Karachi, Pakistan).

Carcharhinus gangeticus: Misra, 1969, *Fauna of India, Pisces* (2nd ed.), 1: 63, fig. 19.

*Common Name:*

Ganges shark ... English

Distinguishing Characters:

Body fairly stout, with a broadly rounded short snout. Eyes minute. Upper teeth with high, broad, serrated triangular cusps; lower anterior teeth with long, hooked, protruding cusps having unserrated cutting edges, giving the cusps a clawlike shape, and low cusplets. First dorsal fin high, inserted over rear ends of pectoral bases; second dorsal fin rather large, about half height of first dorsal fin. Upper precaudal pit longitudinal.

Colour: in life, grey on back, becoming dull white on belly. Fins greyish; posterior edge of caudal fin rather dark.

Geographical Distribution: Pakistan and India.

Inhabits inshore and marine estuarine habitats, ascend rivers.

Fishery Information: This species is famed for its occurrence in the Ganga-Hooghly river system. This species is reputed to be dangerous to people in the Ganga river. Probably fished in the Ganga-Hooghly system but more work is needed since this is a poorly known species. This species has been reported from the Chilka lake (Orissa) but this needs confirmation.

Genus *Lamiopsis* Gill

Lamiopsis Gill, 1862, *Ann. Lyceum Nat. Hist. New York*, 7: 401 (type-species: *Carcharias temmincki* Muller & Henle); Compagno, 1984, *FAO Fish. Synop.*, (125) 4(2): 511-513 (Review).

Diagnosis:

Body fairly stout. Head broad and flattened; snout broadly parabolic in dorsoventral view and moderately long, as long as mouth width. Eyes fairly small; spiracles absent; anterior nasal flaps short, broadly triangular. Labial furrows short, essentially confined to mouth corners, falling far behind eyes. Teeth strongly differentiated in both jaws; upper anteroposteriors with erect, broad, triangular cusps, no cusplets or blades, and serrations; lowers with smooth, hooked, narrow cusps. Second dorsal fin as large as first dorsal fin, its origin about opposite to anal fin origin.

Monotypic.

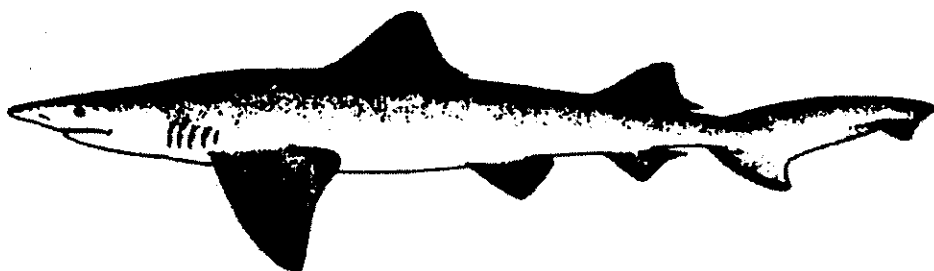
Lamiopsis temmincki (Muller & Henle)

(fig. 10)

Carcharias (Prionodon) temmincki Muller and Henle, 1839, *Syst. Besch. Plagiost.*, (2): 48, pl 18 (type-locality: Pondicherry).

Carcharias temminckii: Day, 1878, *Fishes of India*: 717; Day, 1889, *Fauna Br. India*, Fishes, 1: 17.

Carcharhinus temminckii: Misra, 1969, *Fauna of India*, Pisces (2nd ed.), 1: 74, fig. 24.

*Common Name:*

Broadfin shark ... English

Distinguishing Characters:

A small, rather stocky shark. Snout moderately long, nearly equal to mouth width. Eyes small and rounded, with a nictitating eyelid. Upper teeth serrated and with broad triangular cusps; lower teeth with smooth, hooked, narrow cusps. Second dorsal fin nearly as large as first fin. Pectoral fins broad and triangular. No dermal ridge between dorsal fins, and no keels on caudal peduncle.

Colour: in life, grey or yellow-grey above, lighter below; no conspicuous markings.

Geographical Distribution: Pakistan, India, Burma, Indonesia and China.

Inhabits inshore waters, often enters estuaries.

Fishery Information: This small, stocky shark rarely enters the Hooghly estuary (West Bengal) and is of no interest to fisheries in Indian inland waters. Not known to be dangerous to people. It attains a size of 170 cm.

Genus *Rhizoprionodon* Whitley

Rhizoprionodon Whitley, 1929, *Aust. Zool.*, 5(4): 354 (type-species: *Carcharias crenidens* Klunzinger); Springer, 1964, *Proc. U.S. natn. Mus.*, 115(3493): 590-630 (Revision); Compagno, 1984, *FAO Fish. Synop.*, (125) 4(2): 524-533 (Review).

Diagnosis:

Body fairly slender to moderately stout. Head fairly broad, only moderately depressed; snout narrowly to broadly parabolic or obtusely wedge-shaped in

dorsoventral view. Eyes rather large, without notches; spiracles absent. Nostrils small and widespaced. Labial furrows short to rather long, with uppers shorter or longer than lowers but falling far behind eyes. Teeth similar in upper and lower jaws, small, oblique and narrow-cusped, with distal blades and serrations variably present or absent but without cusplets; cusps of lower teeth *not* prominently protruding when mouth is closed. Interdorsal ridge absent or rudimentary; no dermal keels on caudal peduncle; upper precaudal pit transverse and crescentic. First dorsal fin inserted usually over pectoral inner margins; second dorsal fin much smaller than first dorsal and about 1/3 height of first or less, inserted about over anal insertion. Anal fin considerably larger than second dorsal, with long preanal ridges and a straight or slightly concave posterior margin.

Small sharks, adults not exceeding 1.3 to 1.5 m and most smaller than 1 m. Seven species; two in Indian area of which only one inhabits the estuaries.

KEY TO SPECIES

- 1 (a) Upper labial furrows long and rather prominent, about eye length ... *R. acutus*
 (b) Upper labial furrows very short and often inconspicuous, much less than eye length ... *R. oligolinx**

Rhizoprionodon acutus (Ruppell)

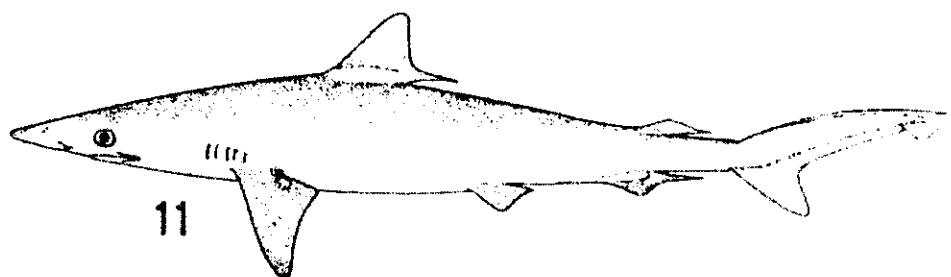
(fig. 11)

Carcharias acutus Ruppell, 1837, *Neue Wirbel. Fauna Abyssinien, Fische Rothen Meeres*, (11): 65, pl. 18, fig. 4 (type-locality: Djedda, Red Sea).

Carcharias walbeehmii Bleeker: Day, 1878, *Fishes of India*: 712, pl. 185, fig. 2.

Carcharias walbeehmi: Day, 1889, *Fauna Br. India, Fishes*, 1: 10.

Scoliodon walbeehmi: Misra, 1969, *Fauna of India, Pisces* (2nd ed.), 1: 49.



Common Name:

Milk shark ... English

* *Rhizoprionodon oligolinx* Springer does not enter Indian inland waters.

Distinguishing Characters:

Body fairly slender and fusiform. Snout long and depressed, its tip narrowly rounded. Labial furrows well developed and moderately long, upper ones about equal in length to eye-diameter and ending well behind eyes. First dorsal fin inserted over or posterior to inner corners of pectoral fin. Anal fin with very long preanal ridges.

Colour: in life, grey or grey-brown above, white below. Dorsal and anal fins with dusky or blackish edges, fins slightly darker than back.

Geographical Distribution: Indo-west Pacific and the Eastern Atlantic.

Inhabits inshore and offshore waters of continental shelves, sometimes in estuaries.

Fishery Information: The name 'milk shark' refers to the use of its flesh in India to promote lactation in women. Though this shark supports rich artisanal and commercial fisheries in inshore waters of Indian region, it is of minor interest to fisheries in inland waters.

Genus *Scoliodon* Muller & Henle

Scoliodon Muller and Henle, 1837, *Sitzb. Akad. Wiss. Berlin*: 144 (type-species: *Scoliodon laticaudus* Muller & Henle); Springer, 1964, *Proc. U.S. natn. Mus.*, 115(3473): 573–583 (Revision); Compagno, 1984, *FAO Fish. Synop.*, (125) 4(2): 533–535 (Revision).

Diagnosis:

Body moderately stout. Head broad, greatly depressed and trowel-shaped; snout parabolic or bell-shaped in dorsoventral view, very long, with preoral length greater than internarial space and mouth width. Eyes small, without posterior notches; spiracles absent. Labial furrows very short to rudimentary, with uppers shorter than lowers and falling far behind eyes; teeth similar in upper and lower jaws. Interdorsal ridge absent or rudimentary; no dermal keels present on caudal peduncle; upper precaudal pit transverse and crescentic. First dorsal fin inserted over or behind pectoral rear tips; second dorsal fin much smaller than first. Pectoral fins very broad and triangular, its length from origin to free rear tip about equal to pectoral anterior margin. Anal fin much larger than second dorsal fin, its origin anterior to second dorsal fin origin.

Monotypic.

Scoliodon laticaudus Muller & Henle

(fig. 12)

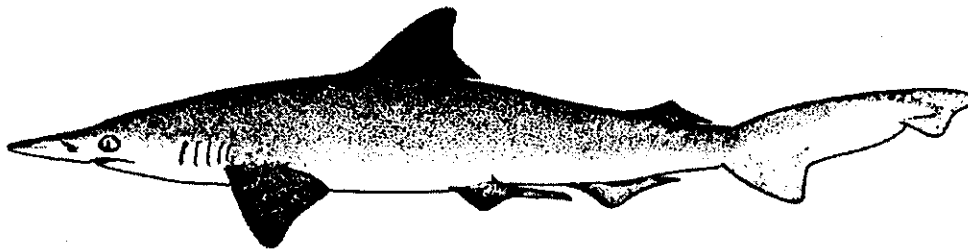
Scoliodon laticaudus Muller and Henle, 1838, *Syst. Besch. Plagiost.*, (1): 27 (type-locality: "Aus Indien").

Carcharias laticaudus: Day, 1878, *Fishes of India*: 712, pl. 188, fig. 1; Day, 1889, *Fauna Br. India, Fishes*, 1: 9, fig. 1.

Carcharias mulleri Valenciennes: Day, 1878, *Fishes of India*: 713; Day, 1889, *Fauna Br. India, Fishes*, 1: 11.

Physodon mulleri (Valenciennes): Misra, 1969, *Fauna of India*, Pisces (2nd ed.), 1: 43.

Scoliodon sorrakowah (Cuvier): Misra, 1969, *Fauna of India*, Pisces (2nd ed.), 1: 47, fig. 14.



Common Name:

Spadenose shark ... English

Distinguishing Characters:

Body slender and fusiform. Head broadly depressed, with a very long, flat, laterally expanded, spade-like snout. Eyes small. Upper labial furrow poorly developed, as a short crease directed at right angle from lower furrow, visible when mouth is closed. Teeth small, smooth-edged, blade-like, with oblique cusps, distal blades and no cusplets. First dorsal fin well rearward on back with its rear tip about over pelvic midbases. Anal fin inserted anterior to second dorsal fin origin. Caudal fin with its postventral margin only moderately concave.

Colour: in life, bronzy grey above, white below, without conspicuous markings. Fins often darker than body.

Geographical Distribution: Indo-west Pacific.

Inhabits inshore and offshore waters, enters brackish waters.

Fishery Information: This shark is fairly common in the lower reaches of the Hooghly estuary and also in the Chilka lake (Orissa). Perhaps smallest among the viviparous elasmobranchs. It attains a length of 75 cm, but most individuals smaller.

Family : SPHYRNIDAE

[Hammerhead sharks]

Body elongate and moderately slender, anterior portion of head much flattened dorsoventrally and widely expanded laterally in "hammer" form, with the eyes at its outer edges. Well developed nictitating eyelids. Mouth inferior; labial furrows vestigial or absent; teeth blade-like, with a single cusp. Two dorsal fins; first high and pointed, its base wholly anterior to pelvic fins; second dorsal and anal fins small. Caudal fin strongly asymmetrical, with a well marked subterminal notch and a small, but well-defined lower lobe; precaudal pits present. Colour predominantly grey or brassy on back, belly whitish. Development viviparous.

Attachment 6

Download from Website of IUCN Shark Specialist Group

Shark Specialist Group

SSG Selections...

SHARK NEWS

SHARK NEWS 9 NEWSLETTER OF THE IUCN SHARK SPECIALIST GROUP JUNE 1997

River Shark Discovered in Sabah

Sarah Fowler, Shark Specialist Group, UK

Specimens of one of the world's most elusive genera of sharks, the river sharks, *Glyphis*, have finally been obtained from Sabah's Kinabatangan River in Northern Borneo. They were discovered over a year after the start of the 18 month Shark Specialist Group's (SSG) Darwin project on Elasmobranch Biodiversity and Conservation in Sabah. This project, funded by the UK Darwin Initiative for the Survival of Species, is being undertaken in cooperation with the Sabah Department of Fisheries, and with help from WWF-Malaysia.

The river shark is the rarest of the very scarce freshwater species of sharks and rays for which the Shark Specialist Group survey team had been searching. The researchers were beginning to believe that the occasional reports of a freshwater shark whose description appeared to match that of the almost mythical Borneo river shark (see box below) would never be substantiated. Heavy rainfall and continual river flooding had severely hampered fieldwork in 1996, preventing successful fishing for river sharks and rays. Only a single small specimen of the giant freshwater stingray (*Himantura chaophyra*) was obtained. But, as the river level eventually began to subside, the message came in from a small riverside kampong (village) on the Kinabatangan River that a shark



It is extremely unlikely that the breakthrough could have been made without the invaluable help of local fishermen who offered their assistance. The villagers were provided with a tank of formalin and a single-use camera in case they caught any freshwater sharks or stingrays while carrying out their usual fishing operations. At last, some months ago, they found several juvenile River Sharks answering to the description of *Glyphis* in one of their nets and carefully preserved one for the researchers. Others were photographed before being discarded. Another four females, about 60 cm in total length (probably new-borns) were taken at the end of May. This time all were kept.

The excitement of those who were shown the first shark had been intense. Darwin Project officer Mabel Manjaji and UK volunteers Rachel Cavanagh and Scott Mycock reported their delight over the find: "The family led us to the tank of formalin which they had been keeping locked up at the back of their stilt house, insisting that they had a shark for us in there. They looked on in bewilderment; we could barely contain ourselves – could it really be *Glyphis*? We all crowded round as the tank was opened, oblivious to the formalin fumes. There it was, black beady eyes, blunt snout, fins like we'd never seen before but just like those in the books – there was no doubt about it: this was *Glyphis*, at last!"

Shark Specialist Group expert, Dr Leonard Compagno (Curator of Fishes and Head of the Shark Research Center, South African Museum) has studied the few existing museum specimens of this group, most of which were collected in the 19th Century. He remarked: "We have very little idea of the geographic distribution of these sharks, much less their general biology. They show up like ghosts, few and far between, in a handful of scattered localities. Finding one is cause for celebration ... External differences between the known species are subtle, but body and fin shape shown in the photos suggest that the Kinabatangan shark may be closer to another undescribed species, *Glyphis* 'species A' from Queensland, Australia, than to the original Borneo river shark."

Fortunately the wet weather last year did not interrupt the remainder of the Darwin project's work programme. Regular visits to coastal fish markets have resulted in the collection and curation of a wide range of sharks and rays from the coastal waters of northern Borneo. Discoveries include some sharks which are completely new to science, as well as new species records for the region. This area has been confirmed as one of the international centres of shark and ray biodiversity.

The collection of sharks and rays made during the Darwin project will be retained in Sabah for future research. It represents a unique resource for biodiversity and taxonomic research in the region. Duplicate specimens will be housed in other international fish collections.

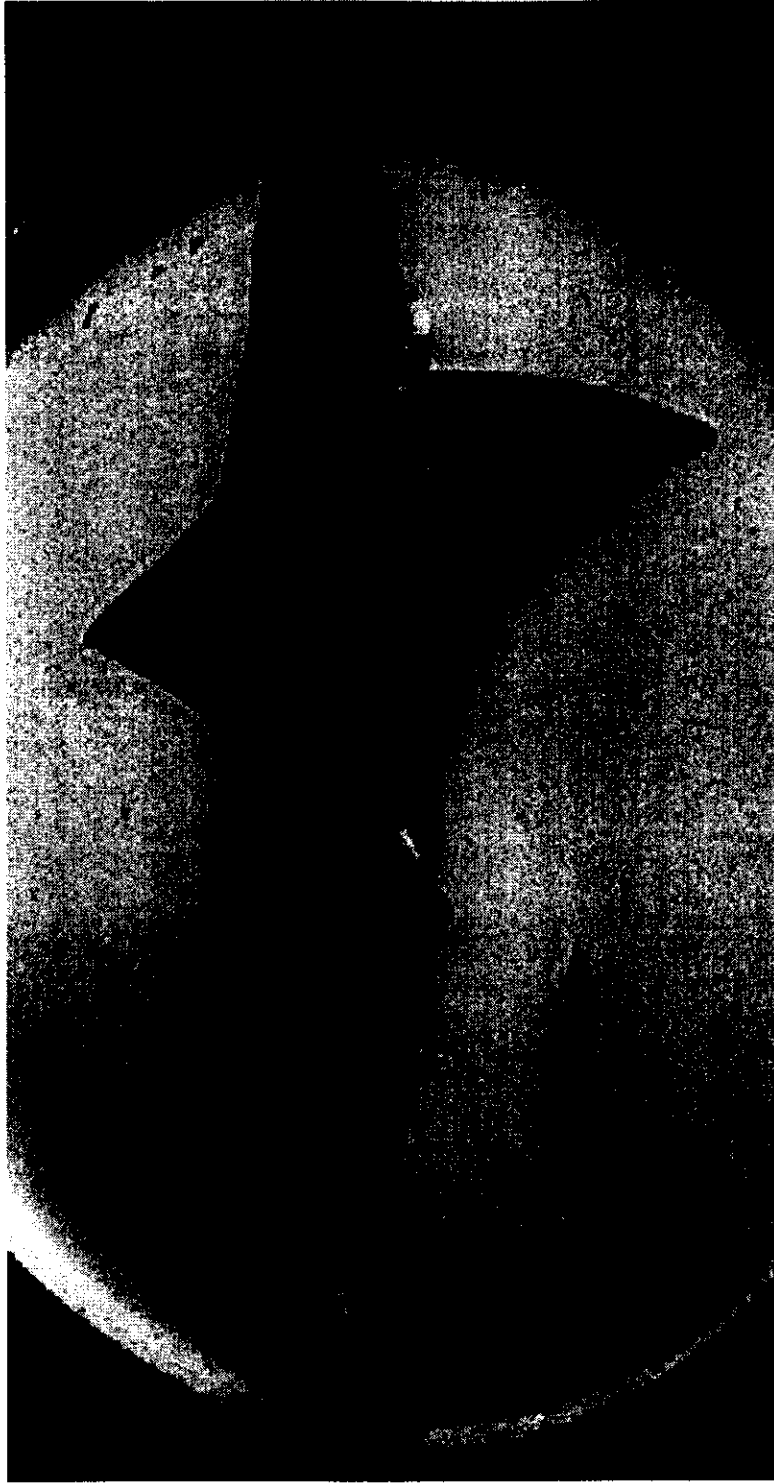
Conservation footnote: The River Sharks were caught as incidental catch in fishing operations targeted at other fish. They were found dead in the nets, not killed by the villagers to provide research specimens, and were not sold, but given to the project team. The Darwin project leaders are anxious that their research programme does not create an artificial market and fishery for these rare species, but educates the local fishermen about the rarity of their freshwater sharks and rays and encourages them to conserve these fish and their habitat.

The genus *Glyphis*, river sharks

These are large sharks, probably reaching about 3 m in length, although most specimens known are juvenile or new-born (because of the difficulty of preserving large adults). The smallest from the Kinabatangan was just 60 cm long and had an open umbilical scar, indicating an age of only one or two months. River Sharks have characteristic small eyes and a relatively large second dorsal fin. Their small eyes and slender teeth suggest that they are primarily fish-eaters adapted to life in turbid river waters. Some may also enter seawater. It is uncertain how many species of *Glyphis* exist, but there are at least four or five. The Ganges river shark *Glyphis gangeticus* is listed as Critically Endangered in the 1996 IUCN Red List of Threatened Species. It was known from only three museum specimens collected over 100 years ago, until a freshly caught adult female (280 cm long) and two fresh jaws were seen last year. The speartooth shark *Glyphis glyphis* was originally known from eight specimens. One small stuffed fish is in a Berlin museum, two small preserved specimens have been destroyed by poor curation and the rest are dried jaws. Its original geographic origin is unknown. There may be three undescribed species. The Bizant river shark, *Glyphis* species 'A', is known from two specimens, one lost, from Queensland, Australia. The Borneo river shark, *Glyphis* species 'B', is recognised from just one preserved specimen found in a museum in Vienna, taken from an unknown river in Borneo over 100 years ago. The New Guinea river shark, *Glyphis* species 'C', may possibly be identical to *Glyphis glyphis*. Of seven specimens collected, two whole young have been lost, and five are only represented by jaws.

Leonard Compagno

See related article: *Glyphis* n.sp.: A Shark Once Feared Extinct is Rediscovered



The first preserved specimen of river shark *Glyphis* sp. from the Kinabatangan River, kept by local fishermen for the Darwin project team in Sabah, Malaysia.