

## Two New Records of Lamniform Shark from the Waters Adjacent to Taiwan

Po-Feng Lee<sup>1,2</sup> and Kwang-Tsao Shao<sup>1\*</sup>

(Received, October 22, 2009; Accepted, December 8, 2009)

### ABSTRACT

The specimens of two new records of lamniform shark (Chondrichthyes: Lamniformes) were collected in the waters off eastern Taiwan. They are *Megachasma pelagios* Taylor, Compagno & Struhsaker, 1983 (Megachasmidae) and *Mitsukurina owstoni* Jordan, 1898 (Mitsukurinidae). The monotypic families Megachasmidae and Mitsukurinidae which both have only one species in each family are new records to Taiwan. Megamouth shark, *Megachasma pelagios*, were collected by trawlers off Hualien County and Taitung County, and goblin shark, *Mitsukurina owstoni*, were collected by bottom trawlers in the waters off Tashi and Nanfangao harbors. This paper includes diagnostic characters and geographical distributions of the two species. Color photos and a key to the families of the order Lamniformes from Taiwan are given.

**Key words:** Lamniform, Shark, New record, Taiwan.

### INTRODUCTION

The order Lamniformes have 15 species which only contain below 3% of the total number of known species of sharks. However, lamniform sharks are a diverse group that seven of 34 families of sharks are in this order and four families are monotypic (Compagno, 2005).

Megamouth shark, *Megachasma pelagios*, is one of the most famous three fishes in the 20th century (Berra, 1997). Only 28 specimens had been reported in the world when the first catch record of megamouth shark in Taiwan was reported by the Hualien Fishermen Association on April 25, 2005. Five specimens of megamouth shark were caught continuously by trawl net off Hualien within ten days which were numbered as No. 29-33 by Ichthyology Department, Florida Museum of Natural History (<http://www.flmnh.ufl.edu/fish/sharks/megamouth/mega.htm>). The 2nd specimen of megamouth shark (No. 30) was landed on May 2, the

3rd (No. 31) on May 4, the 4th (No. 32) and the 5th (No. 33) on May 5. Two specimens, No. 31 and No. 32, were purchased and then preserved in the Research Museum of Academia Sinica and National Museum of Marine Biology and Aquarium, respectively, for research purpose. The others were sold by the auctions of fish market in Hualien Fishermen Association for consumption.

All megamouth shark from Taiwan were caught by trawl fishery boats, and most of them were sold for US\$ 2 per kilogram at auctions in local market. From 2005, megamouth shark, whale shark, great white shark and basking shark were listed as immediate-acknowledge species by Taiwan Fisheries Agency.

The No. 31 megamouth shark was caught by Captain Wu-Nan Dai with his fishing boat which named as Li-De-Hao about three nautical miles away from the coast of Fengpin Township, Hualien County during midnight, under the depth of about 15 m. No. 32 megamouth shark was caught

<sup>1</sup> Biodiversity Research Center, Academia Sinica, Taipei, Taiwan 115, R.O.C.

<sup>2</sup> Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan 106, R.O.C.

\* Corresponding author, E-mail: zoskt@gate.sinica.edu.tw

by Captain Jhong-He Liou with his fishing boat Sheng-Ji-Yi-Hao off Chisingtan, Hualien County in the morning. The total length of specimen No. 32 was as long as that of specimen No. 31, but with larger girth and more body weight than those of No. 31.

Among the 46 records of megamouth shark until 2009, eleven records were reported from Japan, nine from Taiwan (Table 1) and eight from Philippines in the Northwestern Pacific. It suggested that this area may have the highest density of megamouth shark in the world.

Goblin shark was also a rare shark species which occurred only in a few areas in the world. In April 2003, Captain Chan-Kun Chen of alfasino gill-net fishery boat Yi-Shang-Liu-Hao landed 14 specimens of goblin shark during three-day cruise under 400-500 m in depth off Su-ao, Ilan county. The total lengths of most specimens ranged from 150 and 200 cm, and wet weights ranged between 60 and 120 kg. All specimens were treated as trash fish due to their watery meat. The specimens in this paper were contributed by Captain Din-Mu Chen and Wen-Chang Chen of bottom trawlers at Dashi fishing harbor. One of the two specimens in the museum of Academia Sinica was fixed to show pulled-out jaws. Some shrimps and unknown detritus were found in the stomach of the specimen.

This paper includes diagnostic characters and geographical distributions of the two species. Color photos and a key to the species

of the order Lamniformes from Taiwan are given.

## MATERIALS AND METHODS

Methods for taking counts and measurements were followed Compagno (2001) and Last and Stevens (2009). Specimens were then preserved in formalin and deposited in 70% alcohol permanently at the Research Museum of Biodiversity Research Center, Academia Sinica (BRCAS) and National Museum of Marine Biology and Aquarium. Fish names in Chinese were based on Latin-Chinese Dictionary of Fishes Names (Wu *et al.*, 1999).

## RESULTS

### Order Lamniformes Garman, 1885

Key to families of the order Lamniformes in the waters adjacent to Taiwan

- 1a. Snout greatly elongated and flattened, forming a dagger-like blade; no precaudal pits; ventral caudal lobe absent.....Family Mitsukurinidae
- 1b. Snout very short to moderately elongated, conical to flattened and broadly rounded but not blade-like; precaudal pits and ventral caudal lobe present.....2
- 2a. Snout very short and broadly rounded in dorsoventral view; mouth terminal on head.....Family Megachasmidae

**Table 1.** Records of megamouth shark from Taiwan

Number*	Location	Date	Sex	Length	Weight	Note
20	Hualien	03 July 2003	Male	250 cm	Unknown	Consumed
29	Hualien	25 April 2005	Unknown	Unknown	630 Kg	Consumed
30	Hualien	02 May 2005	Unknown	Unknown	680 Kg	Consumed
31	Hualien	04 May 2005	Female	487 cm	689 Kg	ASIZM0071582
32	Hualien	05 May 2005	Female	483 cm	807 Kg	NMMBP8950
33	Hualien	05 May 2005	Unknown	Unknown	400-500 Kg	Consumed
41	Hualien	30 June 2008	Male	Unknown	200 Kg	Consumed
42	Hualien	10 July 2008	Male	500-550 cm	870 Kg	Consumed
45	Taitung	9 June 2009	Female	390 cm	350 Kg	Preserved in Taiwan Shark Museum

\*Numbers of megamouth sharks were recorded by Ichthyology Department, Florida Museum of Natural History.

## SPECIES ACCOUNT

***Megachasma pelagios* Taylor, Compagno & Struhsaker, 1983 巨口鯊****Fig. 1**

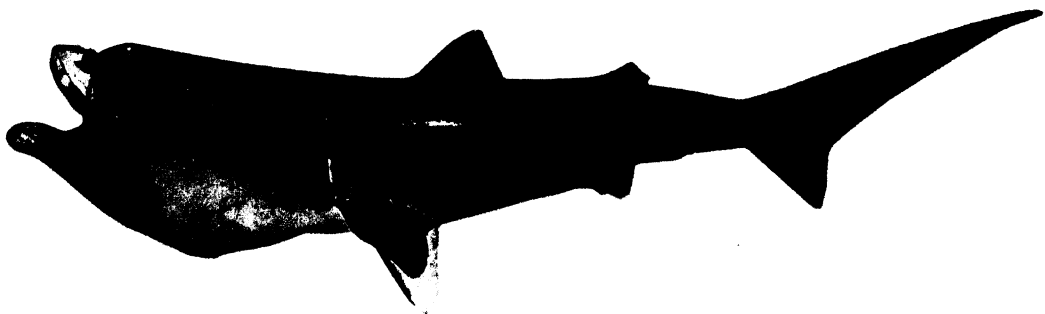
*Megachasma pelagios* Taylor, Compagno & Struhsaker 1983:96, Figs. 2-5. Type locality, about 42 km northeast of Kahuku Point, Oahu Island, Hawaii Islands, 21°51'N, 157°46'W, depth about 165 m. Holotype (unique): BPBM 22730 [part of specimen as CAS 63118].

Specimens examined (2 specimens): ASIZP0071582, 1 specimen, 483 cm TL, collected in 4 May 2005, off Fengpin Township, Hualien County; NMMBP8950, 1 specimen, 487 cm TL, collected in 5 May 2005, off Chisingtan, Hualien County.

*Description:*

Head elongated and about length of trunk. Snout short and broadly rounded. Eyes small, length 1.17% to 1.35% of total length (TL). Gill openings moderately long, length of first 5.3% to 5.5% of TL, not extending onto dorsal surface of head; last two gill openings over pectoral-fin bases; unique gill rakers of finger-like dermal papillae with cartilage cores fringing internal gill slits. Mouth very large and arcuate, terminal on head; jaws greatly protrusible anteriorly beyond snout tip but not greatly distensible laterally. Teeth small, continuously varying and more or less awl-

- 2b. Snout longer and narrowly to broadly parabolic in dorsoventral view; mouth subterminal on head.....3
- 3a. Caudal fin about as long as rest of shark.....Family Alopiidae
- 3b. Caudal fin much shorter than rest of shark.....4
- 4a. Caudal fin asymmetrical, not lunate; caudal peduncle without lateral keels or with weak ones.....5
- 4b. Caudal fin nearly symmetrical and lunate; caudal peduncle with very strong lateral keels.....6
- 5a. Eyes very large, body slender; anal fin narrow-based; caudal peduncle with both upper and lower precaudal pits and low lateral keels on each side; gill openings extending onto dorsal surface of head.....Family Pseudocarchariidae
- 5b. Eyes relatively small, body stout; anal fin broad-based; caudal peduncle with an upper precaudal pit but without a lower pit or lateral keels; gill openings not extending onto dorsal surface of head.....Family Odontaspidae
- 6a. Teeth relatively few, enlarged and blade-like, with less than 40 rows in each jaw; gill openings large but ending far lateral to mid-dorsal surface of head.....Family Lamnidae
- 6b. Teeth numerous, minute and hooked, with over 150 rows in each jaw; gill openings extremely large, extending nearly to mid-dorsal surface of head.....Family Cetorhinidae



**Fig. 1.** *Megachasma pelagios*, ASIZP0071582, 480 cm TL., female.

shaped, no differentiation between anterior, intermediate, lateral, or symphyseal teeth. Trunk cylindrical and somewhat compressed, stout, and relatively flabby. Caudal peduncle compressed and without lateral keels but with small fossate-shaped upper precaudal pit only. Dermal denticles very small and smooth, with flat crowns, small ridges and cusps and with cusps directed posteriorly on lateral denticles. Pectoral fins large, narrow and elongated, much shorter than head in adults. Pelvic fins moderate-sized, smaller than pectoral and first dorsal fins. First dorsal fin moderately large, semierect and angular. Second dorsal fin less than half size of first but moderately large. Anal fin smaller than second dorsal fin and with its base slightly behind second dorsal-fin base. Caudal fin not lunate, dorsal lobe long but less than half as long as rest of shark, ventral lobe short but strong. Intestinal valve of ring type with 23 or 24 turns. Size very large with adults 4.5 to 5.5 m in TL. (Table 2).

*Distribution:*

Off Hualien and Taitung County, Eastern Taiwan; this species is now known from the Indian, Pacific and Atlantic Oceans.

***Mitsukurina owstoni* Jordan, 1898** 歐氏尖吻鯊

**Fig. 2**

*Odontaspis nasutus* de Braganza, 1904: 49, 104, pl. 1, Figs. 1-1c. Type locality, Mare de Sezimbra, Portugal, 603 m.

*Scapanorhynchus jordani* Hussakof, 1909: 257, text-figs., pl. 44. Syntypes (2):

American Museum of Natural History, AMNH-00004SW, jaws, model on display from one 300 mm female; one 155 mm female, formerly in the Zoological Department at Columbia University. Type locality, Japan.

*Scapanorhynchus dofleini* Engelhardt, 1912: 644. Holotype: Zoologischen Staatssammlung München, two 100 mm female, Mayegawa, Sagami Sea, Japan. Locality of holotype unknown according to Eschmeyer (1998: CD-ROM).

*Scapanorhynchus mitsukurii* White, 1937: 29 (error for *Mitsukurina owstoni* Jordan, 1898). Japan.

Specimens examined (2 specimens, TL 111-128 cm): ASIZP0070657, 1 specimen, 128 cm TL, collected in 6 July 2002, off Tashi, Ilan county; ASIZP0065068, 1 specimen, 111 cm TL, collected in 8 July 2005, off Tashi, Ilan county.

*Description:*

Head as long as trunk or slightly shorter. Snout greatly elongated, blade-like and flattened. Eyes small, length 1.2% to 1.4% of TL. Gill openings short, length of first 2.4% to 3.1% of TL, not extending onto dorsal surface of head; all gill openings anterior to pectoral-fin bases; no gill rakers on internal gill slits. Mouth large, parabolic, ventral on head; jaws strongly protrusible to about opposite snout tip but not greatly distensible laterally. Teeth large, anteriors and laterals very narrow and awl-like; three rows of large anterior teeth on each side of upper and lower jaws, the uppers separated from the smaller upper lateral teeth by a gap without intermediate teeth; a pair of lower symphyseal



**Fig. 2.** *Mitsukurina owstoni*, ASIZP0070657, 128 cm TL., female.

Table 2. Measurements of megamouth shark

Total length (mm)	NMMBP8950		ASIZP0071582	
	4870 / Female		4830 / Female	
	mm	%TL	mm	%TL
Precaudal length	3390	69.6	3235	67.0
Prenarial length	10	0.2	83	1.7
Preoral length	660	13.6	610	12.6
Preorbital length	240	4.9	240	5.0
Prespiracular length	500	10.3	498	10.3
Prebranchial length	990	20.3	920	19.0
Head length	1320	27.1	1260	26.1
Prepectoral length	1270	26.1	1283	26.6
Prepelvic length	2540	52.2	2415	50.0
Vent-caudal length	675	13.9	675	14.0
Pre-first dorsal length	1700	34.9	1620	33.5
Pre-second dorsal length	2830	58.1	2540	52.6
Interdorsal space	695	14.3	550	11.4
Second dorsal-caudal space	470	9.7	485	10.0
Pectoral-pelvic origins	1300	26.7	1220	25.3
Pectoral-pelvic space	1060	21.8	969	20.1
Pelvic-anal space	1600	32.9	245	5.1
Pelvic-caudal space	740	15.2	690	14.3
Anal-caudal space	255	5.2	288	6.0
Eye length	57	1.2	70	1.4
Eys height	55	1.1	66	1.4
Interorbital space	550	11.3	627	13.0
Nostril width	15	0.3	15	0.3
Internarial space	390	8.0	420	8.7
Anterior nasal flap length	10	0.2	17	0.4
Mouth length	450	9.2	425	8.8
Mouth width	930	19.1	730	15.1
First gill slit height	270	5.5	255	5.3
Fifth gill slit height	260	5.3	245	5.1
Caudal peduncle height	265	5.4	258	5.3
Girth	2220	45.6	2089	43.3
Pectoral anterior margin	910	18.7	970	20.1
Pectoral base	300	6.2	350	7.2
Pectoral height	390	8.0	410	8.5
Pelvic anterior margin	330	6.8	300	6.2
Pelvic base	160	3.3	257	5.3
Pelvic height	230	4.7	250	5.2
Pelvic inner margin	275	5.6	118	2.4
Pelvic posterior margin length	245	5.0	261	5.4
First dorsal anterior margin	440	9.0	435	9.0
First dorsal base	410	8.4	360	7.5
First dorsal height	295	6.1	252	5.2
First dorsal inner margin	120	2.5	125	2.6
First dorsal posterior margin	300	6.2	300	6.2
Second dorsal anterior margin	215	4.4	180	3.7
Second dorsal base	220	4.5	200	4.1
Second dorsal height	130	2.7	105	2.2
Second dorsal inner margin	110	2.3	96	2.0
Second dorsal posterior margin	185	3.8	170	3.5
Anal length	210	4.3	200	4.1
Anal anterior margin	140	2.9	115	2.4
Anal base	120	2.5	108	2.2
Anal height	85	1.7	87	1.8
Anal inner margin	90	1.8	105	2.2
Anal posterior margin	110	2.3	131	2.7
Dorsal caudal margin	1690	34.7	1613	33.4
Preventral caudal margin	670	13.8	650	13.5
Lower postventral caudal margin	350	7.2	380	7.9
Upper postventral caudal margin	144	3.0	127	2.6
Terminal caudal margin	90	1.8	104	2.2
Subterminal caudal margin	115	2.4	50	1.0
Spiracle diameter	230	4.7	220	4.6

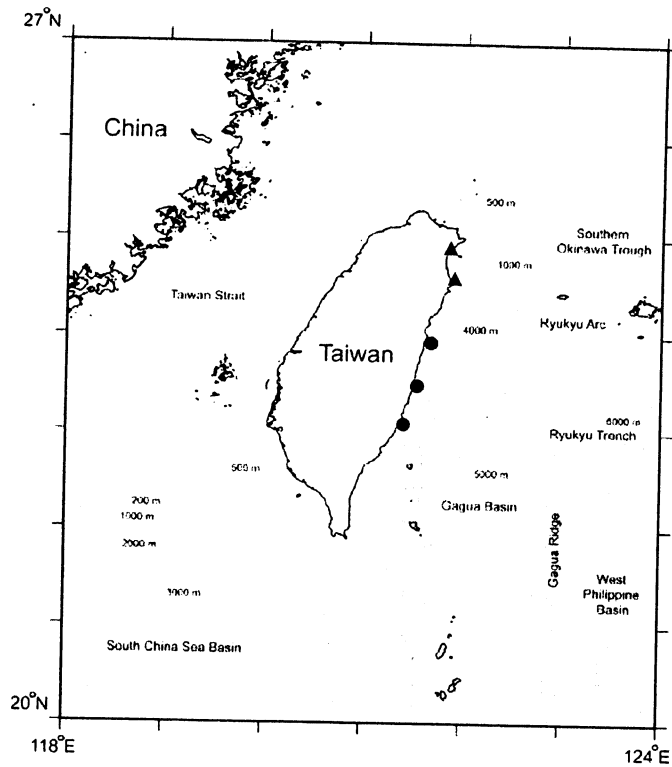


Fig. 3. Distribution map of megamouth sharks and goblin sharks from the waters adjacent to Taiwan (▲: *Mitsukurina owstoni*; ●: *Megachasma pelagios*)

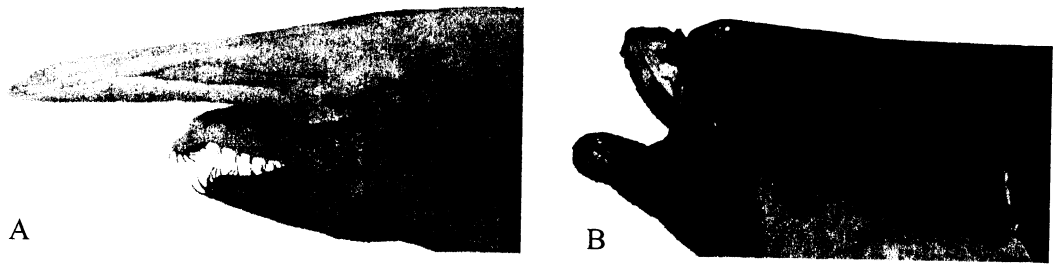


Fig. 4. Lateral view of head with both jaws. A: *Mitsukurina owstoni*; B: *Megachasma pelagios*.

teeth present. Trunk compressed and moderately slender, very soft and flabby. Caudal peduncle compressed and without keels or precaudal pits. Dermal denticles small and rough, with erect spike-like crowns with narrow cusps and ridges; cusps of lateral denticles pointing perpendicular to surface of skin. Pectoral fins short and broad, much shorter than head in adults.

Pelvic fins large, larger than dorsal fins. Dorsal fins small, low, and rounded, first and second dorsals equal-sized and smaller than the large, rounded anal fin. Second dorsal and anal fins with broad, nonpivoting bases. Anal fin larger than second dorsal fin and with its base slightly behind second dorsal-fin base. Caudal fin not lunate, dorsal lobe long but half length of rest of shark or less, ventral

**Table 3.** Measurements of goblin shark

Total length (mm)	ASIZP0070657		ASIZP0065068	
	1280 / Female		1110 / Female	
	mm	%TL	mm	%TL
Precaudal length	840	65.63	730	65.77
Prenarial length	162	12.66	115	10.36
Preoral length	178	13.91	140	12.61
Preorbital length	192	15.00	158	14.23
Prespiracular length	228	17.81	212	19.10
Prebranchial length	282	22.03	261	23.51
Head length	362	28.28	310	27.93
Prepectoral length	355	27.73	308	27.75
Prepelvic length	560	43.75	482	43.42
Vent-caudal length	235	18.36	168	15.14
Pre-first dorsal length	448	35.00	390	35.14
Pre-second dorsal length	680	53.13	612	55.14
Interdorsal space	165	12.89	160	14.41
Second dorsal-caudal space	115	8.98	80	7.21
Pectoral-pelvic origins	198	15.47	170	15.32
Pectoral-pelvic space	151	11.80	128	11.53
Pelvic-anal space	62	4.84	66	5.95
Pelvic-caudal space	190	14.84	170	15.32
Anal-caudal space	33	2.58	20	1.80
Eye length	15	1.17	15	1.35
Eys height	11	0.86	11	0.99
Interorbital space	70	5.47	87	7.84
Nostril width	13	1.02	13	1.17
Internarial space	45	3.52	49	4.41
Anterior nasal flap length	4	0.31	4	0.36
Mouth length	86	6.72	66	5.95
Mouth width	73	5.70	80	7.21
First gill slit height	40	3.13	27	2.43
Fifth gill slit height	38	2.97	23	2.07
Caudal peduncle height	45	3.52	37	3.33
Girth	265	20.70	228	20.54
Pectoral anterior margin	100	7.81	100	9.01
Pectoral base	66	5.16	56	5.05
Pectoral height	68	5.31	66	5.95
Pelvic anterior margin	82	6.41	70	6.31
Pelvic base	115	8.98	82	7.39
Pelvic height	60	4.69	42	3.78
Pelvic inner margin	32	2.50	40	3.60
Pelvic posterior margin length	76	5.94	46	4.14
First dorsal anterior margin	106	8.28	88	7.93
First dorsal base	68	5.31	60	5.41
First dorsal height	40	3.13	40	3.60
First dorsal inner margin	44	3.44	36	3.24
First dorsal posterior margin	35	2.73	20	1.80
Second dorsal anterior margin	98	7.66	96	8.65
Second dorsal base	72	5.63	66	5.95
Second dorsal height	48	3.75	30	2.70
Second dorsal inner margin	36	2.81	36	3.24
Second dorsal posterior margin	30	2.34	20	1.80
Anal length	125	9.77	118	10.63
Anal anterior margin	76	5.94	50	4.50
Anal base	110	8.59	105	9.46
Anal height	32	2.50	29	2.61
Anal inner margin	13	1.02	10	0.90
Anal posterior margin	48	3.75	60	5.41
Dorsal caudal margin	440	34.38	380	34.23
Upper postventral caudal margin	325	25.39	255	22.97
Terminal caudal margin	40	3.13	26	2.34
Subterminal caudal margin	52	4.06	38	3.42
Spiracle diameter	4	0.31	4	0.36

lobe not developed. Intestinal valve of ring type with 19 turns. Size large, with adults 2.6 to 3.6 m in TL. (Fig. 3, Table 3, Fig. 4)

*Distribution:*

Off Ilan county, Northeastern Taiwan; this species is now known from the Indian, Pacific and Atlantic Oceans as a bathydemersal deep-water shark.

#### ACKNOWLEDGEMENTS

The authors express their appreciation to D. M. Chen, captain of bottom trawlers in Tashi fishery harbor for providing specimens. We thank the financial support of the

Deep-Sea Biodiversity project by National Science Council (NSC 96-2628-B-001-006-MY3). We thank Dr. Hsin-Ming Yeh for his suggestions and corrections of the manuscript. Thanks are also to members of the Laboratory of Fish Ecology and Evolution, Biodiversity Research Center, Academia Sinica for their assistance in the project.

#### REFERENCES

- Berra, T. M. (1997). Some 20th century fish discoveries. *Environ. Biol. Fish.*, **50**: 1-12.
- Compagno, L. J. V. (1984). FAO Species Catalogue, Vol. 4, Parts 1-2, Sharks of the World. FAO, Rome, Italy.
- Compagno, L. J. V. (2001). FAO Species Catalogue for Fishery Purposes. No. 1, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO, Rome, Italy.
- Compagno, L. J. V. (2005). Checklist of living Chondrichthyes. Chapter 16. In *Reproductive Biology and Phylogeny of Chondrichthyes* (W. C. Hamlett, ed.), Science Publishers, Enfield, NH, U.S.A. pp. 503-548.
- Last, P. R. and J. D. Stevens. (1994). *Sharks and Rays of Australia*. CSIRO, Melbourne, Australia.
- Taylor, L. R., L. J. V. Compagno and P. J. Struhsaker (1983). Megamouth—a new species, genus and family of Lamnoid shark (*Megachasma pelagios*, family Megachasmidae) from the Hawaiian Islands. *Proc. Calif. Acad. Sci.*, **43**(8): 87-110.
- Wu, H. L., K. T. Shao and C. F. Lai (1999). *Latin-Chinese Dictionary of Fishes Names*, The Sueichan Press., Keelung, Taiwan, R.O.C. (in Chinese)



