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Results of the research cruises of FRV "Walther Herwig" to South America. LIII*).

Sharks from the pelagic trawl catches obtained during Atlantic transects, including some specimens from other cruises

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With 4 figures and 3 tables

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Abstract

Sharks were represented by small numbers in the pelagic trawl catches during the various Atlantic transects run by FRV "Walther Herwig" in recent years. In addition to well-known oceanic sharks, other, normally bottom-dwelling species were unexpectedly taken in midwater, and their occurrence in this habitat is discussed. Moreover, representatives of a few very rare species were obtained, the catches of which show a considerable extension in range. Therefore, a complete list of the species taken, and additional notes on taxonomy and distribution are given. The list enumerates 11 species of 10 genera.

Kurzfassung

Ergebnisse der Forschungsreisen des FFS „Walther Herwig“ nach Südamerika. LIII. Haie aus Schwimmschleppnetz-Fängen der Atlantiksnitte, mit Einschluß einiger Stücke von anderen Reisen.

Haie waren nur in geringer Zahl in den pelagischen Schleppnetzfangen der verschiedenen „Walther Herwig“-Reisen der letzten fünfzehn Jahre vertreten. Da jedoch neben typisch ozeanischen Freiwasserarten einige normalerweise als „Grundhaie“ betrachtete Arten im Mesopelagial gefangen wurden, wird hier eine vollständige Übersicht über alle gefangenen Haie wiedergegeben, sowie eine Neubeschreibung einiger sehr seltener Arten. Die Übersicht umfaßt 11 Arten aus 10 Gattungen. Einleitend wird der Übergang vom Bodenleben zum pelagischen Habitat diskutiert und als ein über nächtliche Nahrungswanderungen entstandener Evolutions-schritt verstanden, welcher eine anderweitig nicht mögliche Erweiterung des geographischen Verbreitungsgebietes zur Folge hat.

*) Ergebnisse der Forschungsreisen des FFS „Walther Herwig“ nach Südamerika. LI. Ascidien des Argentinischen Schelfs aus den Grundtrawl-Fängen des FFS „Walther Herwig“ auf seiner dritten Südamerika-Expedition. Von M. DIEHL in Mitt. Hamburg. zool. Mus. Inst. 74: 139—153, 1977.
 und LII. Actiniaria des Südwestatlantik. IV. *Actinostola crassicornis* (Hertwig, 1882) mit einer Diskussion verwandter Arten. Von K. RIEMANN-ZÜRNECK in Veröff. Inst. Meeresforsch. Bremerh. 17: 65—85, 1978.

A. Introduction

Sharks, according to their habitats, conventionally are grouped into a) pelagic, and b) benthic or "ground sharks". Group a) is subdivided into an epipelagic (most of the Lamniformes, the Carcharhiniformes and the Rhiniodontidae) and a meso- to bathypelagic subgroup (some of the Hexanchiformes, all of the Dalatiinae, a few of the Lamniformes and of the Carcharhiniformes). Group b) is made up by most of the Squaliformes, all of the Pristiophoriformes, the Squatiniformes, the Orectolobiformes (except for the Rhiniodontidae), and by part of the Carcharhiniformes. This kind of differentiation in habitat selection, however, is not as strict as thought before. In recent years it became obvious that at least a number of species of the dogfish family Squalidae, grouped heretofore with the bottom-dwelling ground sharks, sometimes may be taken in midwater also, mainly during the night, thus blurring the ecological separation into pelagic and benthic ways of life. Also, as a consequence of such "unconventional" behaviour the pretended ecological differences between subfamilies of the Squalidae, like, e. g. the Dalatiinae and the Etmopterinae, are lessened.

Diurnal migrations of preponderantly deep-living sharks may be understood as feeding migrations as it is obviously the case with respective migrations in several Macrouridae and other slope fishes. From such diurnal migrations far-reaching movements may have been derived in the course of evolution resulting in considerable extensions in range inhabited by migratory species. This can be shown by the geographical distribution areas of many of the dalatiine sharks living habitually in midwater, which like most of the epipelagic sharks have wide-spread distribution patterns. Since some of the smaller benthic sharks, which make up a representative part of the slope ichthyofauna, also show this distribution pattern, such species may be able to perform far-ranging midwater migrations as well. That this is true can be seen from some of our records quoted below. Most probably, dalatiine sharks evolved from benthic ancestors of an ancient squalid stock populating the deeper parts of the slope areas. The transition from bottom to midwater may have started by diurnal feeding migrations into midwater, which became more and more extended, finally resulting in a permanent midwater life, thus diminishing the numbers of competitors. Other, still preponderantly benthic squalids of various genera may undergo a similar evolutionary step today.

During a number of pelagic transects run in the years 1964 through 1976 in the Atlantic Ocean, most of them in connection with bottom trawl surveys off South America, only a rather small number of sharks were taken. However, some of these belong to very rare species, and others were found never before in pelagic catches. Altogether, we got 11 species of 10 genera. These are listed in the following report. The order of presentation follows COMPAGNO (1973). Lengths are total lengths, time data are given in GMT. The gear was a pelagic Engel trawl with 1600 meshes circumference, if not otherwise stated.

B. Account of Species

Family: Squalidae

Subfamily: Etmopterinae

1. *Etmopterus gracilispinis* Krefft, 1968

Etmopterus gracilispinis KREFFT, 1968 a: 3—9, figs. 2, 3 a, 4, 5 a (off Uruguay).

A single paratype, ISH 935/66, of this otherwise benthic deep-water species was taken pelagically off the mouth of the river La Pata. "Walther Herwig" Station 197/66:

35° 56' S, 50° 33' W, 480—70 m, 30. V. 1966. Depth of the bottom is 2240 m. The specimen is a ♀ of 331 mm.

The species, described from an area stretching from off the northernmost part of Argentina to southern Brazil, has been found in recent years off Virginia and Florida (SCHWARTZ & BURGESS, 1975), suggesting an antitropical distribution pattern in the subtropical western Atlantic. C. KARRER (1973) reports the species also from 33° 54' S, 17° 28' E in the southeastern Atlantic.

2. *Etmopterus pusillus* (Lowe, 1839)

Acanthidium pusillum Lowe, 1839: 91—92 (off Madeira).

Specimens taken by pelagic trawl (MT 1600) are as follows:

ISH 891/71. W. H. St. 380—II/71: 39° 53' S, 21° 44' W, 260—0 m, 12. III. 1971, 2113—2138 h (1 ♀, 467 mm).

ISH 903/71, W. H. St. 380—III/71: 39° 53' S, 21° 33' W, 708—0 m, 12./13. III. 1971, 2325—2437 h (1 ♀, 501 mm).

ISH 1100/71. W. H. St. 409—I/71: 38° 14' S, 01° 15' E, 110—0 m, 20. III. 1971, 1932—1947 h (1 ♂ juv., 200 mm).

Etmopterus pusillus inhabits continental and island slope areas in subtropical and tropical parts of the Atlantic and western Pacific Oceans. In the Indian Ocean the species has been found off Natal. Its enormous range most probably is due to its ability for extensive migrations in midwater, shown here for the first time by its oceanic occurrence in the area of the South Atlantic Subtropical Convergence. Except for small differences in the numbers of trunk vertebrae no morphological differences could be found when comparing specimens from off Madeira, Angola, Uruguay and Japan. An increase in total length with increasing depth, found by the present author on the South American slopes (KREFFT, 1968 a), could again be observed in the pelagic specimens.

Subfamily Squalinae

3. *Centrophorus squamosus* (Bonnaterre, 1788)

Squalus squamosus Bonnaterre, 1788: 12 (no type locality given).

A single specimen of this well-known antitropically distributed deepwater shark inhabiting the slopes of the eastern North and South Atlantic and of Australasia has been taken far off from the bottom. ISH 608/73. W. H. St. 700/73: 52° 35' N, 22° 20' W, 1250—0 m, 24. IX. 1973, 1840—1948 h (1 ♂ adult, 117 cm).

Although this specimen was taken during the "ICES OVERFLOW '73"-Expedition, it is included here, because according to the present author's knowledge it represents the first specimen of this shark taken in midwater; the depth of the bottom was 3940 m at the station concerned.

Subfamily Somniosinae

4. *Scymnodon obscurus* (Vaillant, 1888) (Fig. 1, table 1)

Centroscymnus obscurus Vaillant, 1888: 67—68, pl. II (figs. 2, 2 a—e) ("Côtes du Soudan").

Specimens taken by pelagic trawl (MT 1600) from the following stations:

ISH 511/68. W. H. St. 11—III/68: 16° 08' N, 22° 22' W, 580—0 m, 29. I. 1968, 2255—2351 h (1 ♂ adult, 493 mm).

ISH 1488/68. W. H. St. 27—III/68: 32° 11' S, 45° 08' W, 580—0 m, 14. II. 1968, 0100—0130 h (1 ♂ juv., 451 mm).

ISH 823/71. W. H. St. 376/71: 39° 55' S, 26° 02' W, 2000—0 m, 11. III. 1971, 2015—2338 h (1 ♀ juv., 316 mm).

Since VAILLANT's original account the species has never been described again. GARMAN (1913: 208) considered *obscurus* as a synonym of *ringens* Bocage & Capello, 1864, MAURIN & BONNET (1970: 21) as a questionable synonym. BIGELOW & SCHROEDER (1957: 100), however, retained *obscurus* because of "a more abruptly truncate caudal fin, with more definite subterminal notch and smaller pectorals . . . than in *ringens*, and flank denticles with a double series of transverse ridges between the more prominent longitudinal ridges". BASS *et al.* (1976: 35) tentatively identified four semidigested sharks from the stomach of a sperm whale harpooned 112 km southeast of Durban as *Scymnodon ?obscurus* "by their teeth, denticles and general body form". These Indian Ocean specimens would represent the first record of the species outside the Atlantic Ocean.

There cannot be any doubt that *S. obscurus* and *S. ringens* are different species. *S. ringens*, a species growing obviously to a larger size, is much more stout in body shape, and its caudal fin differs remarkably from that of *S. obscurus*. The dermal denticles of *ringens* are much more spiny than those of *obscurus*, giving *ringens* specimens a distinctly rougher touch. *S. ringens* denticles have no transverse ridges at all, unlike those of *S. obscurus*. A redescription of *S. obscurus*, therefore, seems in order (proportional dimensions are summarized in table 1).

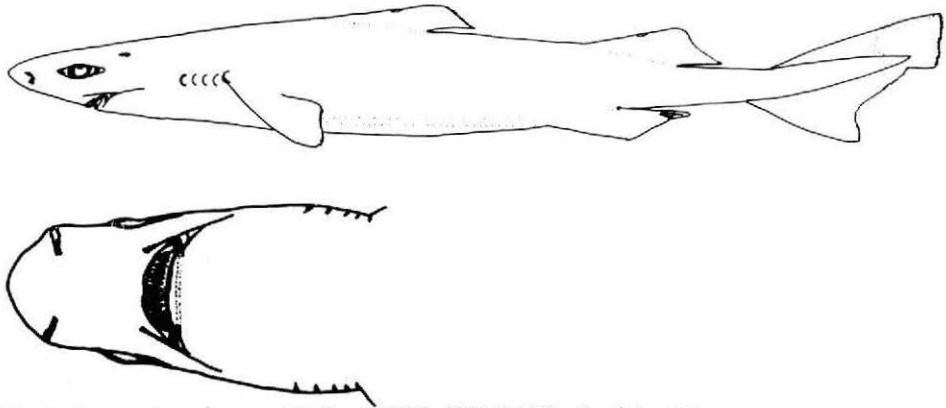


Fig. 1: *Scymnodon obscurus* (Vaillant, 1888). ISH 511/68. ♂ adult, 493 mm.

Trunk subcylindrical, moderately elongate, its height at 1st dorsal fin between 5.5 to 6.5 (17.5 to 15.3 %) in its length to origin of caudal, without mid-dorsal ridge. Caudal peduncle subquadrate, without lateral ridges or caudal pits. Dermal denticles small, overlapping to form a continuous armor, their peduncles very short, the blades tridentate and leaflike, except for those on the upper surface of the head and lower surface of the snout, which are elongately ovate with only a median ridge. Denticles on body and fins with a distinct median ridge and a weaker secondary ridge at either side of the blade,

connected with the median longitudinal ridge by feeble transverse ridges numbering 5 to 7. These characteristic denticles are figured by VAILLANT, 1888: pl. II, fig. 2 c, BIGELOW & SCHROEDER, 1957: figs. 13 F, G, and BASS *et al.*, 1976: fig. 27 c. The smallest

Table 1 Body proportions measured as % of total length in three specimens of *Scymnodon obscurus*

	ISH 823/71	ISH 1488/68	ISH 511/71
Total length	316.0 mm	451.0 mm	493.0 mm
Trunk at origin of pectoral:			
breadth	12.56	11.39	11.75
height	11.16	10.58	10.59
Snout length in front of:			
outer nostrils	1.33	1.38	1.30
mouth	9.01	8.30	7.80
Orbit:			
horizontal diameter	5.73	4.98	5.27
Spiracle:			
length	1.33	1.20	1.26
Mouth:			
breadth	7.75	7.70	7.79
height	1.89	1.85	1.68
Nostrils:			
distance between inner ends	4.65	4.38	4.32
Labial furrow lengths from angle of mouth:			
upper	3.01	3.22	3.12
lower	1.30	1.60	2.01
Gill opening lengths:			
1st	1.71	1.42	1.30
3rd	1.74	1.52	1.30
5th	1.71	1.81	2.01
First dorsal fin:			
vertical height	2.15	2.19	2.25
length of base*	2.91	3.08	3.87
length of exposed spine	0.35	0.20	0.43
Second dorsal fin:			
vertical height	3.01	3.30	3.65
length of base*	5.00	5.16	5.33
length of exposed spine	0.35	broken	0.37
Caudal fin:			
upper margin	20.51	20.11	20.12
lower anterior margin	12.78	12.75	12.78
Pectoral fin:			
extreme length	11.30	12.14	13.12
extreme breadth	6.08	5.40	7.40
Pelvic fin:			
length	9.56	11.14	11.50
length of clasper	—	6.09	8.32
Distance from snout to:			
1st dorsal spine	42.91	41.52	40.80
2nd dorsal spine	65.19	65.28	66.84
upper caudal fin	78.51	80.71	80.19
pectoral fin	23.67	22.95	22.63
pelvic fins	57.56	58.30	58.17
Interspace between:			
1st dorsal and 2nd dorsal spine	19.43	22.10	22.45
2nd dorsal and caudal pelvics and caudal	9.68	9.78	9.96
10.70	12.72	12.90	
Distance from origin to origin of:			
pectoral and pelvics	32.22	34.38	34.60
pelvics and caudal	17.72	21.06	21.10
1st and 2nd dorsal spines	21.93	26.56	29.70

*) measured from origin of spine.

specimen at hand differs very little only in its scalation from the larger two specimens in having faint lateral ridges on the snout denticles as well, which, however, do not end into projecting points.

Head about 3,3 to 3,4 in trunk to origin of caudal, its dorsal profile weakly and evenly convex, somewhat flattened anteriorly. Snout thick and fleshy at tip, its sides very slightly concave at eyes, moderately ovate and long, its length in front of nostrils about $\frac{1}{6}$ to $\frac{1}{7}$ as great as length in front of mouth, the latter 2,6 to 3 in head length. Distance between nostrils little more than $\frac{1}{2}$ as great as length in front of mouth. Eye narrowly oval, its outline about as convex above as below, horizontal diameter of orbit almost $\frac{2}{3}$ as long as snout in front of mouth, center of eye distinctly in front of mouth. Spiracle about $\frac{1}{4}$ as long as diameter of eye, above upper margin of latter. Gill openings small, less than $\frac{1}{2}$ as long as diameter of eye, first to fourth of about equal length, the fifth somewhat longer, evenly spaced, the fifth close in front of pectoral. Nostril close to anterior margin of snout, less than $\frac{1}{2}$ as long as horizontal diameter of eye, slightly oblique, its inner margin expanded as a short, triangular lobe with blunted tip about at the end of its anterior third, its inner corner much nearer tip of snout than front of mouth. Mouth only very slightly arched, its breadth about 1.7 times as great as distance between nostrils and a little smaller than length of snout in front of mouth. Upper labial furrows extending nearly $\frac{1}{2}$ of the way, the lower about $\frac{1}{3}$ of the way, toward the respective symphyses. Preoral cleft voluminous and extended as a narrow furrow rearward, nearly $\frac{1}{2}$ the way toward 1st. gill slit.

Teeth numbering about $\frac{25-1-26}{18-1-18}$ in ISH 1488/68, $\frac{24-1-25}{19-1-19}$ in ISH 511/68. Upper teeth erect, lanceolate, with bifid bases, much longer along each side of the jaw than either toward the center of the mouth or toward the outer corners. Lower teeth triangular, their cutting edges inclined toward the outer corners of the jaw, except for the median one in the two males, which is broken away but seemingly had a vertical direction, whereas the two median lower teeth in the small female (ISH 823/71) are directed toward the respective corners of the mouth. Two or three rows of teeth regularly functional in upper jaw, one in lower jaw.

First dorsal fin small, with broadly rounded apex, its length at base (measured from origin of spine) 12.3 (smallest) to 16.4 (largest) % of head length, its vertical height a little less than length of base, its rear margin nearly straight, its free rear tip longer than base, its origin posterior to inner corner of pectoral fin by a distance a little less than twice as long as the diameter of orbit, the midpoint of its base a little nearer to axil of pectoral than to origin of pelvics, its spine exposed at tip, but very short. Second dorsal fin similar in shape to 1st dorsal, but 1.3 to 1.7 times as long at base, origin of its spine below (in the smallest specimen) or somewhat behind axil of pelvic fins, its rear margin straight, its spine exposed at tip as in 1st dorsal. Interspace between 2nd dorsal and caudal about 1.8 times as long as base of 2nd dorsal (measured from origin of spine). Caudal fin $\frac{1}{3}$ (about 20 %) of total length, its extreme breadth 0.7 to 0.8 times its length, truncate posteriorly, with deep subterminal notch, its lower posterior margin deeply concave, its lower anterior margin somewhat less than $\frac{2}{3}$ as long as upper margin (Fig. 1). Pelvic fins a little longer at base than 2nd dorsal, with straight margins, shallowly rounded apices and pointed tips. Clasper of the adult male with long, curved spur. Pectoral fins about $\frac{1}{2}$ as long as head, not quite twice as long as broad (1.7 to 2), with softly convex outer, and slightly concave distal margins and moderately rounded corners.

The vertebral counts (according to X-rays) are as follows (terminology following KREFFT, 1968 b):

ISH No.	Vtr	Vac	Vt	VΣ
511/68	52	72	28	100
1488/68	53	74	26	100
823/71	53	74	26	100

The colour is an uniformly dark chocolate brown below as well as above. All fins with exposed tips of ceratotrichia forming very narrow translucent fringes.

Our catches from off Brazil and from the South Atlantic Subtropical Convergence represent a considerable extension in range; moreover they are the first ones made by pelagic trawl. Midwater migrations across the Atlantic Ocean along the STC could lead the sharks easily around the Cape to the eastern coast of South Africa.

Subfamily Dalatiinae

5. *Euprotomicroides zantedeschia* Hulley & Penrith, 1966

Euprotomicroides zantedeschia Hulley & Penrith, 1966: 222—229, fig. 1 (west of Cape Town in 250—350 fathoms).

A single specimen of this very aberrant species known hitherto by its holotype only was taken at the end of leg I of the German Antarctic Expedition 1975/76.

ISH 701/76. W. H. St. 109—I/76: 35° 00.6' S, 40° 01' W, 25—0 m, 9. I. 1976, 2327—2348 h (1 ♂ adult, 413.5 mm).

This specimen will be described in a forthcoming paper (COMPAGNO, KREFFT & STEHMANN, in preparation), therefore no further remarks are appropriate here.

6. *Euprotomicrus bispinatus* (Quoy & Gaimard, 1824)

Scymnus bispinatus Quoy & Gaimard, 1824: 197—198, pl. 44 (figs. 1—2) (île de France = Mauritius).

We got two specimens in a single haul with the MT 1600:

ISH 2010/71. W. H. St. 463-III/71: 08° 11' S, 14° 12' W, 640—0 m, 8. IV. 1971, 2125—2315 h (2 ♀♀ juv., 109.3, 115.0 mm).

This pygmy shark was described by HUBBS & MCHUGH (1951), PARIN (1964) and HUBBS *et al.* (1967) so thoroughly as to render a further description needless. It should be mentioned only that the tail fins in our young specimens still show the pigment pattern of the embryo figured by PARIN (l. c.: fig. 3 c). The vertebral counts are (larger specimen first): Vtr 31, 31, Vac 47, 46, Vt 15, 11 (+?), VΣ 62, 57 (+?).

The species has been found in the Atlantic Ocean only once before. The Shimonoseki College of Fisheries vessel "Koyo Maru" took a female of 105 mm by dipnet at 06° 00' S, 25° 19.2' W in January 1966; the surface temperature was 25.5° C. At our Station 463/71 we measured a surface temperature of 27.5°, the salinity at 5 m depth was 36.194 ‰. The 200 m-temperature was 11.25°, fitting quite well with the respective values given by HUBBS *et al.* (1967: 38). Our record as well as that of the Japanese vessel lies within the South Atlantic Central Water, and within the South Equatorial Current.

7. *Heteroscyrnoides marleyi* Fowler, 1934 (Fig. 2, table 2)

Heteroscyrnoides marleyi Fowler, 1934: 240, fig. 4 (Point Ocean Beach, Natal).

A single specimen representing not only the first Atlantic record, but also the second specimen known as yet:

ISH 1502/71. W.H. St. 431—III/71: 30° 04' S, 05° 22' E, 502—0 m, 31. III. 1971, 2205—2252 h (1 ♀, 284.5 mm).

The description is as follows (proportional dimensions are summarized and compared with those of the holotype in table 2): Trunk subcylindrical, moderately slender, its height at 1st dorsal fin about 6.6 in its length to origin of caudal; dorsal and ventral profiles in front of 1st dorsal moderately arched, thereafter nearly straight. Body sector to cloaca about 1.7 times as long as tail sector. Caudal peduncle without any ridges or caudal pits. Dermal denticles densely spaced, overlapping, lanceolate with three (to four on lower surface of snout) longitudinal ridges, the median of which is strongest. Pedicels of denticles very short. Photophores in form of tiny spherical, black spots underneath the blades of denticles building a semicircular band around the posterior half of the pedicels. These photophores are densely crowded on the lower side of head and body, they also exist, much more sparsely distributed, on the flanks and upper side. The configuration of the demal denticles correspond much better to the figure provided by BIGELOW & SCHROEDER (1957: fig. 15 b) than to that drawn by BASS *et al.* (1976: fig. 32).

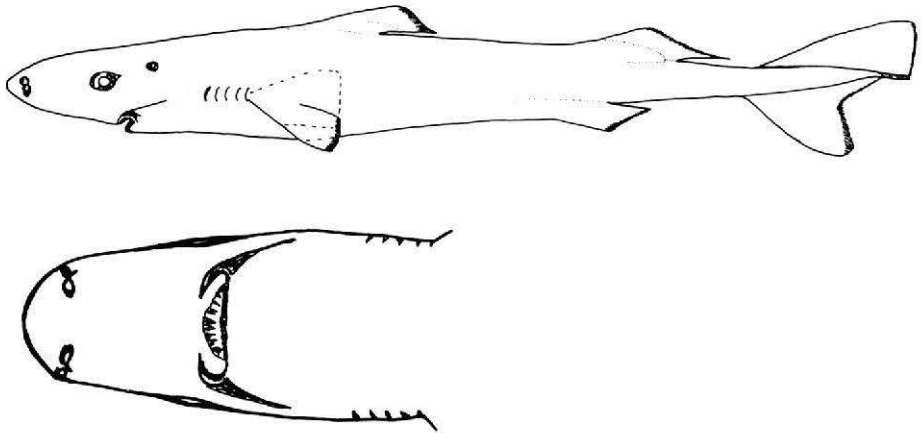


Fig. 2: *Heteroscyrnoides marleyi* Fowler, 1934. ISH 1502/71. ♀, 284.5 mm.

Head $\frac{1}{3}$ (33.1%) of length to origin of caudal. Snout thick, broadly ovate and long, its length in front of mouth a little less than $\frac{1}{2}$ of head length. Eye oval, small, its horizontal diameter only about $\frac{1}{3}$ of length in front of mouth. Spiracles at the upper side of head, straight, subcircular, about $2\frac{1}{2}$ in length of eye and posterior to latter by a distance a little less than twice their own diameter. Gill openings small, subequal, their lengths somewhat more than $\frac{1}{3}$ as long as the horizontal diameter of eye, rather low on sides of head, the 5th close in front to origin of pectoral. Nostrils large, more than $\frac{1}{3}$ as long as horizontal diameter of eye, very slightly oblique, their anterior margins

expanded as acutely triangular lobes, pointed at tip. Mouth very little arched. Lips fleshy, adnate to the gum along midsector of upper jaw only, preoral pouch not very voluminous but extended as narrow clefts rearward from corners of mouth for about $\frac{1}{2}$ of the distance to 2nd gill opening.

Table 2 Body proportions measured as % of total length in *Heteroscymnoides marleyi*

		ISH 1502/71	ANSP* 53046
Total length		284.5 mm	126 mm
Trunk at origin of pectoral:	breadth	11.28	—
	height	11.25	—
Snout length in front of:	outer nostrils	2.25	—
	inner nostrils	4.01	4.7
	mouth	13.00	16.0
Orbit:	horizontal diameter	3.94	4.2
Spiracle:	length	1.58	1.4
Mouth:	breadth	7.98	7.2
	height	1.81	—
Nostrils:	distance between inner ends	3.16	4.3
Labial furrow lengths from angle of mouth:	upper	2.00	2.0
	lower	1.44	3.9**
Gill opening length:	1st	1.41	0.6
	3rd	1.41	0.6
	5th	1.48	0.7
First dorsal fin:	vertical height	2.64	3.4
	length of base	8.79	13.7
Second dorsal fin:	vertical height	2.88	2.3
	length of base	8.26	9.6
Caudal fin:	upper margin	17.79	19.1
	lower anterior margin	12.51	13.0
Pectoral fin:	extreme length	11.14	11.6
	extreme breadth	6.82	—
Pelvic fin:	length	11.25	9.0
Distance from snout to:	1st dorsal fin	34.38	33.3
	2nd dorsal fin	65.17	—
	upper caudal origin	82.25	81.8
	pectoral fin	27.24	30.1
	pelvic fin	62.50	57.0
Interspace between:	1st and 2nd dorsal	23.34	19.8
	2nd dorsal and caudal	8.61	—
	pelvics and caudal	14.24	—
Distance from origin to origin of:	pectorals and pelvics	31.99	27.3
	pelvics and caudal	21.55	21.3
	1st and 2nd dorsal	32.16	33.19***
	2nd dorsal and caudal	17.93	18.3

*) according to BASS *et al.*, 1976: table 27.

***) obviously rearward extension of preoral cleft.

****) measured by the present author at fig. 32 G in BASS *et al.*, 1976, which give erroneously 3.0.

Teeth $\frac{6-1-6}{10-1-10}$ as far as countable without disfiguring the specimen. The central teeth are figured by BIGELOW & SCHROEDER (1957: fig. 15 F).

Dorsal fins without spines.

First dorsal fin moderately small, with broadly rounded apex, its base 3.4 in head length (29.7%), its vertical height about $\frac{1}{3}$ or length of base, its anterior margin slightly convex, its rear margin straight, its free rear tip somewhat more than $\frac{2}{3}$ of base length, its origin just behind inner corner of pectoral fin, the midpoint of its base much nearer to axil of pectoral than to origin of pelvics. Second dorsal fin similar to 1st, but a little longer at base and a little higher, its origin about over axil of pelvics. Interspace between 1st and 2nd dorsals about 2.8 times as long as that between 2nd dorsal and origin of caudal fin. Caudal fin 5.6 times in total length, more than $\frac{4}{5}$ as broad as long, its tip narrowly rounded, its posterior outline deeply concave, the lower lobe broadly triangular with broadly rounded tip, its anterior margin more than $\frac{2}{3}$ as long as upper margin of caudal. Pelvic fins not quite $\frac{2}{3}$ as long at base as base of 2nd dorsal, with straight margins, shallowly rounded apices and sharply pointed tips. Length of pectoral fins about 2.5 in head length, not quite $\frac{2}{3}$ as broad as long, with softly convex outer, and slightly convex distal margins, the corners are very slightly rounded.

There are 34 monospondylous (Vtr) and 19 diplospondylous vertebrae in front of the caudal fin (Vac 53) and 19 terminal vertebrae (Vt) giving a vertebrae sum of 72.

The colouration (in isopropanol) is brown, somewhat darker on the lower side, all fins with fringed, translucent edges due to the uncovered tips of the ceratotrichia.

***8. Isistius brasiliensis* (Quoy & Gaimard, 1824)**

Scymnus brasiliensis Quoy & Gaimard, 1824: 198 (Brazil).

During our various cruises we got the following specimens:

ISH 623/64. W. H. St. 111/64: 14° 30' N, 18° 37' W, IKMT 10', 400—0 m, 26. III. 1964, 0035—0215 h (1 ♂ adult, 365.0 mm).

ISH 292/66. W. H. St. 181/66: 19° 11' N, 21° 58' W, 460—0 m, 14. V. 1966, 2205—2335 h (1 ♂ adult, 376.0 mm).

ISH 779/66. W. H. St. 192/66: 23° 02' S, 33° 19' W, 180—0 m, 25. V. 1966, 2055—2215 h (1 ♂ juv., 319.0 mm).

ISH 873/68. W. H. St. 16/68: 03° 00' S, 26° 16' W, ca. 2000—0 m, 3. II. 1968, 1915—2045 h (1 ♂ juv., 187.0 mm).

ISH 1416/71. W. H. St. 427/71: 33° 00' S, 07° 50' E, ca. 2000—0 m, 30. III. 1971, 2100—2343 h (1 ♂ ad., 390.0, 1 ♀, 465.5 mm).

ISH 1467/71. W. H. St. 431—I/71: 30° 09' S, 05° 26' E, 105—0 m, 31. III. 1971, 1938—2008 h (1 ♂, juv., 285.5 mm).

ISH 1754/71. W. H. St. 451/71: 15° 45' S, 06° 06' W, 1900—0 m, 5. IV. 1971, 2050—2305 h (1 ♂ juv., 247.0 mm).

ISH 2773/71. W. H. St. 498—II/71: 17° 24' N, 22° 57' W, 315—0 m, 17. IV. 1971, 2050—2124 h (1 ♂ ad., 376.0 mm).

ISH 2811/71. W. H. St. 498—III/71: 17° 27' N, 22° 55' W, 610—0 m, 17. IV. 1971, 2129—2250 h (1 ♂ adult, 393.5 mm).

This small, luminous shark is so well known as to not demand any further description. It should be mentioned however, that there is a single female only amongst our ten specimens. The species is widely distributed in all three oceans; according to SEIGEL (1978) it "mostly inhabits the colder, richer waters of the Pacific and Atlantic equatorial water masses".

9. *Squaliolus laticaudus* (Smith & Radcliffe, 1912)

Squaliolus laticaudus Smith & Radcliffe, 1912: 683—685, pls. 54, 55, fig. 1 (Batangas Bay, Luzon, Philippines).

Of the six specimens taken by FRS "Walther Herwig" three were taken by MT 1600 during the 1966- and 1968-transects, whereas three others came from bottom trawl hauls off southeastern South America. Since all of them have been published by SEIGEL et al. (1977) and SEIGEL (1978), only those taken pelagically are mentioned here.

ISH 293/66. W. H. St. 181/66: 19° 11' N, 21° 58' W, 460—0 m, 14. V. 1966, 2205—2335 h (2 ♀♀, 223, 228 mm).

ISH 1658/68. W. H. St. 30/68: 36° 37' S, 51° 32' W, ca. 2000—0 m, 16. II. 1968, 2340—2440 h (1 ♂? adult, 223 mm).

Family: Pseudocarchariidae

10. *Pseudocarcharias kamoharai* (Matsubara, 1936)

Carcharias kamoharai Matsubara, 1936: 380—382 ("Koti fish market", Japan).

This wide-ranging species is represented in the ISH collections by:

ISH 587/68. W. H. St. 12—II/68: 12° 07' N, 23° 08' W, ca. 2000—0 m, 30. I. 1968, 2235—2355 h (1 ♀, 1020 mm, with 4 embryos: 3 ♂♂, 389.0, 390.5, 405.0, 1 ♀, 397.5 mm). The embryos were near-term, without a visible umbilical scar, and were born in the laboratory of the ship about 15 minutes after the end of the haul. They all have the characteristic large, white blotch between the corner of the mouth and the 1st gill slit followed in one of the specimens by a smaller one between 1st and 2nd gill slit, and in another one by two blotches between gill slits 1 and 2 and between 2 and 3. There is no trace of such a white area in the mother. The spiracula are small and slit-like, and can be easily overlooked as happened obviously in the original description by MATSUBARA (1936). D'AUBREY (1964) has shown convincingly that *Carcharias yangi* Teng, 1959 and *Pseudocarcharias pelagicus* Cadenat, 1963 are mere junior synonyms of *P. kamoharai*.

This nyctiepelagic (?) midwater species has been found in the warm waters of the eastern Atlantic, off Cape Town, in the southwestern Indian Ocean, the Bay of Bengal and in the western and eastern Pacific. Most of the specimens were taken by longliners in deep water.

Family: Carcharhinidae

11. *Carcharhinus falciformis* (Bibron, 1841)

Carcharias falciformis Bibron in Müller & Henle, 1841: 47 (Cuba).

A single specimen of this wide-ranging epipelagic shark has been taken by MT 1600:

ISH unregistered. W. H. St. 15—I/68: 00° 20' N, 25° 20' W, 90—0 m, 2. II. 1968, 2113—2138 h (1 ♂ juv., 1780 mm; only jaws and piece of skin preserved). The Silky Shark has

and almost worldwide distribution in tropical waters, it is mainly oceanic, much more rarely found in neritic habitats.

The tooth formula in our specimen, $\frac{15-1-15}{14-1-15}$, is in agreement with that of other specimens investigated by the present author from off West Africa (KREFFT, 1968 b: 50).

C. Discussion

When compared with the very large numbers of bony fishes taken in midwater during the "Walther Herwig" transects, the number of sharks appears surprisingly small at the first look. It should be remembered, however, that not only the total number of living shark species is very modest, but that oceanic species inhabiting the pelagic realm actually are only a few. Moreover, most of these seem to build much smaller populations than bony fishes normally do. Sharks growing to a large size prefer near-shore or island habitats, i. e. more productive areas, except for a couple of species. According to our observations on board "Walther Herwig" such large oceanic predators were seen at the surface on rare occasions only, and these sharks always were *Carcharhinus maou*, the Oceanic White-tip. Since the MT 1600 was towed during the transects almost exclusively in deeper layers of the ocean, catches of true epipelagic species could not be expected at all, because the gear tends to collapse already early, when hauled back from greater depths. The capture of the single Silky Shark in so far was an exception, it happened in one of the very few shallow hauls. It seems improbable that avoidance of the gear could have played an important role. Our experiences from the shelf and slope areas off South America and elsewhere gave ample proof of the ability of the Engel trawl to catch large sharks in midwater as well as close to the surface.

Sharks, which could be expected in our midwater hauls, therefore were restricted almost entirely to the monotypic Pseudocarchariidae and the Dalatiinae. These sharks, most of

Table 3 Geographical distribution and recorded numbers of specimens of oceanic species of the subfamily Dalatiinae (Squalidae)

Species	Atlantic	Indian Oceans	Pacific	total No. of specimens recorded	"Walther Herwig" captures
<i>Euprotomicroides zantedeschia</i> *)	1	—	—	1	1
<i>Euprotomicrus bispinatus</i> **)	1	11	22	37	2
<i>Isistius brasiliensis</i> ***)	11	2	40	53	10
<i>Isistius plutodus</i> ****)	1	—	1	2	—
<i>Heteroscymnoides marleyi</i> *****)	—	1	—	1	1
<i>Scymnodalatias sherwoodi</i> *****)	—	—	1	1	—
<i>Squaliolus laticaudus</i> *****)	3	1	26	30	6
					(thereof 3 in bottomtrawls)

*) according to HULLEY & PENRITH, 1966

***) according to HUBBS *et al.*, 1967

****) according to PARIN, 1964

*****) according to PARIN, 1975

*****) according to BASS *et al.*, 1976

*****) according to GARRICK, 1956

*****) according to SEIGEL, 1978

them growing to a very small size, seem to be nowhere common. For example, the number of *Pseudocarcharias* taken in the Atlantic Ocean heretofore is not more than three specimens. With an apparent progeny of not more than four pups per litter, the total stock must be small and is widely scattered. Similar conditions may prevail in most of the Dalatiinae. Except for the relative large *Dalatis*, which prefers slope areas rather than the open sea, and is spending most of the time close to the bottom, dalatiine populations seem to be sparse. All of the species concerned have low rates of propagation as far known, ranging from 6 to 7 mature eggs found in *Isistius brasiliensis* and 8 in *Euprotomicrus* to perhaps 24 in *Squaliolus*. The low fecundity in these dwarf sharks may

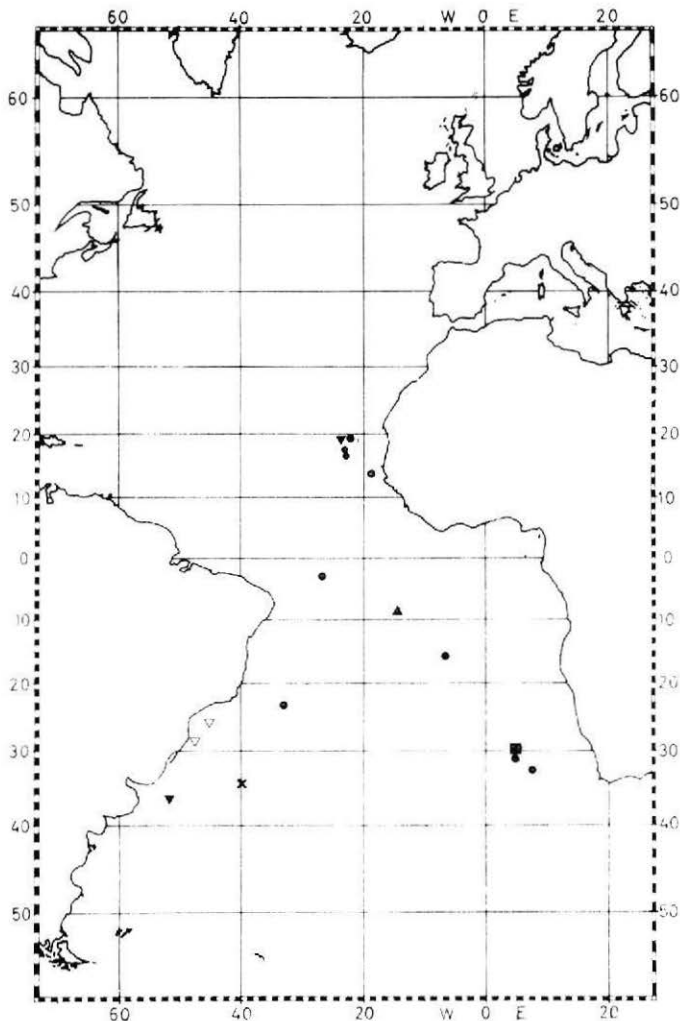


Fig. 3: Distribution of shark catches in the "Walther Herwig" transects. Dalatiinae: × *Euprotomicroides zantedeschia*, ▲ *Euprotomicrus bispinatus*, ■ *Heteroscymnoides marleyi*, ● *Isistius brasiliensis*, ▼ *Squaliolus laticaudus* (MT 1600), ▽ same species (bottom trawl).

be an ingenious mechanism for keeping the populations at a low level, that may be important in an environment where food is scarce, and where intraspecific competition has to be avoided. The somewhat higher fecundity of *Squaliolus* probably can be referred to its ways of life, which differ from those of other dwarf species. Opposite to the species of *Euprotomicrus* and *Isistius* (and probably *Euprotomicoides* and *Heteroscymnoides*), *Squaliolus* spends part of its life at or close to the bottom. Three of the six specimens taken by "Walther Herwig" came from bottom trawl hauls at depths ranging from 300 to 500 m, they were caught in daylight. Moreover, one of the first Atlantic specimens was found in very shallow water near Arcachon, France, among seaweed (*Zostera*).

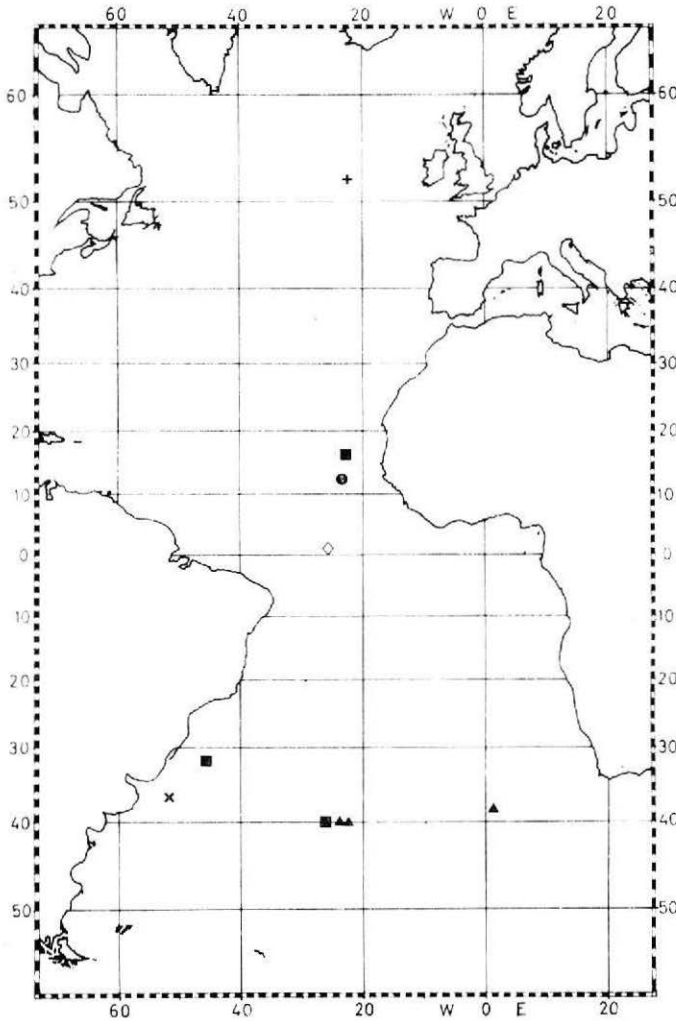


Fig. 4: Distribution of shark catches in the "Walther Herwig" transects. Non-dalatiine species: \times *Etmopterus gracilispinis*, \blacktriangle *E. pusillus*, \blacksquare *Scymnodon obscurus*, $+$ *Centrophorus squamosus*, \bullet *Pseudocarcharias kamoharai*, \diamond *Carcharhinus falciiformis*.

A look at the small numbers of the various dwarf dalatiines recorded in literature underlines the obvious scarcity of the various species. In table 3 these earlier records, as far as available, are compared with the catches by FRV "Walther Herwig". From this comparison the relative frequency of the species can be seen. The "Walther Herwig" catches then are very close to, or even surpass in some cases the published Atlantic records.

The localities where sharks have been taken by us are shown in figs 3 and 4. In addition to the expected species a number of non-dalatiine squalid sharks were taken pelagically, which as a rule are known from bottom trawl catches only. All of them belong to wide-spread species colonizing more than one ocean. Presumably such species owe their wide ranges to their ability to perform oceanic migrations. If this is correct, the same ability may be concluded for a number of other squalid species from their ranges. This seems to be particularly true of species growing to a smaller size only and showing a reduction or complete loss of fin spines either (some *Centroscymnus* species), or have well-developed photophores (*Etmopterus*).

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