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**HEPTRANCHIAS DAKINI WHITLEY, 1931,
A SYNONYM OF *H. PERLO* (BONNATERRE, 1788),
THE SHARPSNOUDED SEVENGILL OR
PERLON SHARK, WITH NOTES ON
SEXUAL DIMORPHISM IN THIS SPECIES**

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Abstract

Purported differences between *H. dakini* described from Australia and the world-wide *H. perlo* stem from sexual dimorphism, females usually having the anal fin origin beneath the middle of the dorsal fin base, whereas in males it is below the end of the dorsal base. The nature of the dimorphism is discussed and measurements are given of Australian, New Zealand and Cuban specimens. A range of 90-93 precaudal centra and 52-59 caudal centra in six Australian and New Zealand specimens conforms with published counts from Atlantic specimens of *H. perlo*. Brief notes are included on the known distribution and the presumed habitat and mode of life of *H. perlo*.

INTRODUCTION

THE purpose of this account is to establish that the Australasian shark *Heptranchias dakini* Whitley, 1931, is conspecific with *H. perlo* (Bonnaterre, 1788), the widely distributed Sharpsnouted Sevengill shark (alternatively named the Slender Sevengill shark or the Perlon shark). The main reported difference between these nominal species—the relative positions of the dorsal and anal fins—can be shown to be due to sexual dimorphism, and other listed differences are apparently derived from an inaccurate illustration of a single Australian specimen or cannot be substantiated.

PREVIOUS ACCOUNTS

Whitley (1931, p. 310) proposed the new species *Heptranchias dakini* on the basis of an earlier account (McCulloch, 1911, p. 2) of seven specimens from Victoria, Australia, which McCulloch identified as *H. perlo*. Whitley noted that the specimen in McCulloch's figure "appears to differ in having the head $4\frac{1}{2}$ in total length and anal originating below middle of dorsal, with its base shorter than that of dorsal", and he selected as holotype of *H. dakini* the specimen figured by McCulloch (1911, pl. 1, fig. 1).

No definitive account of *H. dakini* has appeared since the original description. In fact, there have apparently never been any measurements taken from a specimen; those of Whitley (1931) were, as far as we can determine (see below), taken straight from McCulloch's illustration. Although this illustration has been re-published several times, no new illustrations of the species have appeared.

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Several Australian workers have referred briefly to the Sharpnosed Sevengill shark. Whitley (1940, 1968), Munro (1956), Scott (1962) and Lynch (1963) treated it as *H. dakini*, while Stead (1963) treated it as *H. perlo*, stating, without supporting evidence, that "Whitley's *Heptranchias dakini* is identical with this species".

Heptranchias was first recorded from New Zealand in 1953 from one specimen (DM 2745) which was referred to *H. dakini* by McCann (1953) and to *H. perlo* (mis-spelt *parlo* in title) by Parrott (1953). The same specimen was discussed in Parrott (1958). No further specimens are recorded in the literature, although several were received and catalogued by the Dominion and Canterbury Museums from 1953 onwards. Whitley (1956, 1968) listed the New Zealand species as *H. dakini*. Richardson and Garrick (1953) mentioned that both *dakini* and *perlo* might occur in the New Zealand area.

Bigelow and Schroeder (1948) listed the two species as distinct, but with some reservations, viz. (p. 92): *Heptranchias perlo* "is represented in Australian waters by a relative (*dakini*) so close to *perlo* that it might finally prove identical". Garrick and Schultz (1963) implied in their account of *H. perlo*—"almost world-wide in distribution", with no mention of a related species *H. dakini*—that only one species existed.

Early brief accounts and listings of *Heptranchias indicus*, *Notidanus indicus* and *Notorynchus indicus*, sometimes named as the "Perlon Shark", in New Zealand literature (e.g. Hutton, 1872: 79; 1904: 54; Sherrin, 1886: 121; Waite, 1907: 6; Hamilton, 1908: 30; Thomson, 1913: 235; Thomson and Anderton, 1921: 68) are inadequate and confusing. We suspect, from the context of the brief accounts, that they refer to the more commonly caught Broadnosed Sevengill *Notorynchus*. We have not checked the early Australian literature, but the same situation may well occur there.

PRESENT STUDY

One of us (L.J.P.) observed that two female *Heptranchias* trawled in New Zealand waters during 1969 had the anal fin origin beneath the middle of the dorsal fin base, while a male also trawled in 1969 had the anal fin origin below the posterior end of the anal base (Plate 1). The females agreed, therefore, with one of Whitley's criteria for *dakini*, while the male fitted *perlo* as diagnosed and figured from a Cuban specimen in Bigelow and Schroeder (1948, p. 88, fig. 10).

The other of us (J.A.F.G.), who was studying in the Australian Museum at the time, took the opportunity of re-examining the material of *Heptranchias* in that institution, including the types of *H. dakini*. We later examined New Zealand *Heptranchias* material in the Dominion Museum collection.

Although *Heptranchias* was not recorded from New Zealand until 1953, and has generally been regarded as rare, we found that there were 14 specimens available, including the three 1969 specimens mentioned above. In addition, we had measurements for two other New Zealand specimens examined by one of us (J.A.F.G.) several years ago in the Canterbury Museum, Christchurch.

Information from these 16 New Zealand specimens, plus five Australian specimens examined in the Australian Museum, plus the account in Bigelow and

Schroeder (1948) of Atlantic specimens, was utilised in arriving at the present conclusion that only one species is involved. Details of the material examined are as follows.

MATERIAL EXAMINED

AUSTRALIA: AMS I.10825, female, 695 mm (possible holotype of *H. dakini* Whitley, 1931), Victorian coast, 1910, *Endeavour*; AMS IB.3277, female, 720 mm, New South Wales, off Barrenjoey, Jan. 1955, J. E. Smith; AMS I.13929, female, 778 mm, New South Wales, N.E. of Cape Solander, 56 fathoms, 1916, State Trawling Dept.; AMS I.10795, female, 822 mm (supposed holotype of *H. dakini* Whitley, 1931), Victorian coast, 60 miles S. of Cape Everard, 60-70 fathoms, 1910, *Endeavour*; AMS I.10794, male, 845 mm (paratype of *H. dakini* Whitley, 1931), same data as AMS I.10795.

NEW ZEALAND: DM 4951, female, 805 mm, Doubtless Bay, 80 fathoms, Feb. 2, 1969, L. J. Paul; DM 4952, male, 856 mm, between Plate Island and White Island, 65-110 fathoms, Feb. 9, 1969, L. J. Paul; DM 1947, male 857 mm, Castlepoint, 40-50 fathoms, Jul. 11, 1956, F. Abernethy; DM 3103, male, 860 mm, off Plate Island, 124-190 fathoms, Feb. 1961, W. Sampson; DM 3023, female, 964 mm, Palliser Bay, 15 fathoms, Mar. 15, 1954, F. Abernethy; DM 3022, female, 1016 mm, off Te Awaiti, 40-70 fathoms, Jul. 8, 1955, F. Abernethy; DM 1848, four females, 1044 mm, 1072 mm, 1078 mm and 1305 mm, Hawke Bay, 180 fathoms, Dec. 16, 1955, J. A. F. Garrick; DM 4953, female, 1100 mm, N.W. of Cape Farewell, 200 fathoms, Jul. 30, 1969, L. J. Paul; CM (no number), female, 1100 mm, probably from Kaikoura; DM 1870, female, 1104 mm, Kaikoura, off Oaro, 100 fathoms, Feb. 14, 1956, R. Baxter; DM 2180, female, 1340 mm, Palliser Bay, 30 fathoms, Mar. 14, 1957, J. Slater; CM (no number), female, 1365 mm, Kaikoura, off Oaro, 180 fathoms, Feb. 1954, R. Baxter; also DM 2745, female, damaged and with some fins removed, not measured by us because of this, but length given by Parrott (1953) as 52 in. (1320 mm), Tasman Bay, off Cape Susie (presumably Cape Soucis), Apr. 18, 1950, J. Cotton.

ATLANTIC: Measurements from Bigelow and Schroeder (1948, p. 89) of MC2 35897, male 698 mm and female 932 mm, Cuba.

TYPE SPECIMENS OF *Heptranchias dakini*

The annotations regarding holotypes of *H. dakini* in the list of material above stem from conflicting data in Whitley (1931, 1957) regarding type material of this species. In the original account of *H. dakini*, Whitley (1931, p. 310) stated that "The holotype of *H. dakini* is the specimen from sixty miles south of Cape Everard, Victoria, figured by McCulloch." McCulloch's illustration (1911, pl. 1, fig. 1) is undoubtedly of a female, although it is not labelled as such, and the illustration is stated to be two-sevenths natural size. The total length in the illustration is 200 mm, which means the specimen was about 700 mm long. Subsequently, Whitley (1957, p. 1) listed as "Types" of *H. dakini* two specimens in the Australian Museum, a male of 845 mm (AMS I.10794) and a female of 822 mm (AMS I.10795). The male cannot be the holotype, because Whitley (1931) nominated McCulloch's figured female as such. The female is thus the supposed holotype—and this supposition is supported by data from the file-card catalogue in the Fish Department of the Australian Museum. However, this female, 822 mm long, appears to be much too long—unless McCulloch's statement of "two-sevenths

natural size" was a very general approximation. If neither of these two specimens is the holotype, the possibility remains that a third specimen in the Australian Museum (AMS I.10825), a female of 695 mm labelled "Victorian Coast. 1910. Commonwealth Fish Bureau. *Endeavour*", was one of the seven specimens, all from the same haul, on which McCulloch based his account, but we are not able to establish this. The size of this female closely accords with our calculated size for the shark figured by McCulloch. Consequently we treat this specimen as the "possible holotype" in our list of material examined and in Tables 1 and 2. We do not know the fate of the remainder of McCulloch's specimens.

IDENTIFICATION OF *Heptranchias dakini* AS *H. perlo*

Whitley (1931, p. 310) gave three diagnostic characters for *H. dakini*. The first of these was that the head was " $4\frac{1}{2}$ in total length", but Whitley did not say how this differed from the situation in *H. perlo*. From our data (Table 1) we find no obvious difference in head length (measured to the posterior end of the 7th gill-opening) relative to total length between Australian, New Zealand and Atlantic *Heptranchias*. Nor do we find any specimens in which this proportion is $4\frac{1}{2}$. The range for three Australian specimens, including the two "Types" of *dakini*, is 5.0 to 5.5 (mean 5.3); for 15 New Zealand specimens 4.8 to 5.6 (mean 5.2); and for two Cuban specimens the almost equivalent prepectoral lengths, as given by Bigelow and Schroeder, equal 4.8 and 5.2 in total length. We note that McCulloch's illustration shows a head length of about 4.5 in total length and assume that this was the basis of Whitley's statement.

Whitley's second diagnostic character for *H. dakini* was that the anal fin originates below the middle of the dorsal fin base. We have examined this character and find that it occurs only in females; it is present in New Zealand specimens and in a Cuban specimen of *H. perlo* as well as in Australian specimens. Males on the other hand have the anal fin origin further rearward, below the posterior end of the dorsal base or at least nearer to that level than to the middle of the dorsal base. There is some overlap between the sexes, with a minority of the females approaching or overlapping the male condition. Table 1 shows for each of our specimens the proportion (%) of the dorsal fin base which is anterior to the anal fin origin. In 13 of the 17 females there is from 50.0% to 71.7% of the dorsal base anterior to the anal fin origin. In other words, in these 13 females the anal fin origin is nearer to the middle of the dorsal base than to the posterior end. In the remaining four females there is from 75.4% to 100.0% of the dorsal base anterior; thus their anal fin origin is nearer to the posterior end of the dorsal fin base than to the middle. The condition in these four females is similar to that of the five males in which from 76.3% to 102.8% of the dorsal base is anterior.

It is clear from the above data that the position of the anal fin relative to the dorsal fin in *Heptranchias* predominantly reflects sexual dimorphism and offers no evidence for distinguishing a separate Australian species, *H. dakini*, from the world-wide *H. perlo*.

It is, perhaps, surprising that this possibility did not occur to Whitley when he described *H. dakini*, insofar as the "Types" of *H. dakini* which he designated (Whitley, 1957) included a male as well as a female specimen—and these particular specimens differ strongly in this feature.

Whitley's third diagnostic criterion for *H. dakini* was that the anal base is shorter than the dorsal base. We find that this is true for the Australian *H. dakini* material, but it also applies to our New Zealand specimens, as well as to the

Atlantic specimens of *H. perlo* described in Bigelow and Schroeder (1948, p. 89). There seems, therefore, to be no substance in this criterion for recognising *H. dakini*.

On the basis of the above data we regard *H. dakini* as conspecific with *H. perlo*.

Because there are relatively few published measurements of *H. perlo* we provide here (Table 2) measurements of five New Zealand specimens and three Australian specimens, plus two Cuban specimens (from Bigelow and Schroeder, 1948).

In the same table we give vertebral counts of six Australian and New Zealand specimens, which range from 90-93 precaudal and 52-59 caudal centra. Such counts closely agree with those published in Springer and Garrick (1964, p.83) for three western North Atlantic specimens (89-90 precaudal, 52-61 caudal) of *H. perlo* and provide supporting evidence that only one species is involved.

SEXUAL DIMORPHISM IN *Heptranchias perlo*

In order to provide further information on the nature of sexual dimorphism in *H. perlo* we have listed in Table 1 various proportional dimensions which appear to be significant in this respect. Because of the small number of specimens involved, and the scarcity of males, we interpret the differences between the sexes with caution.

Expressed as a percentage of total length, the average predorsal length of females is slightly longer (0.8%) than that of males. Conversely, the average distance from snout tip to anal fin origin is slightly shorter (0.7% t.l.) in females than in males. The greater proximity of the dorsal and anal fins in the females compared to the males seems due, therefore, to equal differences in the positions of both of these fins between the sexes rather than to a more marked difference in the position of either one of the fins. In females the average prepelvic length is slightly longer (0.9% t.l.) than in males. This situation coupled with the shorter snout to anal fin length in females provides a more notable difference between the sexes in the distance between the pelvic fin origin and the anal fin origin. In females this distance averages 13.7% t.l., whereas in males it is 15.2% t.l.

Thorson, Watson and Cowan (1966, p. 395) discussed sexual dimorphism in the Bull shark, *Carcharhinus leucas*, from Lake Nicaragua and showed that in that species also the distance between the pelvic and anal fins was shorter in females than males. They concluded that "externally, the pelvic fins and cloaca are displaced posteriorly by about 2.5% of the body length in females, while other features are placed approximately as in the males". Our conclusions for *H. perlo* agree, in general, with those of Thorson *et al.*, but the differences we have observed are much less trenchant.

Hubbs, Iwai and Matsubara (1967) have shown that in the dwarf pelagic shark *Euprotomicrus bispinatus* the length of the abdomen increases with size of fish, and that this increase is most marked in females. They consider this "an adaptation to fecundity in a dwarfed shark", but suggest, after noting the findings of Thorson *et al.*, that a relatively larger abdomen in females "may well be a common characteristic of sharks".

The function of such sexual dimorphism is not well established, but it possibly hinges on two quite different requirements. For females a greater prepelvic length would permit a longer body cavity and hence be advantageous for a live-bearing species. For males a shorter prepelvic length, which in *H. perlo* is combined with a more posteriorly sited anal fin, provides for a longer pelvic-anal fin interspace and hence allows space for the large claspers.

Table 1. Selected dimensions of Australian, New Zealand and Atlantic specimens of *Heptanchias perlo*. Dimensions in columns A-B are those which according to Whitley (1931) should separate *H. dakini* from *H. perlo*. Dimensions in columns B-F illustrate sexual dimorphism in *H. perlo*.

	Sex and total length (mm)	Locality	Catalogue No. ¹	A Head length in total length	
Individual specimens	Females:				
	695	Australia	AMS I.10825 ^a	5.0	
	720	"	AMS IB.3277	—	
	778	"	AMS I.13929	—	
	805	New Zealand	DM 4951	5.3	
	822	Australia	AMS I.10795 ^a	5.4	
	932	Cuba	MCZ 35897 ^b	5.2 ^c	
	964	New Zealand	DM 3023	5.0	
	1016	"	DM 3022	5.3	
	1044	"	DM 1848	5.2	
	1072	"	DM 1848	5.0	
	1078	"	DM 1848	5.0	
	1100	"	DM 4953	5.5	
	1100	"	CM (—)	5.5	
	1104	"	DM 1870	5.2	
	1305	"	DM 1848	5.4	
	1340	"	DM 2180	5.4	
	1365	"	CM (—)	5.6	
	Males:	698	Cuba	MCZ 35897 ^b	4.8 ^c
		845	Australia	AMS I.10794 ^a	5.5
856		New Zealand	DM 4952	5.4	
857		"	DM 1947	4.8	
860		"	DM 3103	5.1	
Regional totals	Females	Australia	(n = 4)		
	Male	"	(n = 1)		
	Combined Total	"	(n = 5)	5.0-5.5 (5.3)	
	Females	New Zealand	(n = 12)		
	Males	"	(n = 3)		
	Combined Total	"	(n = 15)	4.8-5.6 (5.2)	
Cuba	Female	"	(n = 1)		
	Male	"	(n = 1)		
	Combined Total	"	(n = 2)	4.8-5.2 (5.0)	
Combined totals	Females	All localities	(n = 15 or 17) [†]	5.0-5.6 (5.3)	
	Males	"	(n = 5)	4.8-5.5 (5.1)	
	Combined Total	"	(n = 20)	4.8-5.6 (5.2)	
	Female Proportions relative to Male (mean)	"			

¹ Catalogues: AMS = Australian Museum, Sydney, Australia.
 CM = Canterbury Museum, Christchurch, New Zealand.
 DM = Dominion Museum, Wellington, New Zealand.
 MCZ = Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, U.S.A.

² Preanal length, as used here, is distance from snout tip to anal fin origin.

³ Possible holotype of *H. dakini* (see text).

B % dorsal base anterior to anal fin origin	C Predorsal length as % t.l.	D Preanal ² length as % t.l.	E Prepelvic length as % t.l.	F Pelvic origin to anal fin origin as % t.l.
62.8	50.5	54.0	40.3	13.8
50.0	50.5	53.4	—	—
64.6	50.0	53.8	—	—
57.4	50.7	54.0	40.7	13.1
71.7	51.2	55.4	42.5	13.0
59.1	48.3	52.2	38.4	13.8
100.0	47.7	53.9	40.3	13.7
56.7	52.0	55.3	43.2	12.3
55.9	50.7	54.3	41.2	13.2
69.3	52.2	56.3	43.3	13.0
84.3	50.7	55.7	41.5	14.3
57.7	50.5	55.5	41.4	14.1
68.7	50.4	55.3	42.3	13.1
71.7	51.8	56.6	42.1	14.4
75.4	51.3	56.2	42.1	14.2
83.1	51.1	56.7	42.0	14.7
60.0	50.7	55.1	40.8	14.3
93.5	49.0	54.8	40.0	14.8
94.3	50.3	56.2	40.6	15.8
102.0	49.9	55.8	40.0	15.9
102.8	50.5	57.1	41.6	15.4
76.3	49.3	54.1	40.1	14.0
50.0-71.7 (62.3)				
94.3				
55.9-100.0 (70.0)				
76.3-102.8 (93.7)				
59.1				
93.5				
50.0-100.0 (67.6)	47.7-52.2 (50.6)	52.2-56.7 (54.9)	38.4-43.3 (41.5)	12.3-14.7 (13.7)
76.3-102.8 (93.8)	49.0-50.5 (49.8)	54.1-57.1 (55.6)	40.0-41.6 (40.6)	14.0-15.9 (15.2)
-26.2	+0.8	-0.7	+0.9	-1.5

⁴ Listed by Whitley (1957) as "types of *H. dakini*".

⁵ Measurements from Bigelow and Schroeder (1948).

⁶ Measured by Bigelow and Schroeder as prepectoral length; listed here as head length.

[†] We lack complete data on two Australian females, hence for some dimensions n = 15.

Table 2. *Heptanchias perlo*: proportional dimensions as percentage of total length

	♀ 695 mm ¹	♂ 698 mm ²	♀ 805 mm	♀ 822 mm ³
	AMS I.10825	MCZ 35897	DM 4951	AMS I.10795
	Australia, Vict.	Cuba	New Zealand	Australia, Vict.
Snout tip to:				
outer nostrils	2.2	2.0	2.0	2.2
eye	5.3	—	4.7	5.4
mouth	4.9	5.0	4.0	4.6
1st gill-opening	15.5	—	15.5	13.7
4th gill-opening	17.7	—	16.6	16.3
7th gill-opening	19.8	—	18.7	18.4
pectoral origin	21.0	20.9	19.6	19.3
dorsal origin	50.5	49.0	50.7	51.2
anal fin origin	54.0	54.8	54.0	55.4
upper caudal origin	68.6	69.4	68.3	69.1
lower caudal origin	68.8	—	69.6	70.2
pelvic origin	40.3	40.0	40.7	42.5
Nostrils—distance between				
inner corners	3.0	2.6	2.5	2.9
Mouth:				
width	6.5	8.0	5.8	6.8
length	6.0	6.4	6.3	6.0
Length from mouth angle to				
posterior end of labial				
furrow	3.2	—	2.7	3.4
Gill-opening lengths:				
1st	7.3	5.7	7.2	6.7
4th	5.9	4.2	5.2	5.1
7th	3.5	2.6	2.9	2.7
Eye—horizontal diam.	3.9	4.0	3.7	4.0
Dorsal fin:				
length base	6.2	6.2	5.8	6.4
posterior margin	1.7	—	1.5	1.7
height	4.6	4.3	4.0	4.0
Anal fin:				
length base	5.7	5.9	5.6	6.0
posterior margin	1.4	—	1.2	1.3
height	2.9	2.2	2.2	2.6
Pectoral fin:				
length base	6.2	—	5.7	6.2
anterior margin	11.4	11.4	10.3	11.1
distal margin	8.6	9.6	9.3	8.3
Pelvic fin:				
length base	7.9	—	7.5	7.5
anterior margin	4.5	—	4.3	4.1
distal margin	6.0	—	6.8	6.8
length claspers	—	—	—	—
Caudal:				
length upper lobe	31.7	30.6	31.7	31.0
length lower lobe	7.9	9.0	8.1	7.9
Trunk at pectoral origin:				
width	10.1	8.4	8.2	9.1
height	9.9	9.6	9.9	8.8
Dental formula ⁵	—	12-12	10-10	(?)10-10-(?)
Vertebrae:				
precaudal	93	5-1-5	6-1-6	(?)5-1-5-(4?)
caudal	52	—	55	59
total	145	—	146	151

¹ Possible holotype of *H. dakini* (see text).² Measurements from Bigelow and Schroeder (1948, p. 89).³ Supposed holotype of *H. dakini*.

♂ 845 mm ⁴	♂ 856 mm	♀ 932 mm ²	♀ 1100 mm	♀ 1100 mm	♀ 1365 mm
AMS I.10794	DM 4952	MCZ 35897	DM 4953	CM (—)	CM (—)
Australia, Vict.	New Zealand	Cuba	New Zealand	New Zealand	New Zealand
1.7	1.8	2.0	1.8	1.8	2.0
5.1	4.2	—	4.8	4.7	4.4
4.5	4.2	4.8	3.7	4.0	4.0
13.1	15.5	—	15.7	15.3	14.7
13.8	18.1	—	17.9	—	—
16.1	18.4	—	18.2	18.2	18.0
18.2	19.5	19.1	18.6	18.3	18.1
50.3	49.9	48.3	50.5	50.5	50.7
56.2	55.8	52.2	55.5	55.5	55.1
69.7	68.7	69.6	69.5	70.1	71.2
70.1	69.9	—	70.5	—	—
40.6	40.0	38.4	41.4	42.3	40.8
3.0	2.7	2.1	2.8	2.7	2.4
6.7	5.8	7.0	6.2	—	—
6.0	6.2	7.1	5.9	—	—
3.3	2.9	—	2.7	—	—
7.5	8.2	7.2	7.7	6.8	7.1
6.4	5.8	5.3	5.5	—	—
3.2	2.9	3.1	3.0	3.0	2.6
4.0	3.7	3.6	3.4	3.5	3.7
6.3	5.8	6.6	7.1	7.3	7.3
1.7	1.5	—	1.7	—	—
4.1	4.0	4.5	4.3	3.6	3.5
5.6	5.5	5.9	6.3	6.0	6.2
1.4	1.2	—	1.4	—	—
2.6	2.0	2.7	2.4	2.3	2.5
6.0	5.8	—	5.9	—	—
11.4	10.2	11.4	10.0	10.3	8.8
8.8	9.3	8.5	8.6	9.1	—
7.0	7.0	—	7.5	—	—
4.5	3.7	—	4.2	3.9	4.8
9.0	10.2	—	6.5	6.6	6.8
4.5	—	—	—	—	—
30.3	31.0	30.4	30.3	29.7	28.6
7.9	8.0	8.6	7.9	7.5	7.7
9.1	8.8	9.1	9.0	8.2	7.3
9.1	9.3	10.7	10.9	11.2	8.8
(?)6-9-9-(6?)	11-11	12-12	10-11	(7)-10-10-(7)	—
(?)6-5-1-5-(6?)	6-1-6	5-1-5	(1)-5-1-5-(1)	(12)-5-1-5-(9)	—
90	90	—	91	—	—
53	54	—	52	—	—
143	144	—	143	—	—

⁴ Paratype of *H. dakini*.⁵ Some counts here include only the major teeth in each jaw, but in others the very small posterolateral teeth are given in parentheses.

We have not searched the literature on other notidanoid sharks to see if they show sexual dimorphism comparable with that in *H. perlo*, but we do note that illustrations of the male holotype and a female of *Hexanchus vitulus*, a new species of Sixgill shark described by Springer and Waller (1969), show the male with the anal fin origin towards the posterior end of the dorsal base, whereas in the female it is below the middle of the base. Through the kindness of Mr. Stewart Springer, co-author of *Hexanchus vitulus*, we have been given measurements of the type specimens. These establish that in the male holotype the proportion (%) of the dorsal fin base anterior to the anal fin origin is 81%, whereas in the female paratype it is 67% and in another smaller female it is 74%. The situation in *Hexanchus vitulus*, is, therefore, akin to that in *H. perlo*, and it seems likely that such sexual dimorphism is common to all notidanoids.

DISTRIBUTION AND HABITAT

Bigelow and Schroeder (1948) record *H. perlo* from the eastern and western North Atlantic, the Mediterranean, the Cape of Good Hope and Japan. The present paper extends its known range to Australia and New Zealand. It is undoubtedly more widely distributed than has been recorded.

Little is known of its mode of life. Bigelow and Schroeder (1948) note that "It seems to be a bottom dweller chiefly, of coastal waters", and give it an extended depth range from about 400 m off Portugal and deep water off Cuba, to very shallow water and lagoons on the coast of Africa. The latter record is based on Rochebrune's (1882) account of *Notidanus cinereus*, but this possibly is referable to the Broadsnouted Sevengill *Notorynchus*, which is regularly taken in very shallow water in several parts of the world. There is considerable confusion between *Hepranchias* and *Notorynchus* in early accounts.

Australian accounts (of *dakini*) indicate a range of 100 to 400 m, with some captures in more shallow water. Most recorded New Zealand captures have been in moderately deep water, with some shallow-water captures (50 m) in areas where other deep-water fish are also sometimes taken.

We believe that *H. perlo* is a shelf-edge species, and that it may be rather more common than its reported captures indicate, its slenderness and agility allowing it to escape from trawl nets. When caught it is very active and aggressive, its flexible vertebral column allowing almost snake-like movements. Scott (1962) reports it as being frequently taken on long-lines in South Australia, and one of us (J.A.F.G.) took four fish on one long-line set in 330 m in Hawke Bay, New Zealand, in 1955. The lightly calcified skeleton of *H. perlo*, mentioned in passing by Springer and Garrick (1964), and shown here in Plate 2, may be an adaptation to a bathypelagic, or at least "above-bottom" mode of life, similar to that of the lightly-calcified "pelagic" shark *Euprotomicrus bispinatus* (see Hubbs *et al.*, 1967). Bone and Roberts (1969) have tentatively classified *H. perlo* as pelagic, apparently on the basis of an earlier liver-oil density determination (Tsujiimoto, 1932). Further work on fish density, liver-oil analysis (such as that of Shimma and Shimma, 1969) and studies on eye structure (Denton and Nicol, 1964) may provide some answers on the mode of life of this species.

ACKNOWLEDGEMENTS

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the New Zealand specimens in this account were made by Mr. J. Bahler, Fisheries Research Division, Wellington, while the radiographs of the Australian specimens were by Mr. C. Turner, Australian Museum. We thank Dr. R. M. McDowall, Fisheries Research Division, Wellington, for reading our manuscript and suggesting improvements to it.

LITERATURE CITED

- Bigelow, H. B. and Schroeder, W. C. 1948: Fishes of the western North Atlantic. *Mem. Sears Found Mar. Res.*, 1(1), xvii + 576 pp., 106 text-figs.
- Bone, Q. and Roberts, B. L. 1969: The density of elasmobranchs. *J. mar. biol. Ass. U.K.* 49: 913-937.
- Denton, E. J. and Nicol, J. A. C. 1964: The chorioidal tapeta of some cartilaginous fishes (Chondrichthyes). *J. mar. biol. Ass. U.K.* 44: 219-258.
- Garrick, J. A. F. and Schultz, L. P. 1963: A guide to the kinds of potentially dangerous sharks. In Gilbert, P. W. (ed), *Sharks and Survival*, pp. 3-60. (Heath & Co., Boston).
- Hamilton, A. 1908: Fishing and sea-foods of the ancient Maori. *Bull. Dom. Mus., Wellington*, 2: 73 pp.
- Hubbs, C. L., Iwai, T. and Matsubara, K. 1967: External and internal characters, horizontal and vertical distribution, luminescence, and food of the dwarf pelagic shark, *Euprotomicrus bispinatus*. *Bull. Scripps Inst. Ocean., Univ. Calif.* Vol. 10, vi + 64 pp., 10 figs., 8 pls.
- Hutton, F. W. 1872: Catalogue with diagnoses of the species. In Hutton, F. W. and Hector, J., *Fishes of New Zealand*, pp. 1-93. (Colonial Museum and Geological Survey Department, Wellington).
- Hutton, F. W. 1904: *Index Faunae Novae Zealandiae*. 372 pp. (Dulau & Co., London).
- Lynch, D. D. 1963: First Australian record of *Hexanchus griseus* (Bonnaterre) 1780. The Six-gilled Shark. *Mem. Nat. Mus. Vict.* 26: 259-261, 1 pl.
- McCann, C. 1953: Ichthyological notes with special reference to sexual dimorphism in some New Zealand fishes. *Rec. Dom. Mus.* 2 (1): 1-17, 17 text-figs.
- McCulloch, A. R. 1911: Report on the fishes obtained by the F.I.S. "Endeavour", on the coasts of New South Wales, Victoria, South Australia and Tasmania. *Zoological results of the fishing experiments carried out by the F.I.S. "Endeavour"*, 1909-10. Part I, pp. 1-87, pl. 1-16, text-figs. 1-20.
- Munro, I. S. R. 1956: Handbook of Australian fishes. No. 1. *Fisheries Newsletter, Australia*. 15(7): 13-20.
- Parrott, A. W. 1953: The perlon shark (*Hepranchias parlo*) first record from New Zealand waters. *N.Z. Sci. Rev.* 11(9): 113, 1 text-fig.
- Parrott, A. W. 1958: *Big game fishes and sharks of New Zealand*. 127 pp. (Hodder & Stoughton, London).
- Richardson, L. R. and Garrick, J. A. F. 1953: Guide to the lesser chordates and cartilaginous fishes. *Tuatara* 5(1): 22-37.
- Rochebrune, A. T. de. 1882: Faune de la SÉNÉGAMBIE. Poissons. *Act. Soc. Linn. Bordeaux* 6: 37-180, pl. 1-6.
- Scott, T. D. 1962: *The Marine and Fresh Water Fishes of South Australia*. 338 pp. (Govt. Printer, Adelaide).
- Sherrin, R. A. A. 1886: *Handbook of the Fishes of New Zealand*. 307 pp. (Wilson and Horton, Auckland).
- Shimma, H. and Shimma, Y. 1969: Comparative studies on shark liver oils from Suruga Bay. *Bull. Tokai Reg. Fish. Res. Lab. No. 59*: 101-110, 1 fig.
- Springer, S. and Waller, R. A. 1969: *Hexanchus vitulus*, a new Sixgill Shark from the Bahamas. *Bull. Mar. Sci.* 19(1): 159-174, 7 text-figs.
- Springer, V. G. and Garrick, J. A. F. 1964: A survey of vertebral numbers in sharks. *Proc. U.S. Nat. Mus.* 116: 73-96, 1 pl.
- Stead, D. G. 1963: *Sharks and rays of Australian seas*. x + 211 pp., 64 figs. (Angus & Robertson, Sydney).

- Thomson, G. M. 1913: The natural history of Otago Harbour and the adjacent sea, together with a record of the researches carried on at the Portobello Marine Fish-hatchery. *Trans. Proc. N.Z. Inst.* 45: 225-251.
- Thomson, G. M. and Anderton, T. 1921: History of the Portobello Marine Fish-hatchery and Biological Station. *Bull. Bd. Sci. Art. N.Z.* 2: 131 pp.
- Thorson, T. B., Watson, D. E. and Cowan, C. M. 1966: The status of the freshwater shark of Lake Nicaragua. *Copeia* 1966 (3): 385-402, 1 text-fig.
- Tsujimoto, M. 1932: The liver oils of elasmobranch fish. *J. Soc. chem. Ind. Japan* 51: 317-323.
- Waite, E. R. 1907: A basic list of the fishes of New Zealand. *Rec. Canterbury Mus.* 1: 3-39.
- Whitley, G. P. 1929-1931: New names for Australian fishes. *Austral. Zoologist* 6: 310-334, 1 text-fig., pls. 25-27.
- Whitley, G. P. 1940: *The fishes of Australia. Part 1. Sharks, etc.* 280 pp., 303 figs. (Royal Zool. Soc. N.S.W., Sydney).
- Whitley, G. P. 1956: Name-list of New Zealand fishes. In Graham, D. H., *A Treasury of New Zealand Fishes*, pp. 397-414. (A. H. & A. W. Reed, Wellington) 2nd ed.
- Whitley, G. P. 1957: *List of type-specimens of recent fishes in the Australian Museum, Sydney.* (cyclostyled) (Australian Museum, Sydney).
- Whitley, G. P. 1968: A check-list of the fishes recorded from the New Zealand region. *Austral. Zoologist* 15: 1-102.

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ADDENDUM

Since the above manuscript was submitted for publication we have examined another three females and three males of *H. perlo* from New Zealand. All were taken by the Fisheries Research Division's trawler "James Cook" in 130-150 fathoms off the north-west coast of New Zealand, between Cape Reinga and Cape Farewell. The females were 905, 935 and 1395 mm total length, and the males were 640, 818 and 980 mm. Dimensions of these specimens given in the same order, and corresponding with columns B-F in Table 1, are:—

B, 68.7, 54.9, 70.6, 85.4, 83.0, 80.9; C, 50.2, 52.2, 51.9, 49.7, 50.0, 51.5;
D, 54.9, 55.6, 56.3, 55.1, 55.4, 56.7; E, 41.6, 42.8, 43.9, 40.6, 40.3, 41.5;
F, 13.3, 12.8, 12.4, 14.5, 15.1, 15.2.

Mean values of these data for females and males respectively, followed by a figure in parentheses expressing how the females differ from the males, are: B, 64.7, 83.1 (—18.4); C, 51.4, 50.4 (+1.0); D, 55.6, 55.7 (—0.1); E, 42.8, 40.8 (+2.0); F, 12.8, 14.9 (—2.1). The sexual dimorphism illustrated by these additional data conforms very closely with that we report in the present account.

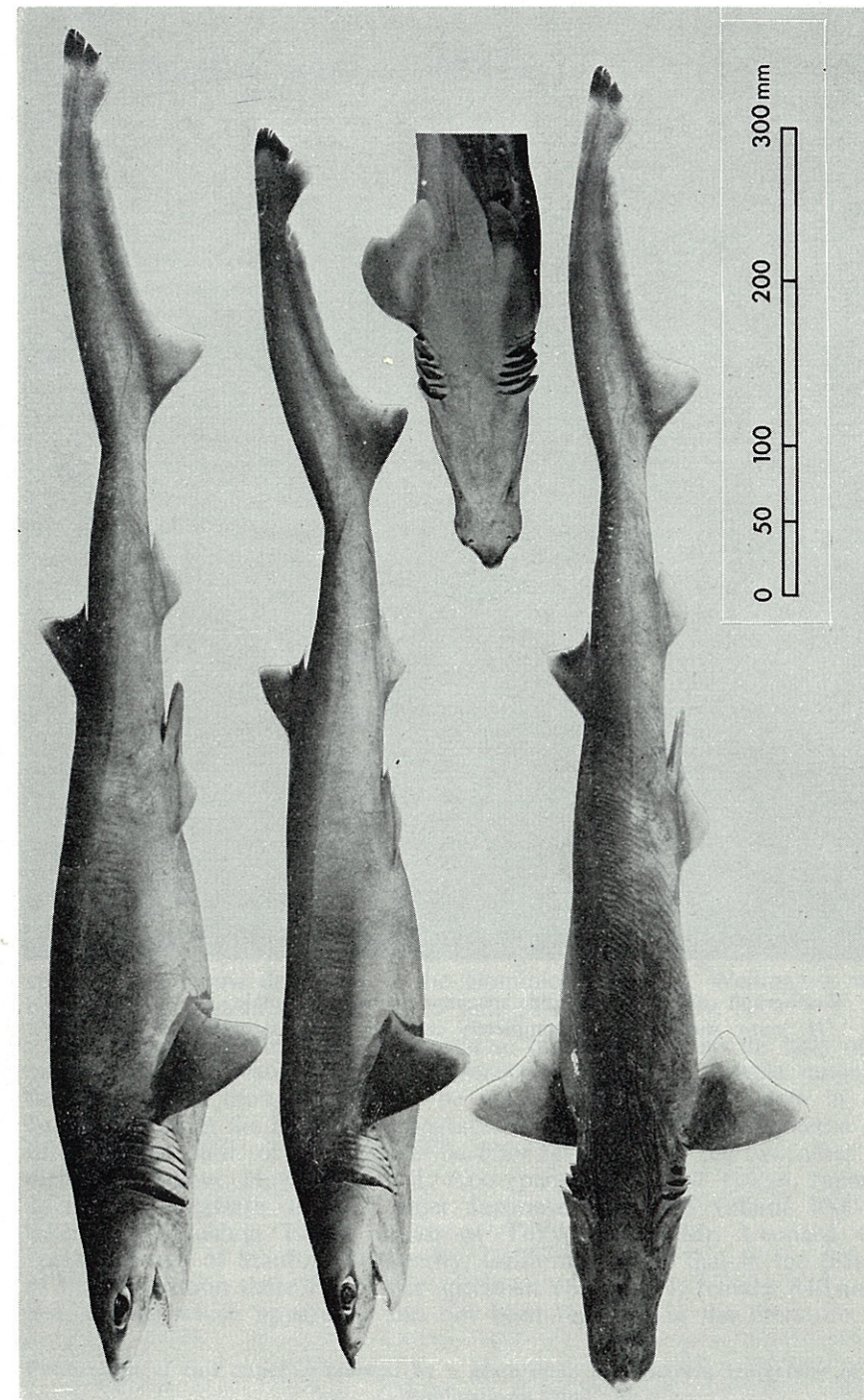


Plate 1. *Heptanchias perlo* specimens from New Zealand. Upper and lower: 856 mm male (DM 4952). Centre, and centre right: 805 mm female (DM 4951). Note that side views are slightly more deep-bellied than is natural, owing to the soft abdominal region being forced ventrally when the specimens were placed on their side for photography. Lower illustration, showing dorsal view of head region and side view of caudal region, demonstrates extreme flexibility of the body.



Plate 2. Radiograph of New Zealand specimen, 805 mm female (DM 4951), of *H. perlo*, showing the incompletely calcified vertebral column.

CIRRHIGALEUS BARBIFER
(FAM. SQUALIDAE), A LITTLE KNOWN
JAPANESE SHARK FROM NEW ZEALAND
WATERS

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Abstract

Two female specimens of *Cirrhigaleus barbifer*, previously recorded only from two Japanese specimens, are described from the Bay of Plenty, New Zealand. Despite close similarities to *Squalus*, the genus *Cirrhigaleus* is regarded as valid because of the remarkable nasal barbels and the lack of precaudal pits.

INTRODUCTION

THIS account records two specimens of the rare spiny dogfish, *Cirrhigaleus barbifer* Tanaka, 1912, from New Zealand waters. The first of these specimens, a female of 922 mm total length, was long-lined in about 360 metres (about 200 fathoms) between Mayor Island and White Island in the Bay of Plenty during September, 1969, by Mr. Goldie Hitching on the commercial fishing vessel "Fair Isle". Mr. Hitching recognised the fish as unique, and sent it, via the New Zealand Marine Department, to Wellington for identification. The second specimen, a female of 1082 mm total length, was taken in similar circumstances a year later. It was long-lined in about 440 metres (about 240 fathoms), 10 miles off Mayor Island, on September 22, 1970, by Mr. J. I. Phillips on the fishing vessel "Moana". Both specimens are now deposited in the Dominion Museum, Wellington, where they bear the registration numbers 5105 and 5163 respectively.

These two specimens are the largest so far recorded, and the only ones known outside Japanese waters. They therefore provide a considerable range extension for the species, though it should be noted that they were taken in a latitude (c. 37°) south of the Equator comparable to that north for the Japanese specimens. Literature accounts of *Cirrhigaleus barbifer* refer only to the two other specimens mentioned below. However, Dr. T. Abe (pers. comm.) of Tokyo, Japan, informs us that he is aware of three other Japanese specimens (about 1000 mm long, taken near Hachijo Island, south of Tokyo), and Mr. Leonard Compagno (pers. comm.) of Stanford University, California, notes that in the fish collection of that institution there is another specimen (SU 14171, female, 840 mm, Sagami Sea, Japan) which apparently has not been reported in the literature.

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PREVIOUS ACCOUNTS

Tanaka (1912, p. 151) established the new genus and species *Cirrhigaleus barbifer* in the Squalidae, based on one male specimen, 855 mm total length, obtained from the Tokyo Fish Market but stated by Tanaka to be from the Sagami Sea. Subsequently Herre (1935, p. 122) proposed another new genus and species, *Phaenopogon barbifer*, for a second specimen, a female 555 mm long, from Misaki Bay, Japan. Herre at that time was not aware of Tanaka's account; when it was brought to his attention he synonymised *P. barbifer* with *C. barbifer* in a brief paper the following year (1936, p. 59). Using the accounts of the first or both of these specimens, Garman (1913), Fowler (1941), and Bigelow and Schroeder (1948, 1957) made judgments on the generic status of *Cirrhigaleus* in relation to *Squalus*.

DESCRIPTION OF NEW ZEALAND SPECIMENS

For proportional dimensions in percent of total length see Table 1.

Head depressed, eye rather large, and snout profile pointed; trunk moderately stout, the abdomen less inflated than shown in Plate 1, which was photographed when the specimen was thawed after deep-freezing and when the abdomen was partially filled with water; anterior half of trunk slightly depressed, flatter below than above, almost trihedral in cross-section owing to ventrolateral thickening of the body wall muscles on each side; posterior half of trunk slightly compressed; dorsal profile in front of the 1st dorsal smoothly and shallowly arched; caudal peduncle slightly flatter in transverse section below than above, with a low dermal keel ventrolaterally on each side extending from the level of the 2nd dorsal fin posteriorly on to the first quarter of the caudal axis (Plate 2); no precaudal pit above or below.

Dermal denticles (Fig. 1A) on sides of trunk rather closely packed, contiguous or only partly overlapping, large and rough to the touch, with essentially tridentate blades and rhomboidal bases; the central tooth of each blade much longer than the lateral teeth; in a few denticles of the 922 mm specimen and in many denticles of the 1082 mm specimen one or both of the lateral teeth are subdivided to give one or occasionally two additional teeth; outer surface of each blade with a high, spine-like median ridge extending the entire length of the blade, and a lower, less prominent ridge along each lateral margin.

Least fleshy interorbital distance 1.9 in head measured to 1st gill-opening; snout broad in contour but bluntly pointed at the snout tip; eye more than twice as long as high; spiracle large, placed slightly above eye and behind it by a distance equal to almost $\frac{1}{4}$ of horizontal diameter of eye; gill-openings almost vertical, slightly concave and in a horizontal series anterior to pectoral base; lengths of gill-openings subequal; interspaces between gill-openings subequal; nostrils slightly oblique, placed a little nearer tip of snout than mouth; each nostril subdivided into a circular anterolateral aperture and a larger ovoid medial aperture by the anterior and posterior nasal flaps; the anterior nasal flap is short and triangular, directed posteriorly, and external to the deeper and fleshy posterior flap; medial to the anterior nasal flap the anterior margin of the medial nasal aperture is strikingly extended posteriorly as a long, thin, tapered barbel projecting postero-ventrally; this barbel (Fig. 1C) is denticle-covered to its tip, and when adpressed to the lower surface of the head reaches almost or quite as far back as the angle of the mouth; mouth moderately broad and weakly arched; preoral clefts short,

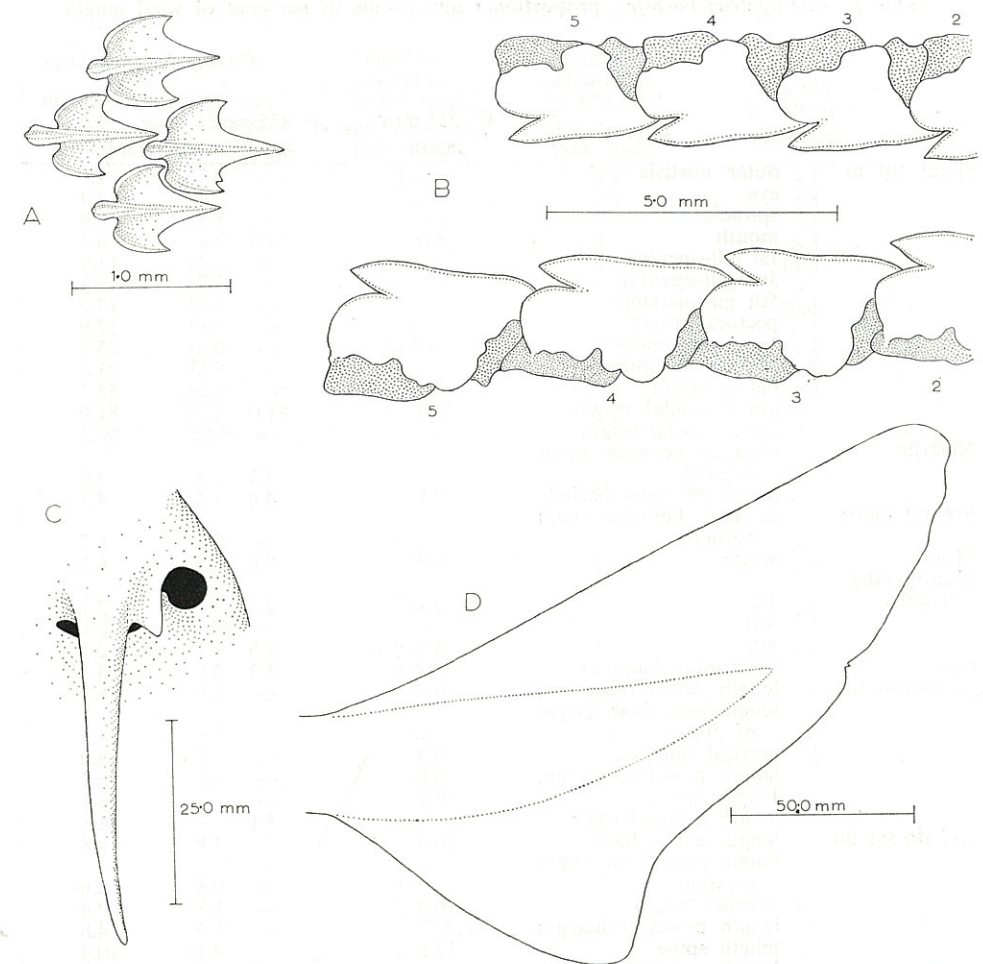


Fig. 1. *Cirrhigaleus barbifer*, D.M. 5105, female 922 mm, New Zealand. A, dermal denticles from high on side at level of 1st dorsal fin; B, 2nd to 5th upper and lower teeth, right side; C, left nostril and nasal barbel; D, caudal fin, showing incipient subterminal notch (possibly due to damage).

reaching less than $\frac{1}{3}$ the distance from the angles of the mouth to the upper symphysis; posteriorly the clefts are continued by oblique furrows which extend about $\frac{1}{5}$ of the distance between the angles of the mouth and the 1st gill-openings.

14 - 13

Teeth $\frac{14}{12}$ - 11, similar in the two jaws, their shape as in Fig. 1B; teeth at the

centre of mouth slightly smaller than those further laterally, and upper teeth generally smaller than lower; two or three rows of teeth visible in both jaws.

First dorsal fin large, triangular, its origin behind the level of the posterior corner of the pectoral fin by a distance equal to $\frac{1}{2}$ the horizontal diameter of eye;

Table 1. *Cirrhigaleus barbifer*, proportional dimensions in per cent of total length

		<i>Cirrhigaleus barbifer</i>		
		♀ 555 mm ²	♂ 855 mm ³	♀ 922 mm
		Japan	Japan	New Zealand DM 5105
Snout tip to	: outer nostrils	—	—	2.5
	: eye	—	—	4.4
	: spiracle	—	—	8.8
	: mouth	8.6	6.6	6.5
	: 1st gill-opening	—	—	13.9
	: 3rd gill-opening	—	—	15.8
	: 5th gill-opening	—	—	17.5
	: pectoral origin	—	—	17.9
	: 1st dorsal spine	—	—	35.2
	: 2nd dorsal spine	—	—	71.6
	: pelvic origin	—	—	53.3
	: upper caudal origin	78.6	81.0	81.0
	: lower caudal origin	—	—	80.2
	Nostrils	: distance between inner corners	—	3.3	3.4
: length of nasal barbel		7.4	4.4	4.7
Preoral clefts	: distance between inner corners	—	—	6.7
	: width	6.9	6.6	6.1
Mouth Gill-opening lengths	: 1st	2.1	2.1	2.1
	: 3rd	—	—	2.1
	: 5th	3.2	2.5	2.1
Eye	: horizontal diameter	4.3	3.3	3.5
	: length entire base	9.7	—	8.6
1st dorsal fin	: length base from origin of spine	—	—	4.4
	: vertical height	10.7	—	9.0
	: length posterior margin	5.8	—	5.2
	: length spine ¹	9.1	—	8.1
	: length exposed spine	—	5.1	4.1
	: length entire base	10.4	—	9.8
	: length base from origin of spine	—	—	2.6
	: vertical height	10.4	—	7.4
	: length posterior margin	c. 6.7	—	4.8
	: length spine ¹	12.6	—	10.4
2nd dorsal fin	: length exposed spine	—	8.2	5.2
	: length base	—	—	5.3
Pectoral fin	: length anterior margin	16.8	—	14.5
	: length base	—	—	7.3
Pelvic fin	: length anterior margin	—	—	9.0
	: length upper lobe	23.8	—	20.3
Caudal	: length lower lobe	—	—	10.7
	: length lower lobe	—	—	10.7
Trunk at pectoral origin	: width	—	—	14.1
	: height	—	—	9.9
Dental formula	: precaudal	13-13	13-13	14-13
	: caudal	11-11	13-13	12-11
Vertebrae	: precaudal	—	—	87
	: caudal	—	—	28
	: total	—	—	115

¹ Measured from base of dorsal fin to top of spine.² Holotype of *Phaenopogon barbifer*, Stanford University No. 13901; dimensions extracted and calculated from data in Herre (1935).

	♀ 1082 mm	<i>Squalus acanthias</i>	<i>Squalus blainvillei</i>	<i>Squalus megalops</i>
	New Zealand	♀ 935 mm ¹	♀ 923 mm ⁴	♀ 588 mm ⁴
	DM 5163	New Zealand	New Zealand	Australia
	DM 5163	DM 1255	DM 2647	
	3.0	3.7	3.8	3.1
	4.7	5.7	5.9	5.8
	8.8	—	—	—
	6.9	7.5	8.7	8.5
	15.2	15.5	16.9	16.6
	17.7	—	—	—
	19.0	19.2	20.8	20.4
	19.3	—	—	—
	36.6	34.7	32.2	33.5
	72.2	66.2	67.0	68.5
	56.8	54.5	53.0	51.0
	83.2	81.0	80.2	82.0
	82.5	—	—	—
	4.0	3.3	4.4	4.4
	5.1	—	—	—
	7.0	5.4	6.1	6.3
	7.1	5.4	5.7	6.3
	1.8	2.0	2.2	2.0
	1.8	—	—	—
	2.4	2.2	2.5	2.5
	3.6	2.7	4.3	4.3
	9.2	—	—	—
	5.2	5.7	6.6	5.6
	9.1	6.0	8.0	7.3
	5.1	—	—	—
	—	—	—	—
	—	—	—	—
	9.5	—	—	—
	3.0	3.7	4.3	3.6
	7.7	3.7	4.7	3.6
	4.7	—	—	—
	14.8	—	—	—
	5.7	—	—	—
	6.1	—	—	—
	14.5	15.1	14.3	14.9
	7.2	—	—	—
	9.0	—	—	—
	17.8	20.0	20.6	19.6
	10.4	10.4	11.2	11.0
	14.8	11.8	14.4	13.7
	11.6	9.1	11.2	11.9
	14-13	—	—	—
	12-11	—	—	—
	87	—	—	—
	28	—	—	—
	115	—	—	—

³ Holotype of *Cirrhigaleus barbifer*, Science College Museum, Tokyo, No. 3397; dimensions extracted and calculated from data in Tanaka (1912).⁴ Data from Garrick (1960).

posterior insertion of 1st dorsal base nearer to origin of pelvic than to axil of pectoral by a distance almost equal to horizontal diameter of eye; exposed origin of 1st dorsal spine midway along 1st dorsal base; exposed spine in the 922 mm specimen extends halfway along that part of 1st dorsal anterior margin distal to exposed spine origin, but tip of spine is obliquely truncated and may have been longer than it is now; in the 1082 mm specimen the spine is broken; spine smooth edged, subtriangular in cross-section, its posterior surface grooved lengthwise; 2nd dorsal fin subequal to 1st dorsal, its base longer, its height slightly shorter; origin of 2nd dorsal not well marked, a little anterior to posterior tips of pelvic fins; exposed origin of 2nd dorsal spine above posterior 1/3 of 2nd dorsal base; exposed spine in the 922 mm specimen reaches almost to 2nd dorsal apex, but its tip is slightly worn or eroded like that of 1st dorsal; in the 1082 mm specimen its tip reaches beyond second dorsal apex; shape of 2nd dorsal spine similar to 1st dorsal; caudal fin shape as in Fig. 1d, with no definite subterminal notch, though in the 922 mm specimen there is a weak indentation, perhaps due to injury, in the margin behind the tip of the caudal axis; pectoral fins moderately large, short and broad, originating just behind the 5th gill-openings; when addressed to the side of the trunk so that their anterior margins are horizontal their tips reach almost or quite to midway between levels of origin of 1st dorsal base and exposed 1st dorsal spine; pelvic fins large, their outer, anterior corners somewhat obtuse, broadly rounded.

Colour: when fresh brownish-grey above, paler to almost white below; after preservation in alcohol steel-grey above, paler below; in the 922 mm specimen most of underside pale grey with some small, irregular areas of white mottling on the ventral surface, particularly under the head and around the mouth; in the 1082 mm specimen most of underside white except for grey mottling below snout tip; trailing margins of all fins white; axils of pectoral and pelvic fins white; nasal barbel grey in the 922 mm specimen, white in the 1082 mm specimen.

Vertebrae: radiographs of the vertebral column are shown in Plate 3; both specimens have exactly the same vertebral counts; of the 87 precaudal centra (counted to upper caudal fin origin) 51 are monospondylous and 36 are diplospondylous; the transition from monospondyly to diplospondyly is accepted as occurring above the posterior 1/3 of the pelvic fin base, where there is an abrupt decrease in the length of the centra; caudal centra (posterior to the upper caudal fin origin) number 28.

COMPARISON WITH JAPANESE SPECIMENS

We have not seen Tanaka's or Herre's specimens, but their descriptions of them were full, and these, together with the accompanying illustrations, give us no reason to believe that our specimens are specifically distinct from *C. barbifer*. In Table 1 we list the proportional dimensions of our specimens for comparison with those from Tanaka's and Herre's accounts. In extracting Tanaka's and Herre's dimensions we have excluded a few, such as head length to 1st gill-opening, which apparently were measured differently from ours, i.e., probably they were point to point measurements rather than projected distances along the main axis of the body. If it is assumed that the remaining dimensions which we include in Table 1 were measured in a comparable fashion with ours, it can be seen that there are still differences between all four specimens. Some of these between Tanaka's and Herre's specimens were no doubt what Herre referred to, but did

not itemise in his 1936 account, where he regarded them as being due to sex and age. We are not able to comment on the extent to which any of these differences are attributable to sex, but we do believe that many of them can feasibly be regarded as expressions of growth-change and hence age.

If we are correct in this view, then the growth changes in *C. barbifer* are generally in accord with those of other squaloid sharks, as outlined in Garrick (1960, p. 546). The data for *C. barbifer* indicate that with growth there is a proportionate decrease, relative to total length, in the length of the head (evidenced in this case only by length of snout in front of mouth), the length of the caudal fin, the horizontal diameter of the eye, and the height of the dorsal fins. The prominent nasal barbel of *Cirrhigaleus*, a unique structure in the Squaloidea, must also undergo a marked relative decrease in length with growth, since Herre's data for this in his 555 mm specimen translate to 7.4% of total length, whereas in Tanaka's 855 mm specimen and our 922 mm and 1082 mm specimens it is only 4.4%, 4.7% and 5.1% respectively. The only other feature which shows marked change is the length of the anterior margin of the pectoral fin—16.8% of total length in Herre's small specimen and 14.5% and 14.8% in our specimens. This decrease, if valid, is at variance with Garrick's (1960, p. 548) statement on the pectoral fin of other Squaloidea, which "compared with the total length . . . may remain reasonably constant, or more often will show a slight increase".

Points of disagreement between Tanaka's and Herre's descriptions (including their illustrations) and our specimens are as follows. Tanaka stated (p. 152) "the anterior edge of upper lip beneath end of first third of eye and angle of mouth beneath beginning of last third", but his illustration (Plate 41) shows the anterior edge of the upper lip below about middle to last third of the eye, and angle of mouth behind the eye. Our specimens agree better with Tanaka's illustration than with his description. Tanaka noted in his generic diagnosis of *Cirrhigaleus* (p. 154) that there is "no pit or keel on root of caudal". We agree, from our specimens, that there are no precaudal pits, but there is a definite longitudinal dermal keel ventrolaterally on each side of the caudal peduncle. This keel, which is low and blunt-topped (see Plate 2) extends from the level of the posterior end of the second dorsal fin back on to the anterior part of the caudal fin. It is, therefore, similar to but less obvious than the comparable keels in *Squalus* species. Herre (1935, p. 124) described a similar keel from his specimen of *C. barbifer*. Herre's illustrations of his specimen agree with ours except that he shows the snout tip as much blunter in ventral view, while in lateral view the dorsal profile from the head back to the first dorsal fin is strongly convex and elevated. We do not place significance on the difference in snout tip shape, and we suggest that the elevated predorsal profile of Herre's specimen was probably due to distortion in preservation.

RELATIONSHIP OF *Cirrhigaleus barbifer* TO OTHER SQUALIDAE

Tanaka's (1912) account of *Cirrhigaleus* and Herre's (1935) account of *Phaenopogon* (= *Cirrhigaleus*) as new genera did not include any indication of their views on the relationship to other genera in the Squalidae. Garman (1913, p. 457) in an addendum to his revision of elasmobranch fishes reduced *Cirrhigaleus* to a sub-genus of *Squalus*; he noted that "the mouth, teeth, scales, spiracles, and fins are those of that genus", and indicated that only the nasal barbel was distinctive. Fowler (1941, p. 262) followed Garman in treating *Cirrhigaleus* as a sub-genus of *Squalus*, but did so without comment. Bigelow & Schroeder (1948,

p. 451; 1957, p. 37) accepted *Cirrhigaleus* as a full genus despite its similarity to *Squalus*, and in a discussion in the later of these two accounts noted that this was justified by the "presence of the nasal barbel, combined with the lack of precaudal pits and of longitudinal-lateral ridges on the caudal peduncle".

Study of our specimens leads us to accept Bigelow & Schroeders' view that *Cirrhigaleus* deserves full generic rank even though the third generic character they cite cannot be upheld; *Cirrhigaleus* does have a ventrolateral keel on each side of the caudal peduncle and hence resembles *Squalus* in this respect. Other resemblances to *Squalus* are strong. Similarity in proportional dimensions is exemplified in Table 1, where for cursory comparison we have listed those of one specimen each of three *Squalus* species previously reported on by one of us (Garrick, 1960). The essential differences in proportions between *Squalus* and *Cirrhigaleus* are that the latter has a shorter snout and head, shorter but higher dorsal fins, and the 2nd dorsal fin is little smaller than the 1st, whereas in *Squalus* it is markedly smaller. Similarities between the two genera in the shape and structure of the mouth, teeth, dermal denticles and fins were noted by Garman (1913). We confirm these strong similarities, and would highlight that of the caudal fin in particular, but we observe that the dermal denticles of *Cirrhigaleus* are proportionately much larger—about twice as long—as those of comparably sized *Squalus* illustrated in Garrick (1960, p. 525, text-fig. 3). Meristic characters—dental formulae and vertebral numbers—differ little between the two genera (for vertebral numbers of *Squalus* species see Springer & Garrick, 1964).

Despite the above strong similarities there remains the fact that *Cirrhigaleus* differs from *Squalus* not only in possessing the remarkable nasal barbels which suggested its generic name but also in lacking completely the precaudal pits which are characteristic of *Squalus*. We believe that in combination these two characters reasonably justify the retention of *Cirrhigaleus* as a separate genus, though we would agree that in any subdivision of the Squalidae it would be necessary to place *Cirrhigaleus* closer to *Squalus* than to any other genus. It might be argued that the nasal barbels are foreshadowed in *Squalus*, especially in *S. blainvillei* and the *S. megalops-cubensis* group, where the anterior nasal flap is bilobed and the medial lobelet is in a comparable position to the nasal barbel of *Cirrhigaleus*. Even if this is the case, and the medial lobelet is homologous with the nasal barbel, the gross differences in the degree of development of the two structures merit recognition. In *Squalus* the medial lobelet is a minor structure, smaller than the lateral lobelet (= anterior nasal flap), and not reaching even to the posterior margin of the medial nasal aperture, whereas in *Cirrhigaleus* the nasal barbel is a major feature extending not only beyond the anterior nasal flap but far posteriorly along the snout.

SIGNIFICANCE OF THE RANGE-EXTENSION OF *C. barbifer*

The present record of *C. barbifer* parallels the recent additions to the New Zealand fauna of the north Pacific *Centroscymnus owstonii* and the north Atlantic *Centroscymnus crepidater* (see Garrick, 1959). It is thus a further and substantiating contribution to the existing situation in which the New Zealand squaloid fauna is composed predominantly of widely distributed rather than local species. A survey of this fauna was given in Garrick (1960).

LIVER OIL OF *C. barbifer*

A sample of liver oil from our 922 mm female *C. barbifer*, together with comparative samples from New Zealand *Squalus acanthias* and *S. blainvillei*, were analysed for squalene and vitamin A by Dr. R. W. Lewis at the Food Technology Division, C.S.I.R.O., Sydney. The *C. barbifer* oil contained 0.81% squalene; hence if one can assume that the liver had a lipid content of 50%, then squalene was present at a level of about 4000 ppm relative to tissue weight. By comparison the *S. acanthias* and *S. blainvillei* contained only 159 ppm and 51 ppm respectively of squalene relative to tissue weight.

The *C. barbifer* liver oil contained no vitamin A, *S. blainvillei* a small amount, and *S. acanthias* a large amount. Dr. Lewis suggests (pers. comm.) that "it may be possible to distinguish between sharks living in the photic zone, or just below it, and deep-water species by the vitamin A content of the liver oil. This would indicate trophic distance from plants". This suggestion is supported by the vitamin A content and depth-ranges of the three species, *C. barbifer* being a deep-water species, *S. blainvillei* living on the deep shelf and shelf edge, and *S. acanthias* ranging over the relatively shallow shelf.

ACKNOWLEDGEMENTS

We are grateful to Mr. Goldie Hitching and Mr. J. I. Phillips for recognising the unusual nature of their "whiskered sharks" and forwarding them to us for identification; to Mr. T. Bonnevie and Dr. G. R. Fish, Marine Department officers at Tauranga and Rotorua respectively, for ensuring safe delivery of the specimens to Wellington; and to Mr. J. A. Bahler, Fisheries Research Division, Marine Department, Wellington, who provided the photographs and radiographs reproduced here.

LITERATURE CITED

- Bigelow, H. B. & Schroeder, W. C. 1948: Fishes of the western North Atlantic Part 1. *Mem. Sears Found. Mar. Res.* 1 (1): 59-576, figs. 6-105.
- Bigelow, H. B. & Schroeder, W. C. 1957: A study of sharks of the suborder Squaloidea. *Bull. Mus. Comp. Zool.* 117 (1): 1-150, 16 figs., 4 pls.
- Fowler, H. W. 1941: Contributions to the biology of the Philippine Archipelago and adjacent regions. The fishes of the groups Elasmobranchii, Holocephali . . . *U.S. Nat. Mus. Bull.* 100, Vol. 13, x + 879 pp., 30 figs.
- Garman, S. 1913: The Plagiostomia. *Mem. Mus. Comp. Zool.* 36, xiii + 515 pp., 77 pls.
- Garrick, J. A. F. 1959: Studies on New Zealand Elasmobranchii. Part VIII, Two northern hemisphere species of *Centroscymnus* in New Zealand waters. *Trans. Roy. Soc. N.Z.* 87 (1 & 2): 75-89, 4 text-figs.
- Garrick, J. A. F. 1960: Studies on New Zealand Elasmobranchii. Part XII, The species of *Squalus* from New Zealand and Australia and a general account and key to the New Zealand Squaloidea. *Trans. Roy. Soc. N.Z.* 88 (3): 519-557, 6 text-figs.
- Herre, A. W. C. T. 1935: Notes on fishes in the zoological museum of Stanford University. II, Two new genera and species of Japanese sharks and a Japanese species of *Narces*. *Copeia*, 1935 (3): 122-127, 2 text-figs.
- Herre, A. W. C. T. 1936: *Phaenopogon* a synonym of *Cirrhigaleus*. *Copeia*, 1936 (1): 59.

- Springer, V. G. & Garrick, J. A. F. 1964: A survey of vertebral numbers in sharks. *Proc. U.S. Nat. Mus.* 116 (3496): 73-96, 1 pl.
- Tanaka, S. 1912: Figures and descriptions of the fishes of Japan including Riukiu Islands, Bonin Islands, Formosa, Kurile Islands, Korea, and southern Sakhalin. (Seen in 2nd edition form, 1935, Kazama Shobo, Tokyo, 12 + 557 pp., pls. 1-141.)

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ADDENDUM

Since the above account was submitted for publication a third New Zealand specimen has come to hand. It is also a female and is larger, being 1220 mm in total length. It was long-lined in about 146 metres (80 fathoms) off Mayor Island in November, 1970, by Mr. Bob Gray on the vessel "Rarangi". Its proportions agree well with those of the other specimens except that the 2nd dorsal base is

a little shorter than the 1st dorsal base. The dental formula is $\frac{12-13}{12-12}$. The

underside of the body is about equally mottled with grey and with white. This specimen was pregnant (the other two were immature with undeveloped oviducts) and contained five embryos in the left oviduct and five in the right. Each embryo is about 85 mm total length and is attached to a yolk sac about 60 mm in diameter. The embryos (DM 5205) and the female (DM 5204) are deposited in the Dominion Museum, Wellington.

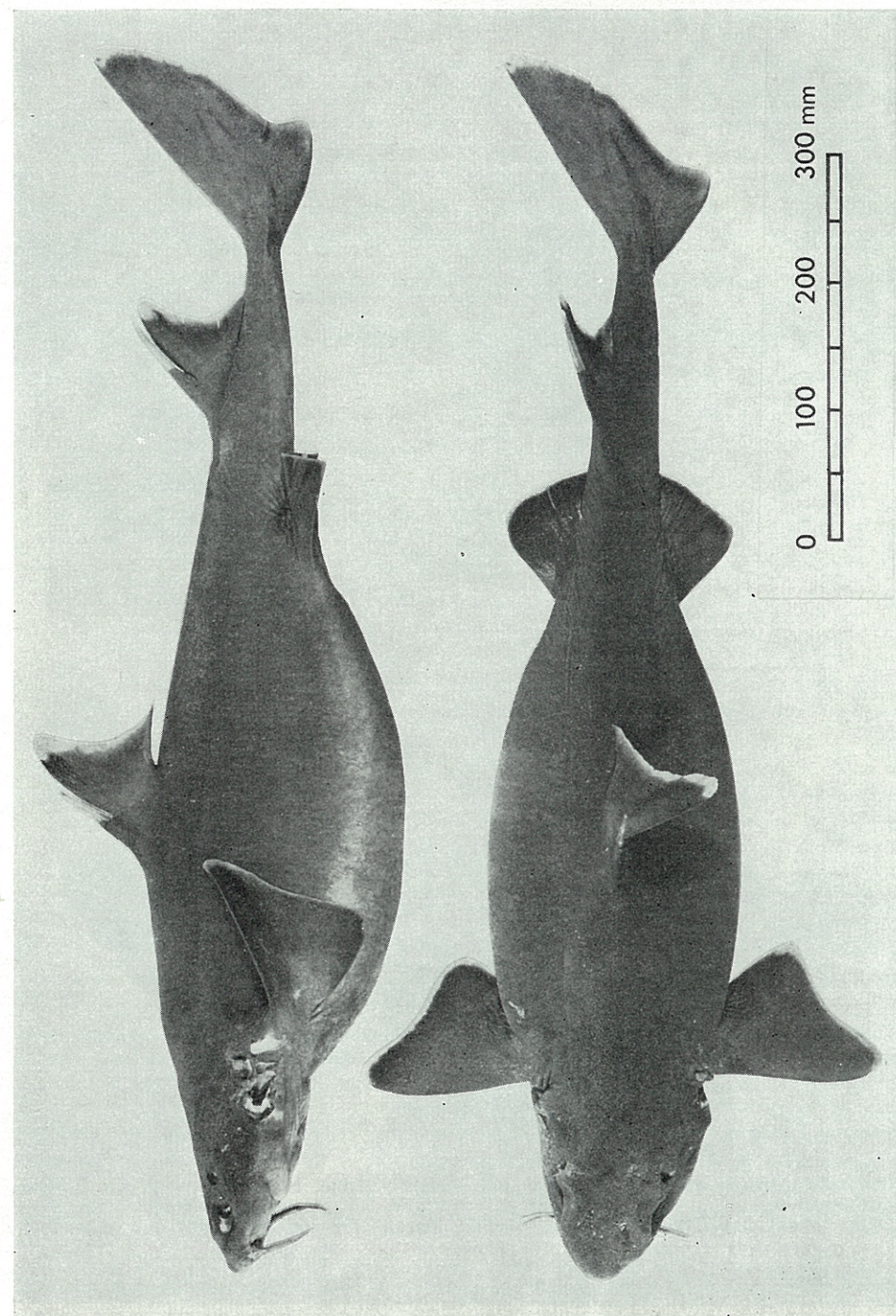


Plate 1. *Cirrhigaleus barbifer*, D.M. 5105, female 922 mm, New Zealand. Lateral and dorsal views.



Plate 2. *Cirrhigaleus barbifer*, D.M. 5105, female 922 mm, New Zealand. Ventral view of head, and lateral view of caudal peduncle and tail. Note in lower figure the low ventrolateral dermal keel extending from the level of the 2nd dorsal fin back on to the caudal axis.

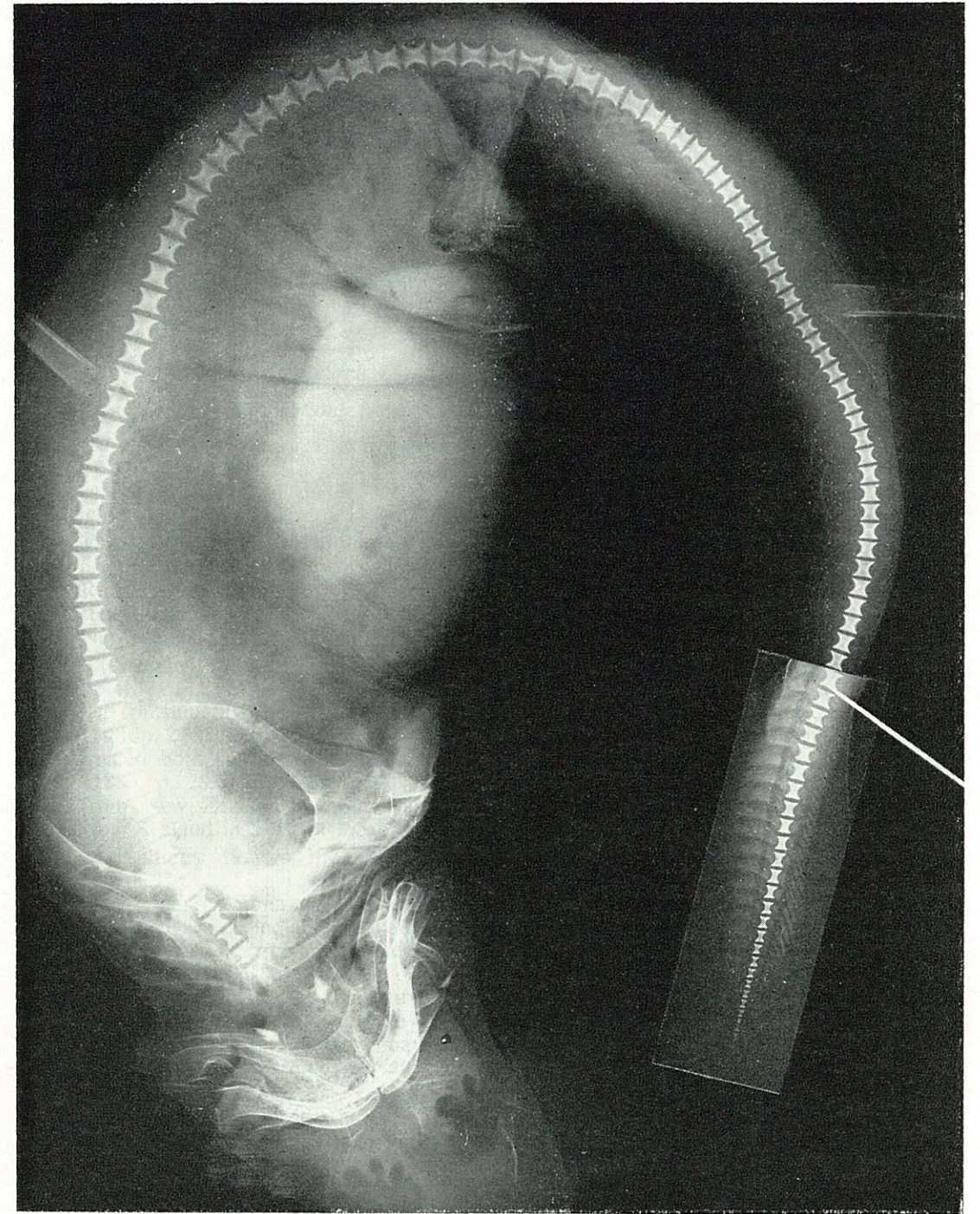


Plate 3. *Cirrhigaleus barbifer*, D.M. 5105, female 922 mm, New Zealand. Composite radiograph showing entire vertebral column; marker pin separates pre-caudal and caudal centra.

**DELETION OF THE AUSTRALIAN RAYS
APTYCHOTREMA BANKSII AND
TRYGONORHINA FASCIATA
FROM THE NEW ZEALAND
ELASMOBRANCH FAUNA**

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Two Australian rays, *Aptychotrema banksii* (Müller and Henle, 1841) and *Trygonorhina fasciata* Müller and Henle, 1841, were listed in the New Zealand fish fauna by Richardson (1843a; 1843b). As discussed below, we believe Richardson was in error in this listing, and we can find no firm evidence from subsequent accounts to substantiate the presence of either of these species in New Zealand.

Sherrin (1886, pp. 127, 299), Fowler (1941, pp. 322, 325) and Stead (1963, pp. 138, 142, 143) listed both species from New Zealand, but without comment, and presumably only on the basis of Richardson's list. Hutton (1872, p. 82; 1890, p. 276), Gill (1893, pp. 109, 111) and Richardson and Garrick (1953, p. 27) treated both species as doubtful members of the New Zealand fauna. Günther (1880, p. 285) listed the genus *Rhinobatus* (= *Aptychotrema*) and *T. fasciata* from New Zealand without comment, while Marshall (1964, p. 32) included New Zealand in a list of localities for *A. banksii*.

Phillipps (1929, p. 102) is the only author who has reported an actual specimen of either species from New Zealand. His description and illustration, as *T. fasciata*, of a female 735 mm in total length, are undoubtedly of that species. Phillipps's specimen was found in the Wanganui Museum, where it bore the label "Electric Ray, *Torpedo fairchildi*, Napier, N.Z." We regard this report with scepticism, partly because of the lack of other records, but mainly on the evidence of Mr J. M. Moreland, Ichthyologist at the Dominion Museum, Wellington, who informs us that the Wanganui Museum acquired many Australian fish specimens early this century, and that there may have been transposition of labels between an Australian *Trygonorhina fasciata* and a New Zealand *Torpedo fairchildi*.

If Phillipps's record is not accepted, the only information that we are aware of which might substantiate the presence in New Zealand of *A. banksii* and *T. fasciata* must lie in Richardson's (1843) listings or in the sources from which he got them.

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Aptychotrema banksii and *T. fasciata* have a similar nomenclatural history. Both were first described by Müller and Henle (1841, pp. 123, 124), the former under the name *Rhinobatus* (*Rhinobatus*) *banksii*—though in an addendum to the same account (p. 192) this was changed to *Rhinobatus* (*Syrrhina*) *banksii*—and the latter as *Trygonorhina fasciata*. The accounts of both were based on illustrations in the British Museum (Natural History) of specimens taken on Captain James Cook's first voyage to New Zealand and Australia. Manuscript names for the species, from the same source as the illustrations, were referred to by Müller and Henle as follows:— for *R. banksii*, "*Raja rostrata*. Banks MS.45", and for *T. fasciata*, "*Raja fasciata*. Banks MS. 47.". The only locality mentioned for each species was "Neuholland", hence Australia.

From the above it is clear that Müller and Henle's accounts in themselves were not the source from which Richardson might have obtained information to list *A. banksii* and *T. fasciata* as New Zealand species, unless of course, he misread "Neuholland" for "New Zealand."

Richardson's own accounts (1843a, p. 29; 1843b, p. 227) of the species are mere listings of Müller and Henle's names, but the 1843a account does give, as well, manuscript names as synonyms which indicate the original source of data on the species. For *R. banksii* ("*Raja rostrata*, Parkinson, i. t. 45") is quoted and for *T. fasciata* ("*Raja fasciata*, Parkinson, i. t. 47).". These synonymic references are essentially the same as those in Müller and Henle except for the spelling "*Raja*" and the substitution of the name "Parkinson" (artist on Cook's first voyage) for "Banks" (naturalist). Information from Beaglehole (1962, vol. 2, p. 60, footnote 1) and from Whitehead (1968, pls. 3, 4) confirms that the references pertain to illustrations of the species made by Spöring (secretary to Banks) during Cook's first voyage. Beaglehole also notes that the illustrations of *A. banksii* and *T. fasciata* were among those made from specimens taken at Botany Bay, New South Wales, Australia.

Despite the above facts, which establish that the two species were Australian in origin, there is one other clue in Richardson's (1843a) account which might explain how Richardson came to list them from New Zealand. In his introduction (p. 14) he states: "In the following list 'Solander' refers to that naturalist's manuscript 'Pisces Australiae', containing his descriptions of the New Zealand fish obtained on Cook's first voyage. The term 'Australia' as used by him relates solely to New Zealand, which was supposed until Cook circumnavigated it, to be part of a great southern continent. The figures of fish executed in the same voyage are quoted under the name of the artist 'Parkinson'." If Richardson, perhaps by oversight, gave the same interpretation of locality to Parkinson's figures as he gave to Solander's manuscript, then this would explain the referral of *R. banksii* and *T. fasciata* to New Zealand.

Our conclusions are that we can find no real evidence that *Aptychotrema banksii* or *Trygonorhina fasciata* have ever been reliably recorded from New Zealand, and accordingly we delete them from the known fauna. Both are shallow, warm-water species and would presumably occur in the coastal waters of northern New Zealand if they were present, but, as far as we are aware, no rays resembling them have ever been reported by commercial or amateur fishermen. Numerous exploratory trawling surveys have been carried out in north-east New Zealand, but these species have not been taken—though several areas provide an abundance of three other species of ray, the sting-rays *Dasyatis thetidis* and *D. breviceaudatus* and the eagle ray *Myliobatis tenuicaudatus*.

However, we are reminded by the single occurrence of the Port Jackson shark, *Heterodontus portusjacksoni*, in Cook Strait (Moreland, 1956) that stray specimens of even the unlikeliest Australian marine fish species may occasionally reach New Zealand, so we will not be surprised if a specimen of *A. banksii* or *T. fasciata* does one day appear in our waters.

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LITERATURE CITED

- Beaglehole, J. C. 1962: *The Endeavour Journal of Joseph Banks 1768-1771*. Trustees Publ. Libr. N.S.W. in assoc. with Angus & Robertson. 2 vols. xxvii + 476 pp., 10 col. pls., 40 pls.; xvi + 406 pp., 6 col. pls., 40 pls.
- Fowler, H. W. 1941: Contributions to the biology of the Philippine Archipelago and adjacent regions. The fishes of the groups Elasmobranchii, Holocephali, Isospondyli and Ostarophysi obtained by the United States Bureau of Fisheries steamer "Albatross" in 1907 to 1910 chiefly in the Philippine Islands and adjacent seas. *Bull. U.S. Nat. Mus.* 100 (13): x + 879 pp., Vol. 13, 30 figs.
- Gill, T. 1893: A comparison of antipodal faunas. *Mem. Nat. Acad. Sci.* 6: 91-124.
- Günther, A. 1880: *An introduction to the study of fishes*. A. & C. Black, Edinburgh. 720 pp., 1 pl.
- Hutton, F. W. 1872: Catalogue with diagnoses of the species. In Hutton, F. W. and Hector, J. *Fishes of New Zealand*. Colon. Mus. & Geol. Surv. Dept., Wellington. xv + 93 pp.
- Hutton, F. W. 1890: List of the New Zealand fishes *Trans. N.Z. Inst.* 22: 275-285.
- Marshall, T. C. 1964: *Fishes of the Great Barrier Reef and coastal waters of Queensland*. Angus & Robertson, Sydney, London, Melbourne. 566 pp., 72 pls.
- Moreland, J. M. 1956: Notes on four fishes new to the New Zealand fauna. *Rec. Dom. Mus., Wellington.* 3: 9-11.
- Müller, J. and Henle, J. 1841: *Systematische Beschreibung der Plagiostomen*. von Veit, Berlin. xxii + 204 pp., 60 pls.
- Phillipps, W. J. 1929: Elasmobranch fishes of New Zealand: No. 3, *N.Z. J. Sci. Tech.* 11: 98-107.
- Richardson, J. 1843a: Report on the present state of the ichthyology of New Zealand. *Rept. Brit. Assoc. Adv. Sci.* 12: 12-30.
- Richardson, J. 1843b: List of fish. In Dieffenbach, E. and others. *Travels in New Zealand with the geography, geology, botany and natural history of that country. 2. Fauna of New Zealand*, pp. 206-228. J. Murray, London.
- Richardson, L. R. and Garrick, J. A. F. 1953: A guide to the lesser chordates and the cartilaginous fishes. *Tuatara* (J. Biol. Sci. Vict. Univ., Wellington) 5: 22-36.
- Sherrin, R. A. A. 1886: *Handbook of the fishes of New Zealand*. Wilson & Horton, Auckland. 307 pp.
- Stead, D. G. 1963: *Sharks and rays of Australian seas*. Angus & Robertson, London, Sydney, Melbourne, Wellington. 211 pp., figs.
- Whitehead, P. J. P. 1968: *Forty drawings of fishes made by the artists who accompanied Captain James Cook on his three voyages to the Pacific, 1768-71, 1772-75, 1776-80*. Trustees Brit. Mus. (Nat. Hist.) London, xxxi pp., 36 pls.

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**DEVELOPMENT OF THE LUMPFISH,
TRACHELOCHISMUS MELOBESIA
(PISCES: GOBIESOCIDAE)**

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Abstract

In the Wellington area eggs of *T. melobesia* Phillipps, 1927 are laid during spring in clusters of three eggs to several hundred on the under-surface of permanently tide-covered stones. The eggs are oval with a flattened, adhesive base, many oil globules and average 1.65 mm x 1.35 mm. Egg clusters are attended by one parent until hatching. Under laboratory conditions this occurs at 12 days in temperatures of about 15°C. The emergent prolarva is 4.8 mm-5.5 mm standard length and has a prominent yolk sac with a single large oil globule. There are scattered melanophores above the gut and a conspicuous yellow tinge surrounds the brain, extending in the lateral muscle mass to the 8th post-anal somite. Larvae of 6.5 mm-7.85 mm standard length, and more advanced in development, occur in the Island Bay plankton from early September to late December.

INTRODUCTION

Trachelochismus melobesia Phillipps, 1927, is an endemic lumpfish (Family Gobiesocidae) not uncommon on the shore in semi-exposed rock and rubble areas in the Cook Strait region of New Zealand. It is found throughout the inter-tidal zone but appears to be most abundant near the upper low-tide level. Adults rarely attain lengths of more than 30 mm s.l. *Trachelochismus pinnulatus* (Forster) is also found in areas inhabited by *T. melobesia*. However, the adult of *T. pinnulatus* (maximum size 71.2 mm s.l.) is larger than that of *T. melobesia*, and lacks the reddish-purple patch on the dorsal surface, a character which readily identifies the latter species. Flattened papillae occur on the central region of the sucker disc of *T. melobesia* (Fig. 4), but are absent in *T. pinnulatus*. The two species are further distinguished by fin ray counts (Briggs, 1955:19-20) as follows:—

T. melobesia D 10 (9-11), A 8 (7-8), P1 23 (22-24), C 12.

T. pinnulatus D 8 (7-9), A 6 (5-7), P1 25 (24-26), C 12 (11-12).

The present study describes the egg and larval development of *T. melobesia*. The life history of *T. pinnulatus* has been studied by Coakley (1964), and Graham (1939, 1953) has briefly described the egg and prolarval stages of *Diplocrepis puniceus* (Richardson, 1846), a further gobiesocid known from the New Zealand seashore. The family is otherwise poorly known in respect of early life history. However, comprehensive accounts of the life history of the South American clingfish *Gobiesox strumosus* Cope, 1870 are given in Runyan (1961:113-141) and Dovel (1963:161-166).

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MATERIALS AND METHODS

On 20.10.69 four egg masses on stones were collected from the western shore of Lyall Bay and kept in rectangular plastic containers (30 x 28 x 13 cm) at the Island Bay Marine Laboratory. The water was changed daily and kept constantly aerated using an eddy-current air pump. The stones with eggs were wedged at a 45° angle against the sides of the containers, with the egg masses on the ventral surface. Porous "air stones" were placed beneath the eggs so that the streams of small bubbles issuing from the "air stones" flowed over the egg masses. This method prevented the accumulation of detritus on the eggs and ensured an adequate supply of oxygenated water. Despite these precautions many eggs died and these were removed each day to prevent the build up of fungi and bacteria. The eggs adhered very closely to the stones and those required for observation were very difficult to remove without damage to the egg membrane. Limited success was obtained by sliding a sharp scalpel between the egg and the stone and then pipetting the dislodged egg into a petri dish. The identity of the above eggs as those of *T. melobesia* was confirmed by comparing these with thirty eggs laid on 30.10.69 by one of three females (22, 23, 26 mm s.l.), which together with two males (27, 29 mm s.l.) were kept alive in an aquarium. Development of these eggs and those obtained earlier was studied and sketches of the eggs and larvae were made using a binocular microscope equipped with a grid eye-piece. A micrometer ocular was used for measuring eggs and larvae. Measurements of the larvae were based on those recommended in Hubbs and Lagler (1958:24-26).

Larvae larger than 5.3 mm were obtained during the spring by making regular plankton tows approximately 100 yards offshore at Island Bay from a small boat. The net used was of standard conical design with a two-foot diameter opening and a mesh size of 500 microns.

SPAWNING AND DEVELOPMENT

In the Lyall Bay and Island Bay areas near Wellington *T. melobesia* spawns from early September to late December. Egg masses are found beneath smooth stones which remain covered with water at low-tide. The egg clusters range from 0.5 cm in diameter, containing as few as three eggs, to about 8 cm in diameter and containing several hundred eggs. The eggs are laid close together forming flat, irregular-shaped masses.

The larger egg clusters always contain groups of eggs which differ in colour, ranging from bright crimson to pale pink. This variation in colour represents the progressive depletion of the yolk supply in the eggs of each group as development advances. It is strongly suggested therefore that the eggs are laid at different times on the same stone. The pale yolked eggs, being the most advanced in development, are found mainly in the middle of the egg masses. However, the difference in development of eggs of some adjacent groups is relatively very small, indicating that these egg groups are laid no more than one to two days apart.

The absolute fecundity of *T. melobesia* is apparently very low, as determined from 10 gravid females each of which was found to contain only 20-30 ripe eggs. Considering the apparent low fecundity and the close development of the adjacent groups within a cluster it is concluded that more than one female is responsible for egg clusters that contain several hundred eggs.

Approximately 60 egg clusters were examined in rock pools in the Wellington area, of which about 80% had an adult *T. melobesia* in attendance. In these cases it was not clear whether this was a male or an immature female. When two adults were found close to the eggs the female could be distinguished by her characteristic pink and distended belly (the condition of a gravid female). Parental vigilance occurs commonly in littoral fish. Gibson (1969:385) observes that predation on the eggs is prevented by the guardian activities of one of the parents, usually the male. Runyan (1961:118) also states that "... eggs in good condition were usually accompanied by a male *Gobiesox strumosus*, that kept them constantly aerated by fanning anal and caudal fins. . . ."

DEVELOPMENT OF THE EGG

The mean dimensions of 100 eggs were 1.65 x 1.35 mm. The eggs are oval and dorso-ventrally depressed and are attached to the substrate by a flattened adhesive base. When first laid the eggs are bright crimson and are about 1.2 mm long, but within minutes they expand to a length of 1.65 mm, by uptake of water through the egg membrane. The yolk is central and subspherical and has a mean diameter of 1.3 mm. The yolk of the fertilised egg is a crimson-red colour, and contains between 10 and 100 oil globules, one of which becomes dominant during later development. Development to hatching (Figs. 1-2, nos. 1-10) took 12 days at a water temperature of 15°C.

Two hours (Fig. 1, no. 1). A single large cell appears from beneath the yolk and later expands and moves to one end of the yolk within one of the lateral perivitelline cavities.

Three hours (Fig. 1, no. 2). The first cleavage divides the cell dorso-ventrally relative to the egg base, and at right angles to the yolk surface. The cells formed round off and appear as two swellings protruding from one end of the yolk-sac.

Four hours (Fig. 1, no. 3). The four celled stage is produced by a second cleavage at right angles to the first. Oil globules are free to move and tend to migrate to the uppermost region of the yolk; hence their position depends on the attitude of the egg.

Five hours. In the eight celled stage the blastomeres are still in a single layer. The cells are arranged in two rows of four cells each.

Six hours. The sixteen celled stage is reached with the cells beginning to form a round blastodisc.

Twenty hours (Fig. 1, no. 4). The blastula is well formed and consists of a prominent cap of cells, beneath which lies the blastocoel.

Forty hours (Fig. 1, no. 5). At this stage the blastodisc has spread halfway around the yolk, in so doing obliterating the blastocoel. Epiboly is not obvious, except for the slight thickening of the lateral rim of the blastodisc.

Sixty-six hours (Fig. 1, no. 6). The blastodisc covers the entire yolk-sac. The primitive streak is well defined and lies deeply notched into the yolk, particularly in the cephalic region.

Eighty-five hours (Fig. 2, no. 7). The outline of the embryo is distinct, encircling half the yolk-sac. The myotome rudiments and the otic capsules are just visible. The main oil globule has become larger, apparently at the expense of the smaller oil droplets which have slowly decreased in size. Fore-brain development is quite evident.

Fourth day. At this time the embryo encircles more than half of the yolk and the tail begins to extend free from the yolk-sac. The oil globule lies directly beneath the tail and remains here for the rest of the development. Optic vesicles contain outlines of the lens, and there is a pronounced enlargement of the hindbrain. Approximately 17 myomeres are present.

Fifth day (Fig. 2, no. 8). The total body length has increased slightly. Nearly all the myomeres are present posterior to the otic capsules and extending well down into the tail. At this time the heart begins to beat very faintly, but blood movement is seen only in the region of the heart. The heart lies well forward beneath the head and is obscured by the yolk.

Seventh day (Fig. 2, no. 9). The yolk is reduced considerably and the ventral aspect of the embryo faces upwards. The tail is well formed and is turned back to lie parallel with the body. The gut is formed and has scattered pigment spots on its upper surface. The heart beats regularly and strongly. Each beat of the heart sends a wave of movement through the yolk. Blood flows in the dorsal and ventral blood vessels, and the vitelline vessels are large and run laterally across the yolk. Pigment has appeared in the chorioid of the eye.

Twelfth day (Fig. 2, no. 10). The mouth and external nares are formed and the gut pigmentation has become darker. There is a further reduction in the amount of yolk. Pigmentation of the chorioid appears complete. The embryo is cramped within the egg and the tail arches forward to overlap the head. Just prior to hatching the embryo becomes agitated and begins to flex its tail. As a result of this activity the chorion is ruptured and the prolarva is released.

Prolarvae (Fig. 3, no. 11-12). Some of the larvae that hatched in the laboratory may have been induced to do so prematurely, as a result of disturbance. This is suggested by the variation in the amount of yolk present in each prolarva immediately after hatching. Prolarval length on hatching ranges from 4.8-5.5 mm. At this stage the gut is long and extends to the base of the 15th myomere. The upper peritoneum of the gut is covered with numerous stellate melanophores, extending from above the yolk to the vent. Posterior to the gut are 16-18 myomeres. Stellate melanophores are present in the myomeres just past the vent, but their number is variable. An obvious yellow tinge surrounds the braincase, and this extends through the myotomes above the gut to the 8th myomere past the vent. All larvae kept in the laboratory died within three days of hatching.

Larvae (Fig. 3, no. 13-14). At 6.5 mm the yolk-sac is almost absorbed and the gut reaches beyond the mid-length of the body. The oil globule is no longer visible. Pigmentation has changed very little except for an increase in the size of the melanophore at the base of the pectoral fin. The jaws are well formed and appear functional, although as yet are without well defined teeth. Two gills and 6-7 branchiostegal rays are visible on either side of the head. Two sucker buds lie ventral to the gills and heart. The longitudinal fin folds have slightly increased in size.

At 7.85 mm (Fig. 3, no. 15-16), the overall shape of the larva changes slightly. Essentially there is a flattening and broadening of the head, and an increase in the depth of the tail. In addition to the existing pigment pattern, numerous grey spots are scattered about the outer edges of the larvae. The dorsal, anal and caudal fins show signs of ray formation. The urostyle is curved upwards and extends a considerable distance into the caudal fin. The ventral sucker is well developed and functional. At this small size the larvae are able to cling to the

sides of glass jars. No specimens larger than 7.85 mm were caught in the plankton nets. Because larvae of this size have a fully functional sucker (Fig. 4, no. 18) it is suggested that at this stage they attach beneath stones.

The average measurements of twenty-five prolarvae are as follows:

Standard length	.....	.....	.....	.....	.....	.....	5.4 mm
Total length	.....	.....	.....	.....	.....	.....	5.7 mm
Head length	.....	.....	.....	.....	.....	.....	0.95 mm
Eye length	.....	.....	.....	.....	.....	.....	0.41 mm
Snout to anus	.....	.....	.....	.....	.....	.....	3.0 mm

Larval measurements are as follows:

Standard length	.....	.....	.....	6.5 mm	7.85 mm
Predorsal length	.....	.....	.....	3.2 mm	5.0 mm
Head length	.....	.....	.....	1.4 mm	2.15 mm
Depth of head	.....	.....	.....	0.9 mm	1.21 mm
Snout length	.....	.....	.....	0.31 mm	0.5 mm
Eye length	0.5 mm	0.57 mm
Interorbital distance	0.35 mm	0.55 mm
Head width	1.1 mm	1.4 mm

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LITERATURE CITED

- Briggs, J. C. 1955: A monograph of the clingfishes (Order Xenopterygii). *Stanford Ichthyol. Bull.*, 6, 224 pp., 114 fig., 1 tab.
- Coakley, A. 1964: Life history and general biology of *Trachelochismus pinnulatus* (Forster) (Order Xenopterygii). Unpublished M.Sc. thesis, University of Canterbury (not seen).
- Dovel, W. L. 1963: Larval development of clingfish, *Gobiesox strumosus*, 4.0 to 12.0 millimeters total length. *Chesapeake Sci.*, 4 (4): 161-166, 6 fig., 3 tab.
- Gibson, R. N. 1969: The biology and behaviour of littoral fish. *Oceanogr. Mar. Biol. Ann. Rev.*, 7: 367-410, 5 fig., 3 tab.
- Graham, D. H. 1939: Breeding habits of the fishes of Otago Harbour and adjacent seas. *Trans. Proc. Roy. Soc. N.Z.*, 69: 361-372, 7 pl.
- Graham, D. H. 1953: *Treasury of New Zealand fishes*. (Wellington: A. H. & A. W. Reed.) 404 pp., 153 fig.
- Hubbs, C. L. & Lagler, K. F. 1958: *Fishes of the great lakes region*. (Michigan: Cranbrook Institute of Science.) 213 pp., 251 fig., 6 tab.
- Phillipps, W. J. 1927: Notes on New Zealand fishes. *Trans. N.Z. Inst.*, 58 (1, 2): 125-135, 6 pl.
- Runyan, S. 1961: Early development of the clingfish, *Gobiesox strumosus* Cope. *Chesapeake Sci.*, 2 (3, 4): 113-141, 33 fig., 6 tab.

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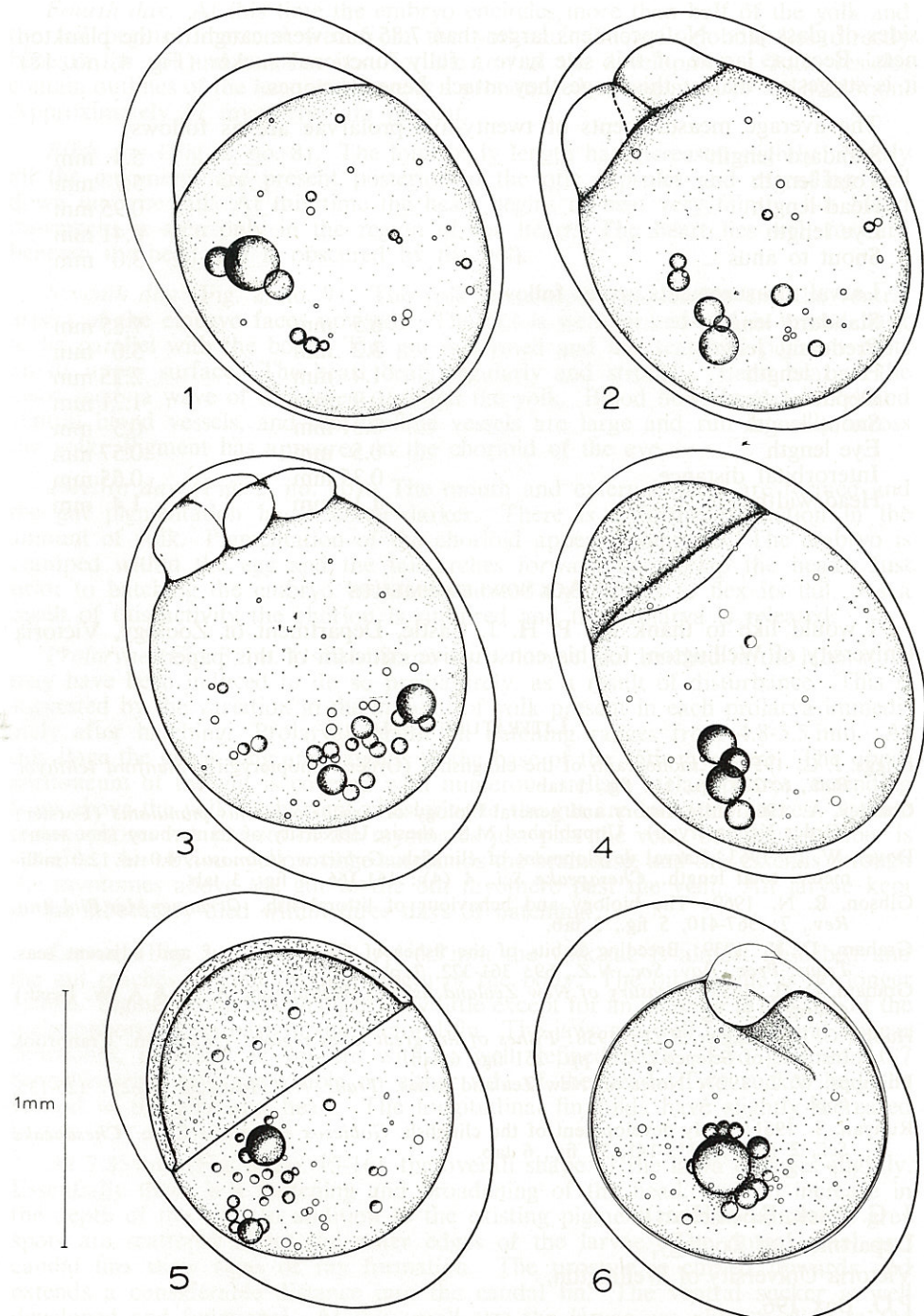


Fig. 1. *Trachelochismus melobesia*. No. 1: 2 hours; 2: 3 hours; 3: 4 hours; 4: 20 hours; 5: 40 hours; 6: 66 hours.

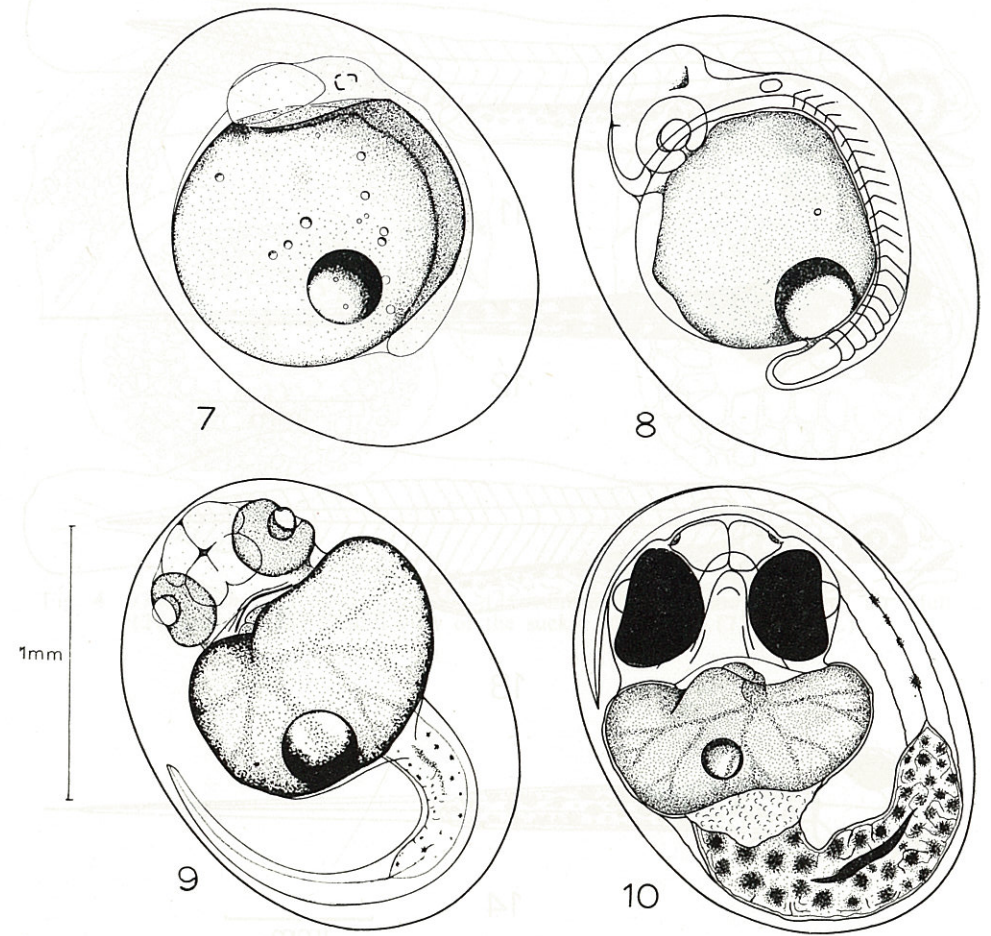


Fig. 2. *Trachelochismus melobesia*. No. 7: 85 hours; 8: 133 hours; 9: 7th day; 10: 12th day.

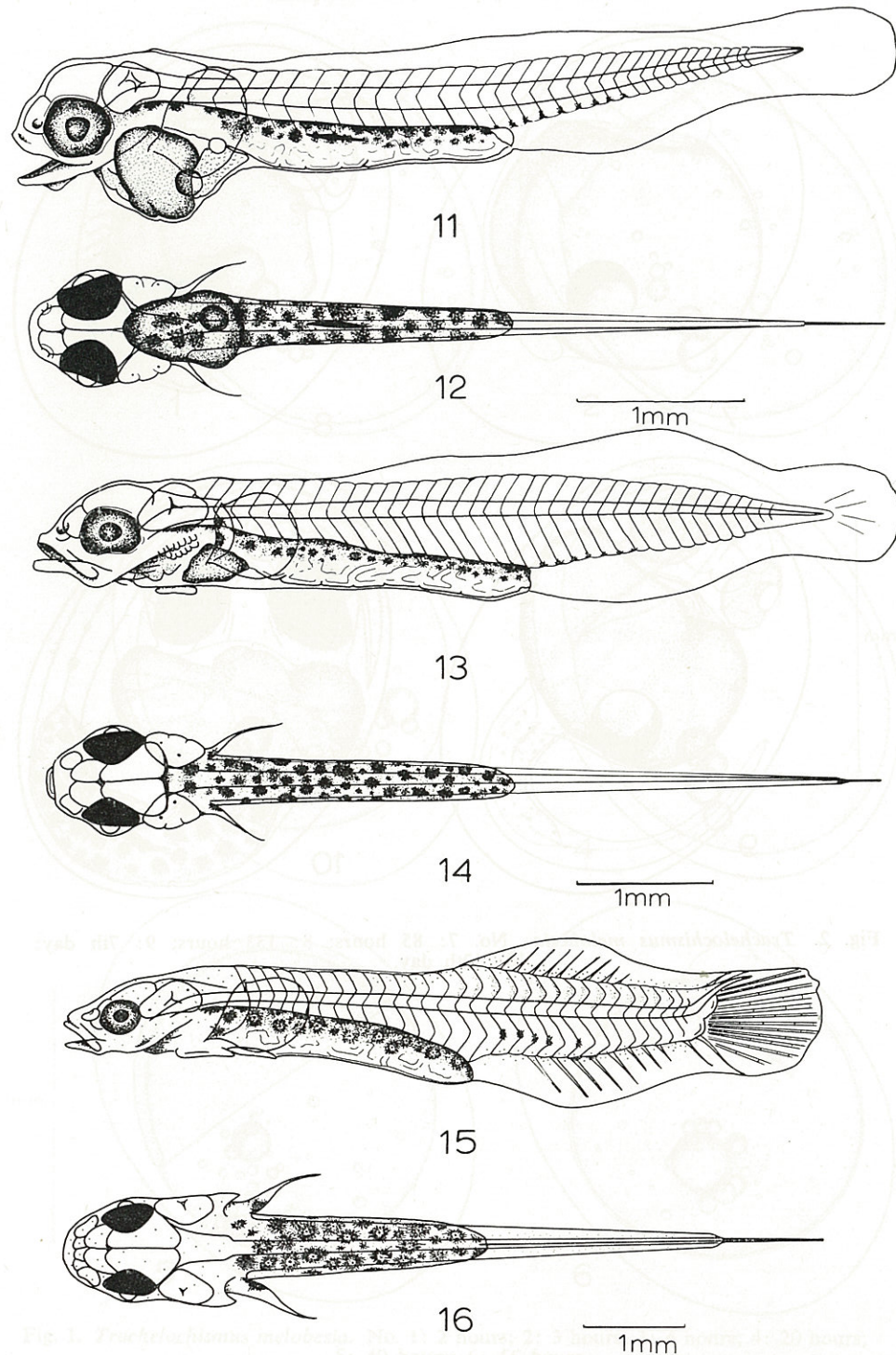


Fig. 3. *Trachelochismus melobesia*. Nos. 11 & 12: lateral and dorsal aspect of a pro-larva; 13 & 14: 6.5 mm larva; 15 & 16: 7.85 mm larva.

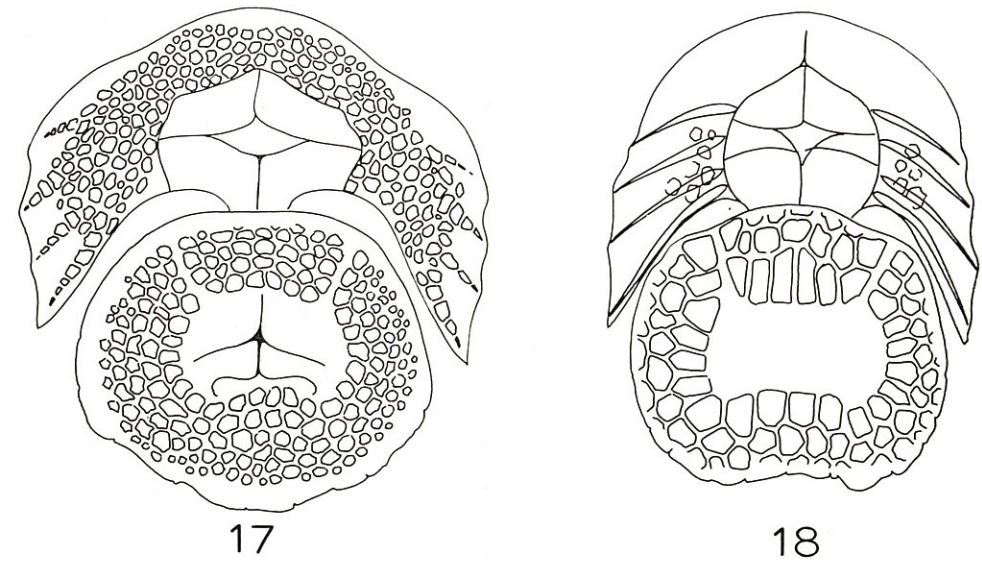


Fig. 4. *Trachelochismus melobesia*. No. 17: ventral view of the sucker of an adult (27 mm s.l.); 18: ventral view of the sucker of a larva (7.85 mm s.l.).



Fig. 11. Dorsal view of the mouthparts of a larva (17 mm SL).
 Fig. 12. Ventral view of the mouthparts of a larva (17 mm SL).



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