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C. Richard Robins

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Two New Species of *Ophidion* (Pisces: Ophidiidae) from Remote Islands of the Eastern Pacific[1]

C. Richard Robins[2]

ABSTRACT. Two dwarf species of *Ophidion* are described from islands in the eastern Pacific Ocean. One occurs at Easter Island and in the Marquesas, the other at Mas A Tierra in the Juan Fernandez Islands and at Isla San Felix. The two are sister species differing principally in meristic characters and they appear to be most closely related to American Pacific species. Zoogeographic implications are discussed. Dwarfism in this instance probably is an adaptive response to a predator-rich environment. The loss of sexual dimorphic features in the swim bladder and associated supportive structures is correlated with dwarfism and life in high energy, noisy environments. These shared losses muddle the phylogenetic picture.

INTRODUCTION

Ophidiid fishes occur peripherally in the Pacific Ocean. Species of many genera (*Genypterus, Lepophidium, Cherublemma, Ophidion,* and *Otophidium*) occur in coastal waters of the Americas, but very few are known from the vast reaches of the Pacific. The southern genus *Genypterus* reaches southern Australia, New Zealand, and the Chatham Islands. *Ophidion muraenolepis* described from the Arafura Sea is common around Hawaii in fairly deep waters (Robins, unpublished) and probably is widely distributed. *Ophidion asiro* occurs in the extreme western Pacific and an undescribed species occurs around Samoa. Finally, there is at least one species of *Ophidion* along the eastern coast of Australia. Basically, the family is largely absent from the Pacific Plate. Robins (1961, 1962) reviewed the eastern Pacific species of *Lepophidium* and *Cherublemma* (=*Brotuloides*), Robins and Lea (1979) commented further on *Lepophidium,* and Lea (1980) revised the species of *Ophidion* and *Otophidium* from the Pacific Coast of the Americas, including the Galapagos Islands.

Three expeditions collected the same undescribed species of cusk-eel at Easter Island: Ramsey Parks and the crew of the ketch CHIRIQUI collected nine specimens in 1958; the medical expedition under the direction of Ian E. Efford in 1965 obtained it at five stations; and John E. Randall and G.R. Allen collected it twice in 1969. Randall and D.B. Cannoy obtained three specimens at the Marquesas Islands in 1971. Material of a second undescribed species, from the Juan Fernandez Islands and Isla San Felix, was obtained by divers from the Southeastern Pacific Biological and Oceanographic Program (SEABOP). This report describes these two species and comments on their distribution and relationships.

For material, notes, and other assistance, I am indebted to Ian E. Efford of the University of British Columbia (BC), David K. Caldwell, Jack Grove, and Robert J. Lavenberg, and Daniel M. Cohen of the Natural History Museum of Los Angeles County (LACM), Don E. McAllister of the National Museum of Canada (NMC), Richard H. Rosenblatt, and the late Carl L. Hubbs of the Scripps Institution of Oceanography (SIO), William N. Eschmeyer of the California Academy of Sciences (also for Stanford University (SU) material now housed at this institution (CAS)), Ernest A. Lachner, W.R. Taylor, and Stanley H. Weitzman of the National Museum of Natural History (USNM), Myvanwy Dick and Karsten Hartel of the Museum of Comparative Zoology, Harvard University (MCZ), Alfred W. Ebeling and Keith S. Thomson of Yale University (BOC), P.H. Greenwood of the British Museum (Natural History) (BMNH), and John E. Randall of the Bernice P. Bishop Museum (BPBM). Randall has made special efforts to obtain specimens and has generously provided notes of life colors and habitat, and photographs. Material from the Smithsonian Oceanographic Sorting Center was made available

1. Contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

2. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida 33149.

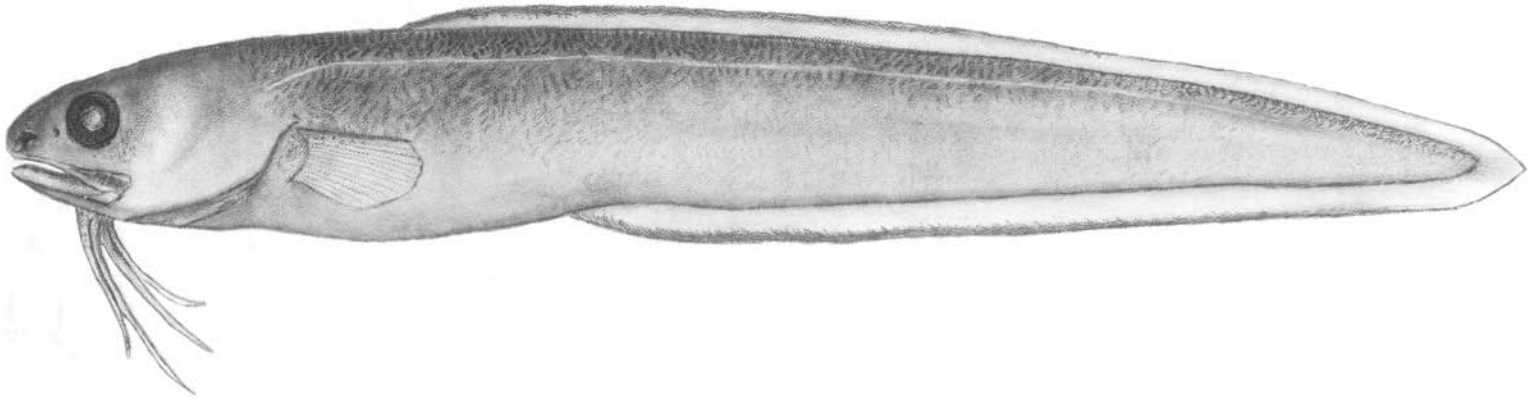

Figure 1. *Ophidion exul,* holotype, NMC 74-524, a male, 93.2 mm SL from Easter Island. Drawn by Catherine H. Robins.

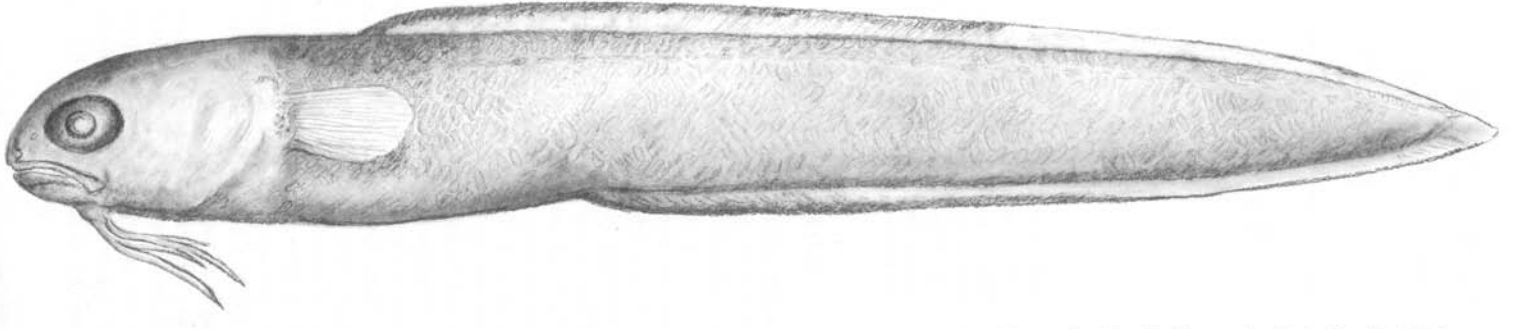

Figure 2. *Ophidion metoecus,* paratype, SIO 65-637, a female, 76.0 mm SL from Isla Robinson Crusoe, Juan Fernandez Islands. Drawn by Catherine H. Robins.

by Leslie Knapp and its advisory committee. Catherine H. Robins prepared Figures 1 and 2 and also commented on the manuscript. This study is part of a program supported by the National Science Foundation (NSF-GB28440X2). Abbreviations in parentheses above are those used in reference to material in the text. Most of this research was done at the author's home laboratory in Miami, Florida.

Ophidion exul new species

Figure 1, Tables 1, 2

No published literature refers to this species.

DIAGNOSIS. Scales ovoid, in staggered rows as in *Anguilla,* head naked, the 2 pelvic-fin rays unequal. Ethmoid process absent. No pyloric caeca. Gill rakers 6 (2 rudiments and 4 developed rakers) on first arch. Vertebrae 69–72 (usually 70–71, anal-fin rays 118–131, dorsal-fin rays 140–152, and pectoral-fin rays 21–24. Longer pelvic ray 13–15 percent of standard length, shorter 9–12 percent. Gas bladder small; a simple sac lacking posterior opening and major bony modifications. Coloration brownish, paler below, without distinctive markings, except margins of vertical fins dark, especially anteriorly and especially in the anal fin.

DESCRIPTION. Frequency distributions of various counts are given in Table 1; Table 2 treats morphometry for the type series. All specimens examined have 9 caudal rays (arranged as is usual in ophidiid fishes [*sensu stricto*], 4 dorsal and 5 ventral) and 7 branchiostegal rays (4 attached to the outer surface of the epihyal and ceratohyal and 3 to the ventral surface of the ceratohyal). Gill rakers were counted on 40 specimens and, with one exception, all have 2 rudiments on the upper arm and 4 short rakers on the lower arm of the first arch for a total of 6 elements. The exception (LACM 6560-2, 113.6 mm SL) has 3 rudiments above and thus a total of 7 rakers. The longest raker generally equals about half the pupil diameter.

There is a single row of small fixed teeth on each palatine bone and a single V-shaped row along anterior edge of head of vomer. Premaxillary and dentary teeth are arranged in a band, best developed in outer row.

The anguilloid squamation covers the entire body except for the head and the course of the lateral line along side of body. However, the scales are deeply imbedded in some areas and, at first glance, the belly, pectoral-fin base, and flanks appear to be naked.

Ophidion exul is elongate, the body being little deeper at the dorsal-fin origin than at occiput or anal-fin origin (Table 2). The two rays of each pelvic fin are unequally developed. The longer (outer) averages 14.8 percent of SL and is possibly proportionally longer in smaller specimens. The shorter (inner) ray averages 10.5 percent of SL. In all instances except one, the pectoral fin was shorter than the shorter pelvic ray.

Life colors are noted from a Kodachrome kindly provided by John E. Randall. Body behind anus and the anterior dorsal half are brown with the lateral line a distinct, pale streak throughout its length. Dorsal and anal fins are pale except for the dark brown edge. Belly and lower half of the sides of head and anterior part of body are whitish with silvery reflections. Pelvic fins are pale except at the basal peduncle. Juveniles are "pale yellowish gray, silvery on head and abdomen, with some dark pigment along base of dorsal and anal fins" (Randall, personal communication). In preservative (see Fig. 1), all are dusky, particularly on the dorsum in smaller specimens, but otherwise without much paling below. Orbit outlined with a narrow dark ring. Dorsal fin is narrowly and sharply edged with dark brown in all specimens. Anal fin is marked similarly in males and small females but is almost unmarked in the series of nine large females (LACM 6560-2). It is unlikely that this mark could have faded in this one series and the dark anal edge probably is a character of males and juveniles. The peritoneum, digestive tract, and oral cavity are pale. The posterior end of the swim bladder is often blackish.

Small specimens (less than 60 mm SL) have the anterior gular region blackish with large scattered melanophores behind and have some deep-seated dark pigment anterior to the eye. One, 45 mm SL, is extreme in these features and has the general facies of the pelagic prejuvenile stage. Presumably, 45 mm SL is about the size at which transformation occurs and a benthic habit is assumed.

The head-pore arrangement does not depart much from that described by Robins (1960:87 and Fig. 2) for *Lepophidium pheromystax.* The supratemporal canal bears 3 pores (the second median), each at the caudal end of very short side canals. The lateral canal contains 1 pore above the posterior half of the dorsal edge of the opercle. The supraorbital canal has 5 pores, 1 above the upper posterior quadrant of orbit, the second a median coronal pore, the third above the anterior edge of orbit, and numbers 4 and 5 above and in front of the anterior nostril. There are 8 pores in each infraorbital canal, 3 on the descending portion of the canal, numbers 4 and 5 below orbit, 6 under the posterior nostril, and 7 and 8 along the preorbital rim behind the anterior nostril. The preoperculomandibular canal bears 8 pores, the first 2 from the end of caudally projecting side canals behind lower half of preopercle, the third at the end of a side canal about halfway forward to corner of mouth, the fourth under the posterior part of maxilla, and the fifth to eighth on alternate sides of mandible near the anterior end of the canal. The anterior pores are difficult to locate in some specimens. The snout tip is ridged and bears a few short papillae at its rim.

All nine specimens collected at Anakena Cove on October 1 (LACM 6560-2) were ripe females. None of those collected in February was ripe.

The swim bladder is a simple, thin-walled sac. It

Table 1. Fin-ray and vertebral counts of *Ophidion exul* (A, B)[1] and *Ophidion metoecus* (C, D).[1]

	Dorsal rays (*O. exul*)												
	140	141	142	143	144	145	146	147	148	149	150	151	152
A	2	4	2	1	3	5	1	1†	2	1	1	3	1
B	—	—	—	—	—	—	2	—	—	2	—	1	—
Total	2	4	2	1	3	5	3	1†	2	3	1	4	2

	Dorsal rays (*O. metoecus*)												
	158	159	160	161	162	163	164	165	166	167	168	169	170
C	1	2	—	1	—	—	—	1	1	5	2	5	6
D	—	—	—	—	—	1	—	—	1	—	—	—	—
Total	1	2	—	1	—	1	—	1	2	5	2	5	6

	Anal rays (*O. metoecus*)												
	129	130	131	132	133	134	135	136	137	138	139	140	141
C	1	2	1	—	2	3	5†	3	4	5	8	5	3
D	—	—	—	—	—	2	—	—	1	—	1	—	—
Total	1	2	1	—	2	5	5†	3	5	5	9	5	3

	Pectoral rays[2]							Vertebrae								
								Precaudal				Caudal				
	21	22	23	24	25	26	27	15	16	17	18	54	55	56	57	58
A	16†	23†	11	2	—	—	—	7	29†	—	—	11	19†	6	—	—
B	—	1	2	5	—	—	—	—	5	—	—	2	3	—	—	—
Total	16†	24†	13	7	—	—	—	7	34†	—	—	13	22†	6	—	—
C	—	—	1	12†	28	15	1	—	5	39†	2	—	—	—	—	1
D	—	—	—	2	6	—	—	—	—	4	—	—	—	—	—	—
Total	—	—	1	14†	34	15	1	—	5	43†	2	—	—	—	—	1

[1] A, Easter I., B, Marquesas Is., C, Juan Fernandez Is., D, Isla San Felix.

[2] Both fins recorded.

† Count includes that of holotype.

is small, confined mostly to the anterior third to half of the body cavity. There is no median rocker bone nor bony encasement of the bladder. The winglike process of the first vertebra (see Rose, 1961) is expanded and is closely associated with the anterior end of the swim bladder.

MATERIAL EXAMINED. Easter Island: HOLOTYPE: NMC 74-524 (formerly BC 65-451), a male, 93.2 mm SL, collected off Hanga Roa, 27°08′37″S, 109°26′10″W in 1–5 m, 2 Feb. 1965. PARATYPES: NMC 74-525 (4 specimens, 71–80 mm SL) and UMML 32674 (3, 79–92 mm SL) collected with the holotype. BC 65-428 (1, 44 mm SL) tide pool at Hanga Piko, 27°08′37″S, 109°26′10″W, 7 Jan. 1965. USNM 213841 (formerly BC 65-453) (2, 71–95 mm SL) also at Hanga Piko, 4 Feb. 1965. BC 65-457 (1, 83 mm SL) at Hanga Roa, date unknown (presumably early Feb. 1965). BC 65-458 (1, 65) at Hanga Roa, 6 Feb. 1965. All material listed above was collected by Ian E. Efford and Jack A. Mathias. LACM 6560-2 (9, 79–131 mm SL) Anakena Cove, east side, 30 m NE of sand beach, 27°03′50″S, 109°19′50″W, in 1–4.5 m, by Ramsey Parks and crew of ketch CHIRIQUI, 1 Oct. 1958 (original field number W58-386). BPBM 6765 (5, 45–81 mm SL) Mataveri o Tai in 6 m, J.E. Randall and G.R. Allen, 2 Feb. 1969. BPBM 6766 (9, 45–73 mm SL) off Aku Akapu in 11 m, J.E. Randall, G.R. Allen, B. Baker, 7 Feb. 1969. BPBM 30546 (1, 91.7 mm SL) off east end of Anakena in 6 m, J.E. Randall, 14 February 1985. BPBM 30547 (1, 40.7 mm SL) off east end of Anakena in 21 m, J.E. Randall and Louis H. Di Salvo, 14 Feb. 1985.

Marquesas Islands (not paratypes): BPBM 10864 (2, 41–45 mm SL) Nuku Hiva, Anaho Bay, in 38–40 m, J.E. Randall, D.B. Cannoy, 2 May 1971. BPBM 11932 (1, 42 mm SL) Tahuata, south end of Vaitahu Bay in 30 m, J.E. Randall, D.B. Cannoy, J. Haywood, 23 April 1971. BPBM 16426 (1–34 mm SL) Tahuata, Haava Straits between Tahuata and Hiva Oa in 68 m, Sta. TH X, crew of the PELE, 1 October 1967. BPBM 17714 (1, 64 mm SL) Nuku Hiva I., in 73–82 m, Sta. NH 7, crew of the PELE, 17 September 1967.

Table 1 Continued.

Anal rays (*O. exul*)

118	119	120	121	122	123	124	125	126	127	128	129	130	131
1	4	1	1	1	4	1	3	4†	4	1	4	1	1
1	1	2	—	—	—	—	—	—	1	—	—	—	—
2	5	3	1	1	4	1	3	4†	5	1	4	1	1

Dorsal rays (*O. metoecus*)

171	172	173	174	175	176	177	178	179	180	181	182	183	184	185
3	4†	2	3	2	—	2	—	3	2	—	—	—	—	1
—	—	1	—	—	1	—	—	—	—	—	—	—	—	—
3	4†	3	3	2	1	2	—	3	2	—	—	—	—	1

Anal rays (*O. metoecus*)

142	143	144	145	146
2	—	2	1	1
—	—	—	—	—
2	—	2	1	1

Vertebrae

Caudal					Total										
59	60	61	62	63	69	70	71	72	73	74	75	76	77	78	79	80
—	—	—	—	—	2	12	19†	3	—	—	—	—	—	—	—	—
—	—	—	—	—	—	2	3	—	—	—	—	—	—	—	—	—
—	—	—	—	—	2	14	22†	3	—	—	—	—	—	—	—	—
1	13†	25	5	1	—	—	—	—	—	—	1	1	15†	25	4	1
1	1	1	1	—	—	—	—	—	—	—	—	1	1	1	1	—
2	14	26	6	1	—	—	—	—	—	—	1	2	16†	26	5	1

NAME. *Exul,* from the common gender Latin noun *exul* (also *exsul*) meaning exile, alluding to the isolated geographic position of this species.

DISTRIBUTION. *Ophidion exul* is known from Easter Island and the Marquesas Islands. It occurs in sandy areas at the base of the rocky shores of these islands from tide pools to about 50 m. It should be looked for at Sala y Gomez, Ducie, Henderson, and Pitcairn islands, but Randall (personal communication) has commented that sandy areas especially near reefs in the Tuamotus and other island groups toward the Central Pacific have been well collected compared to Easter Island and that it is doubtful that *O. exul* or any other shallow dwelling cusk-eel occurs in that region.

GEOGRAPHIC VARIATION. Considering the remoteness of its two known populations, *Ophidion exul* exhibits remarkably little variation. Table 1 separates the meristic data for specimens from Easter Island and the Marquesas. Pectoral-ray counts are lower from Easter Island but there are too few specimens from the Marquesas and they are too small for further morphometric comparison. Additional material may indicate that the two merit subspecific recognition. Because of these considerations, specimens from the Marquesas are not designated as paratypes.

Ophidion metoecus new species

Figure 2, Tables 1, 3

DIAGNOSIS. Very similar to *Ophidion exul* in its size and color but more slender. Gill rakers 6 (2 rudiments and 4 developed rakers) on first arch (also as in *O. exul*). Vertebrae 75–80 (usually 75–78), anal-fin rays 129–146, dorsal-fin rays 158–185, and pectoral-fin rays 23–27 (usually 24–26). Longer pelvic ray 10–13 percent of SL, shorter 7–9 percent. Gas bladder small, without posterior opening or bony modifications.

DESCRIPTION. Frequency distributions of numbers of fin rays and vertebrae are given in Table 1. Morphometric data are given in Table 3. All specimens have 9 caudal rays and 7 branchiostegal

Table 2. Measurements[1] of body parts expressed in percent of SL for the holotype and 19 paratypes of *Ophidion exul* from Easter Island.

Collections[2]	458	453	NMC	NMC	NMC	UMML	NMC	457	UMML
Standard length (mm)	65.2	70.8	70.8	71.5	78.0	78.6	80.5	83.1	87.3
Head length[3]	19	19	20	19	19	18	18	19	19
Snout tip to:									
Dorsal fin	27	28	26	27	27	26	25	27	25
Anal fin	37	38	41	36	37	38	38	37	36
Occiput	16	16	15	15	15	15	15	15	14
End of lateral-line	83	83	84	84	78	90	84	85	81
Tip maxilla	8.3	9.0	8.9	9.0	8.8	8.8	8.7	8.4	8.7
Body depth at:									
Occiput	12	12	13	12	12	12	12	12	12
Dorsal-fin origin	12	13	13	13	14	13	13	13	13
Anal-fin origin	12	13	13	12	13	13	12	11	13
Pectoral fin	8.9	9.7	9.2	9.4	8.7	8.9	9.6	9.4	8.4
Pelvic ray:									
Outer	15	15	17	16	16	16	14	13	16
Inner	10	10	11	11	11	10	11	11	11
Caudal fin	3.1	3.1	2.1	3.5	2.9	3.2	2.7	3.2	3.0
Orbit diameter	5.5	6.5	5.8	5.7	5.4	5.2	5.7	5.4	5.2
Bony interorbit	2.8	2.8	3.1	3.1	2.7	2.5	2.6	2.4	2.6
Snout length	4.8	4.6	4.4	4.2	4.4	4.2	4.0	4.4	4.6
Postorbit[3]	11	11	11	10	10	10	9.4	11	10

[1] For definition of measurements see Robins (1960:90–91).

[2] All numbered collections are in the University of British Columbia 65 series. LACM is Los Angeles County Museum 6560-2, NMC is National Museum of Canada 74-524 (holotype) and 74-525, UMML is UMML 32674.

[3] To tip of opercular flap.

† Holotype.

rays arranged as described above for *O. exul*. All 31 specimens examined have 4 developed gill rakers on the lower limb of the first arch and 29 have 2 rudiments above (total 6); one each has 1 and 3 rudiments above (total 5 and 7, respectively). The developed rakers are somewhat longer than half the pupil diameter. Dentition is as described for *exul* but the scales are more imbedded and many individuals appear almost naked. The head-pore system is the same as in *exul*.

Life colors are unrecorded but likely are similar to those of *O. exul*. The lateral line may not be whitish, however, for it is more solidly pigmented and less conspicuous in preserved specimens than in *O. exul*. Some collections appear darker with the border of the vertical fins bolder but this probably reflects more the ecology at these stations than any specific difference. The gular pigment of juveniles is the same as in *O. exul*.

The swim bladder is small, as in *O. exul*, not extending as far caudally as the tip of the depressed pectoral fin. The winglike process on the first vertebra again is the only bony modification associated with the swim bladder.

The longest specimen, 86 mm SL, is much shorter than the 131 mm recorded for *O. exul*; *O. metoecus* probably is a smaller species.

MATERIAL EXAMINED. Juan Fernandez Islands: Isla Robinson Crusoe: HOLOTYPE: USNM 204246, an adult, probably female, 79.4 mm SL, 33°38′20″S, 78°48′50″W in 6–11 m, ANTON BRUUN Cr. 12, Field No. MV 65 IV 41, 11 Dec. 1965. PARATYPES: SIO 65-634 (6, 72–81 mm SL), Cumberland Bay, *ca.* 33°38′20″S, 78°48′50″W in 6–11 m, MV 65 IV 41, 11 Dec. 1965. SIO 65-636 (1, 86 mm SL) Cumberland Bay, *ca.* 33°38′20″S, 78°49′00″W in 64 m, MV 65 IV 43, 11 Dec. 1965. SIO 65-637 (23, 67–80 mm SL), north side, 800 m NW of San Carlos Pt., 33°37′18″S, 78°50′20″W in 24–27 m, MV 65 IV 44, 12 Dec. 1965. SIO 65-645 (18, 64–80 mm SL) and UMML 32938 (3, 73–76 mm SL) northwest side of Punta Suroeste, *ca.* 33°37′15″S, 78°55′05″W in 20–23 m, 13 Dec. 1965. SIO 65-655 (17, 60–86 mm SL), west end Carvajal Bay, 33°41′10″S, 78°58′30″W in 9–12 m, MV 65 IV 65, 15 Dec. 1965. SIO 65-657 (1, 74 mm SL), west end of Villagra Bay, 33°39′45″S, 78°52′50″W, in 7.5–9 m, MV 65 IV 66, 15 Dec. 1965. SIO 65-659 (6, 68–81 mm SL) off Bacalao Pt. *ca.* 33°38′20″S, 78°47′15″W, to 26 m, MV 65 IV 69, 16 Dec. 1965. MCZ 46159 (1, 82 mm SL) West Bay in 0–2 m, ANTON BRUUN Cr. 13, coll. 15, 1 Dec. 1966. MCZ 46170 (4, 66–77 mm SL) west coast in 0–20 m, ANTON BRUUN Cr. 13, coll. 37, 27 Jan. 1966.

Table 2. Continued.

LACM	LACM	UMML	NMC†	LACM	453	LACM	LACM	LACM	LACM	LACM
89.8	91.5	92.0	93.2	94.4	95.0	112.1	113.6	116.0	129.5	130.9
18	20	19	19	18	18	20	19	18	20	18
27	28	27	25	25	27	27	28	26	26	26
37	39	39	37	39	39	37	39	37	40	40
14	15	15	14	14	14	14	14	14	14	14
85	88	89	86	87	85	84	86	86	88	89
8.6	9.7	8.3	8.8	7.2	8.6	8.9	8.4	8.0	8.4	8.0
12	12	13	12	12	12	12	12	11	12	12
13	14	14	14	12	—	13	13	12	13	—
12	12	13	13	11	11	13	11	12	13	13
9.6	9.0	11	8.6	9.2	9.3	8.6	8.6	8.5	8.0	8.8
16	17	14	13	14	14	15	15	14	14	13
10	12	10	10	9	10	11	10	9	10	10
3.2	3.0	2.3	3.1	2.8	2.9	2.8	2.6	2.8	2.7	2.8
5.2	6.2	5.5	5.7	4.8	5.5	5.7	5.8	5.6	6.0	5.5
2.0	2.1	2.6	3.2	2.0	2.3	2.1	1.9	2.2	2.1	2.1
3.9	4.3	4.3	4.3	3.7	3.9	4.0	4.2	4.0	4.2	4.0
10	10	11	10	9.5	10	10	10	8.9	11	10

Isla San Felix: SIO 65-629 (1, 72 mm SL), Cathedral Rocks, 26°16′10″S, 80°06′30″W, MV 65 IV 36, 7 Dec. 1965. SIO 65-625 (1, 75 mm SL) northwest side, 26°17.1′S, 80°05.2′W, MV 65 IV 31, 5 Dec. 1965. SIO 65-624 (2, 66–74 mm SL) *ca.* 26°17′30″S, 80°05′40″W, 5 Dec. 1965.

NAME. *Metoecus,* from the masculine Greek noun meaning a sojourner, settler.

DISTRIBUTION. *Ophidion metoecus* is known only from Isla Robinson Crusoe (=Mas A Tierra) in the Juan Fernandez Islands and from Isla San Felix. Its depth range is from the waters edge to 30 m in sandy bottom. Bottom temperatures were 15°C. There have been few collections made by divers using ichthyocides in steep-sloped, high energy island environments. The occurrence of *O. metoecus* only on the principal island in the Juan Fernandez group probably reflects nothing more than collection effort. It should occur on the various islands and near surface sea mounts from the eastern end of the Easter Island seamount chain south to the Juan Fernandez group.

COMPARISONS AND RELATIONSHIPS

Ophidion exul and *O. metoecus* are sister species. Substantial differences between them in numbers of fin rays and vertebrae are easily derived from the diagnoses and from Table 1. Also, comparisons of Tables 2 and 3 indicate differences in 9 morphometric features. There is almost no overlap in the distance from snout tip to dorsal fin (smaller in *O. metoecus*), in lengths of both pelvic-fin rays (shorter in *O. metoecus*), but there are average differences in body depth (*O. metoecus* is more slender throughout) at occiput, dorsal-fin origin, and anal-fin origin, and in distance from snout tip to anal-fin origin (smaller in *O. metoecus*). Also, *O. metoecus* has a larger orbit and shorter postorbit. These differences coupled with the consistency of both species throughout their respective ranges, point to their recognition as species.

Table 4 lists the data obtained from examination of the holotypes of *Ophidion muraenolepis* (Günther), *Ophidion iris* Breder, *Ophidion nigracauda* Breder, and *Ophidion fulvum* (Hildebrand and Barton). These species represent the closest geographic neighbors, in different directions, in *Ophidion,* to *O. exul* and *O. metoecus* and each is discussed below.

Ophidion muraenolepis has been known only from the holotype, BMNH 1879.5.14.46, a specimen collected at CHALLENGER st. 192 in the Ki (or Kai) Islands in the Arafura Sea north of Australia, and described by Günther (1880:46, Plate XX, fig. A). I have completed a study of many spec-

Table 3. Measurements[1] of body parts expressed in percent of SL for the holotype and 21 paratypes of *Ophidion metoecus* from the Juan Fernandez Islands and San Felix.

Collection	MCZ 46170	MCZ 46170	SIO65 624*	MCZ 46170	MCZ 46170	SIO65 634	SIO65 629	SIO65 634	SIO65 634	SIO65 634
Standard length (mm)	65.5	65.6	66.5	67.2	67.2	71.5	71.9	71.9	72.7	72.3
Head length[2]	16	16	19	16	16	17	19	19	19	18
Snout tip to:										
Dorsal fin	22	21	22	21	21	22	24	22	23	22
Anal fin	35	36	36	35	35	33	37	36	35	34
Occiput	14	14	15	13	14	14	16	14	15	14
End of lateral-line	85	87	85	87	88	87	87	89	90	86
Tip maxilla	8.2	8.4	8.4	9.1	10	8.1	8.9	8.3	8.7	7.8
Body depth at:										
Occiput	10	10	11	9.4	10	10	11	11	11	11
Dorsal-fin origin	12	10	12	11	11	11	13	12	12	12
Anal-fin origin	10	10	11	9.2	9.1	10	11	12	10	10
Pectoral fin	9.0	9.0	9.3	7.9	8.3	8.1	9.4	8.3	8.8	8.2
Pelvic ray:										
Outer	13	10	12	10	11	11	13	11	12	12
Inner	8.1	7.5	9.5	7.0	6.8	8.1	9.0	7.5	8.1	7.1
Orbit diameter	6.4	5.8	5.9	5.6	5.4	5.9	6.2	6.2	6.0	5.9
Bony interorbit	2.6	2.6	2.2	2.5	2.8	2.6	2.8	2.5	3.4	2.7
Snout length	3.8	3.6	4.1	3.9	3.4	3.8	4.4	3.9	4.6	4.0
Postorbit[2]	9.3	10	9.0	9.1	9.8	9.2	9.2	9.2	9.8	8.6
Sex	—	—	♀	—	—	♀	—	♀	♂?	♂

[1] For definition of measurements see Robins (1960:90–91).

[2] To tip of opercular flap.

* Isla San Felix.

† Holotype.

imens of this species, which occurs as far to the northeast as Hawaii, and this analysis will be published elsewhere. *Ophidion muraenolepis* is a large species with a thick-walled swimbladder with posterior opening and an anterior bony encasement; it is not closely related to *O. exul* or *O. metoecus*.

Analysis of species of *Ophidion* from the Pacific shore of America was done by Robert N. Lea (1980). Comments on a few holotypes are in order. *Ophidion nigracauda* and *O. iris* were both described (Breder, 1936:44–47, figs. 15, 16) from single specimens collected at Refugio Bay and Gonzago Bay, Gulf of California, Mexico, respectively. Study of columns C and D in Table 4 shows that these nominal species are almost identical in their counts and measurements. They are here synonymized and, as first reviser, I select *O. iris*. (Cohen and Nielsen, 1978:16, list *nigracauda* as a synonym of *iris* without comment but based on personal communication from Robins and Lea. It is not clear whether this action qualified them as first revisers.) Although *O. nigracauda* has page priority and its holotype is in better condition, the name is based on an anomalous condition. The black area at the caudal end of the body is overemphasized in the original illustration and appears to be the result of physical damage such as a burn from a hot deck. No melanophores are evident (personal observation, and Lea 1980). It is inappropriate to saddle this very pallid species that never has a black tail with this name when an alternate is available. Basically, *O. iris* is much like *O. exul* and *O. metoecus*. The swim bladder of *iris*, though larger, is similar, its head-pore system is identical, and it has 2 rudiments and 4 developed rakers on its first gill arch. However, it has fewer dorsal- and anal-fin rays, its scales are smaller, and it is longer and more robust. Among described species, *O. iris* and *O. fulvum* are the smallest from the American Pacific.

Ophidion fulvum was known only from the holotype, USNM 144257, collected at Talara, Peru, and described by Hildebrand and Barton (1949:32–34, fig. 9), but Lea (1980) reports it from Costa Rica to Peru. The counts given in the original description are incorrect. There are 142 (not about 115) dorsal-fin rays, 114 (not about 83) anal-fin rays, and 25 (not 26 or 27 pectoral-fin rays). *Ophidion fulvum* also has fewer caudal vertebrae than *O. exul* or *O. metoecus*. In body proportions it generally agrees with *O. exul* except that the pelvic rays are decidedly shorter (outer 10 vs. 13–17 percent of SL, inner 6.4 vs. 9–11 percent SL). Its pelvic-fin rays are more like those of *O. metoecus*. In general form *O. exul* and *O. motoecus* most closely resemble *O. fulvum*.

Table 3. Continued.

SIO65 657	SIO65 624*	SIO65 634	SIO65 625*	SIO65 655	USNM 204246†	SIO65 634	SIO65 655	MCZ 46159	SIO65 655	SIO65 655	SIO65 655
73.8	73.8	74.6	75.4	78.5	79.4	80.8	81.3	82.0	82.9	84.2	86.3
17	18	18	19	19	20	18	19	21	19	18	20
22	24	23	24	23	24	24	24	26	24	22	24
33	36	34	37	37	38	37	36	38	36	35	38
14	16	15	16	15	16	15	15	16	16	14	16
85	92	86	90	87	82	86	88	88	82	86	89
7.3	7.7	8.0	8.4	8.7	9.1	8.0	8.8	9.5	9.5	8.7	9.4
10	12	11	11	11	12	12	12	—	11	11	13
11	13	13	14	11	15	13	13	13	12	11	14
10	12	11	12	10	14	12	11	13	11	10	12
8.1	8.9	9.5	9.4	9.2	10	9.2	9.0	11	10	8.9	10
11	12	12	13	11	12	12	12	13	11	12	12
7.5	8.8	8.0	9.2	7.9	8.8	9.0	7.6	8.2	7.6	8.0	8.3
6.2	5.4	6.3	6.2	6.0	6.7	6.2	6.9	7.1	6.6	5.7	6.6
2.7	2.4	2.8	2.2	2.8	2.6	2.5	2.7	2.7	2.6	2.4	2.7
3.9	4.0	3.8	3.9	3.9	4.2	4.0	4.4	4.9	4.1	3.8	4.4
8.2	9.2	9.2	9.9	10	9.9	9.0	10	10	10	10	10
♀	♀	♂	♀	—	♀?	♂	♂?	—	—	—	♂

ZOOGEOGRAPHY

The origin of a stock of *Ophidion* on the islands and sea mounts of the Nazca Plate is unclear. Rendahl (1921:59–60) analyzed his findings on Easter Island fishes and concluded that the Easter Island fish fauna was derived from the west across the Pacific by dispersion. A western origin is not supported by *Ophidion*. One must go to the Arafura Sea or Hawaii, or Samoa to find the first representative of *Ophidion* in that direction and neither *O. muraenolepis* nor the undescribed species from Samoa belong to species groups closely related to *O. exul* or *O. metoecus*. The Nazca species appear to have been derived from the American fauna. Springer (1982) reviewed in detail the distributional patterns of genera and species of shorefishes occurring on the Pacific Plate and its immediate periphery as well as representative genera and species that avoided the Pacific Plate. His evidence does not support a close relationship between shorefish faunas of the Pacific and Nazca plates although (his fig. 60) he shows a new genus as occurring from the Tuamotus to Easter Island and this pattern is expanded over much of the Pacific Plate for one species of the mollusk genus *Strombus* (his fig. 47).

Bonatti and Harrison (1976), in their discussion of hot spots and hot lines, concluded that Easter Island is over a hot line and that the small Easter Plate possibly resulted from (p. 404) "complex interaction of two patterns of mantle flow at the intersection of the Easter line and the East Pacific Rise." Easter Island is thought to have formed about 3 million years ago at the earliest (Bonatti et al., 1977:2471). What vicariant event led to isolation of the Nazca stocks and speciation of *O. exul* and *O. metoecus* is unclear. The occurrence of *O. exul* in the Marquesas could simply be the result of dispersal as these islands lie downstream in the Southeast Trade Wind Belt. Current patterns also could explain the dispersal of *O. metoecus* to Isla San Felix since this island lies downstream of the Juan Fernandez group.

The geology of the Nazca Plate is complex (as clearly discussed by Bonatti et al. (1977). Also, collections of the kind that yielded the Nazca cusk-eels are few and largely confined to the very islands where these species were found. Such collections are nonexistent for the many sea mounts whose tops may reach sufficiently close to the surface to be populated by cusk-eels. Only in the Tuamotus and nearby islands on the Pacific Plate has there been sufficient collecting effort (Randall, personal communication) to have confidence about the ab-

Table 4. Measurements[1] of body parts expressed in percent of SL and fin-ray and vertebral counts[2] for the types[4] of selected Pacific species of ophidiid fishes.

	A	B	C	D
Standard length (mm)	69.1	169.8	111.1	127.5
Head length[3]	20	22	20	21
Snout tip to:				
Dorsal fin	24	29	27	26
Anal fin	39	45	39	38
Occiput	14	16	15	15
End of lateral-line	87	76	86	85
Tip maxilla	7.8	10.3	9.0	9.1
Body depth at:				
Occiput	11	14	12	12
Dorsal-fin origin	11	14	—	14
Anal-fin origin	11	13	12	12
Pectoral fin	8.0	9.5	8.3	8.9
Pelvic ray:				
Outer	10	14	12	13
Inner	6.4	9.2	8.3	9.5
Caudal fin	2.7	3.2	2.6	2.8
Orbit diameter	5.6	6.1	6.2	5.8
Body interorbit	2.0	2.5	2.4	2.7
Snout length	5.6	4.6	4.4	4.2
Postorbit[3]	11	12	10	11
Dorsal rays	142	160	133	137
Anal rays	114	132	109	110
Pectoral rays	22–25	26–26	24–24	23–23
Gill rakers	2 + 4	2 + 4	2 + 4	2 + 4
Precaudal vertebrae	15	17	16	16
Caudal vertebrae	51	56	54	55
Sex	♂	♂	♂	♀

[1] For definition of measurements see Robins (1960:90–91).

[2] All specimens have 9 caudal rays, 4 above and 5 below.

[3] To tip of opercular flap.

[4] Holotypes: A = USNM 144257, *Ophidion fulvum* (Hildebrand and Barton); B = BMNH 79.5.14.46, *Ophidion muraenolepis* (Günther); C = BOC, *Ophidion iris* Breder; D = BOC, *Ophidion nigracauda* Breder.

sence of these species. It is to be expected that both *O. exul* and *O. metoecus* have more extensive distributions, especially if they occur deeper than here reported. Based on submarine research, in which I have participated, on steep island slopes in the tropical western Atlantic, a depth distribution of 200 m can be expected.

Recent studies on the Juan Fernandez Islands include that by Zeiss and Hermosilla (1970) and the collection of reports in Arana E. (1985). No cusk-eels were included in the list of fishes known from the Archipelago by Sepúlveda V. and Pequeño R. (1985). The geological history of the region relative to events on the Nazca Plate were reviewed by Morales G. (1986). Stuessy et al. (1984) use potassium–argon dating of basalts to age various islands in the Juan Fernandez group. Isla Robinson Crusoe (their "Masatierra") was estimated to be about 4.23 million years old and was intermediate in age among their islands. Thus, these islands are distinctly older than Easter Island.

Both *O. exul* and *O. metoecus* are dwarf species. Dwarfism is a common evolutionary pathway among benthic shore fishes from tropical oceanic islands. Small species can utilize the smaller and abundant food organisms, especially autochthonous plankton, which occurs very close to the bottom along steep slopes (personal observation), and utilize the limited shelter afforded by sandy substrata. Larger size invites predation from insular and oceanic species (e.g., *Polyprion oxygeneios* is common in the Juan Fernandez Islands). Böhlke and Robins (1959) and Robins and Böhlke (1959) described six dwarf species of cusk-eels from the tropical western Atlantic. Like the Nazca species, all six are unusual among ophidiine cusk-eels in lacking strong sexual dimorphism in the swim bladder. This dimorphism involves development of special bony structures and tympanic windows that play various roles in sound production. The small size of the fish and the noisy, surfy environment may be related to the loss of specialized structures associated with sound production since the sound producing ability is diminished and ambient noise may render sound ineffective as a signalling device. The absence of such important and distinctive derived structures makes it difficult to demonstrate relationships of dwarf cusk-eels.

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