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KAUPICHTHYS DIODONTUS SCHULTZ, IN THE WESTERN

INDIAN OCEAN.

A PROBLEM IN SYSTEMATICS.

(With Plate 12)

by

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Illustrations by Margaret M. Smith.

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Family Xenocongridae.

The type genus of this family was first discovered at the island of Assumption, Aldabra group, north of Madagascar. The holotype remains unique. The genus **Kaupichthys** Schultz, (1943: 50), the type, **K. diodontus** Schultz, was discovered in the Samoan group, and a specimen of that species was later found (but not described) by Gosline (1950: 309) at Hawaii. Herre (1953: 9) briefly described a small specimen of **K. diodontus** from the Philippines, while Matsubara and Asano (1959: 292) described from Japan what they considered to be a new subspecies of **K. diodontus**. The type and two further species from the Marshall Islands have been described by Schultz (1953: 65-67). Böhlke (1956: 66) has described **K. atlanticus** from a considerable area about the west Indies (17-25°N x 75-77°W), and it has also been reported from mainland reefs in the Panama Canal zone by Rubinoff and Rubinoff (1962: 1).

The present record of a species of **Kaupichthys** Schultz, from Pinda, northern Mozambique, is the first of this genus from the Indian Ocean, so that it appears to be (virtually) circumtropical.

This genus **Kaupichthys** was placed by Schultz, 1943 in the Echelidae, and again in 1953. Gosline (1950: 309) advanced strong evidence against the alignment of **Kaupichthys** with the more typical Echelid forms, and Böhlke (1956: 63) has demonstrated that **Kaupichthys** is more conformably located in the Xenocongridae, an opinion which is accepted here. While Böhlke includes **Chilorhinus** Lutken, 1852 in the Xenocongridae, that genus is here regarded as meriting family rank, probably monotypic. The family Xenocongridae is at present considered to be comprised of four genera, viz: **Chlopsis** Rafinesque 1810; **Xenoconger** Regan, 1912; **Kaupichthys** Schultz, 1943; and **Powellichthys** Smith (recent, in press).

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These four genera are defined and distinguished as follows:

A.   Abdomen normal. Pectoral absent or small, shorter than snout, rays 11-15. Gillopenings restricted, small, rounded. Sedentary. (Xenocongrinae).

    I.   Pectoral fins absent, at most a rudimentary flap above gillopening.

        a.   Vomerine teeth in a biserial row each side, not meeting posteriorly. Mouth cleft well behind eye .... **Xenoconger**

        b.   A single row of teeth along each side of vomer, meeting posteriorly on midline. Mouth cleft barely beyond eye .... **Chlopsis**

    II.   Pectorals present, small to medium, always shorter than snout. A single row of teeth along each side of vomer .... **Kaupichthys**

B.   Abdomen distensible. Pectorals well developed equal snout, rays 17. Each row of vomerine teeth biserial in front, single behind, not meeting posteriorly. Mouth cleft not beyond eye. Gillopenings moderate vertical slits. Pelagic. (Powellichthinae) .... **Powellichthys**

Kaupichthys Schultz, 1943.

Schultz 1943: 50. The type **K. diodontus** Schultz, 1943.
    The following have been described: **K. diodontus** Schultz, 1943; **K. diodontus japonicus** Matsubara and Asano, 1959 (Japan); **K. atronasus** Schultz, 1953 (Rongelap: Bikini); **K. brachychirus** Schultz, 1953 (Bikini); **K. atlanticus** Böhlke, 1956 (tropical western Atlantic).
    The relationships of these species have been defined as follows:

A.   Pectoral fin exceeds eye.

    I.   14-15 pectoral rays. Front nasal tube not pigmented.

        a.   Vertebrae 98-109 (Pacific) .... **diodontus**

            1.   98 Vertebrae (Central Pacific) **diodontus diodontus**

            2.   109 Vertebrae (Japan) .... **diodontus japonicus**

        b.   Vertebrae 119 (W. Atlantic) .... **atlanticus**

    II.   11 pectoral rays. Base of front nasal tube black. (Pacific) .... **astronasus**

B.   Pectoral fin shorter than eye diameter (Pacific) **brachychirus**

    The data of the Pinda specimen, described below, diverge even more than those of **K. d. japonicus** from those of **K. diodontus** from the central Pacific. A summary of data from specimens from different localities is given in tables I and II below.
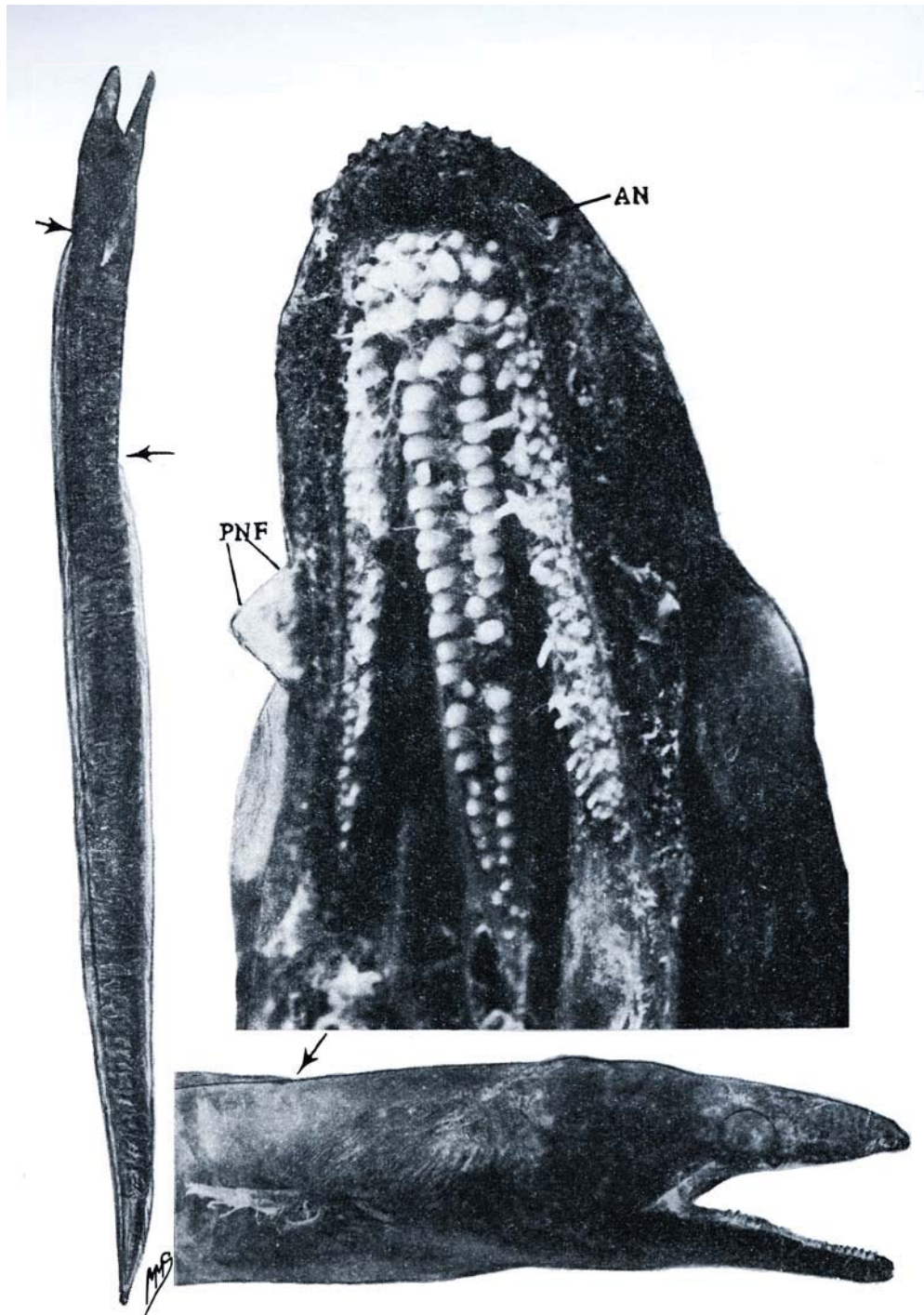
Plate 12.

Kaupichthys diodontus Schultz. 174 mm. (Pinda, Mozambique).
The arrows indicate origins of vertical fins. AN, Anterior nostril.
PNF, Posterior nasal flap, the nasal slit is at the base of the flap.

TABLE I

Data of **Kaupichthys diodontus** Schultz, and of **K. atlanticus** Böhlke.

	K. diodontus				**K. atlanticus**
	Central Pacific	Philippines	Japan	Northern Mozambique	W. Atlantic
No. of specimens	22	1	2	1	33
Total length mm	59-141	98	237,238	174	53-209
Sex	—	—	2 ripe fem.	?	Both
Depth in total length	19-28	20	16-17	22	18-25
Depth in head	2.5-3.7	3	2.2-2.4	3	3-3.8
Head in total length	6.7-7.5	6.1(?7)*	7.2	7.2	6.4-7.3 (Av,6.9)
Head in trunk	0.95-1	0.9(?1.15)*	1.2	1.2	0.95-1.15(Av,1.05)
Tail times rest	2.4-2.8	2.25	2.3-2.4	2.3	2.2-2.7(Av,2.4)
Tail in total length	1.35-1.45	1.45	1.4	1.4	1.35-1.45
Sn-D Origin in trunk	0.9-1.0	—	1.1	1.15	0.9-1.1
Trunk in total length	6.8-7.8	7 (?6.1)*	6.1	6.1	6.3-7.6(Av,6.6)
Eye in head	10-12	—	9.3(fig,10)	10	10-12
Eye in snout	2.4-3	—	2.1(fig,2.4)	2.4	2.3-3.1(Av,2.5)
Interorbital in head	5.8-7.2	—	4.7-4.9	5.5	4.7-6.7
Length mouth in head	2.6-2.8	—	2.4-2.5	2.5	2.5-2.7
Snout in head	3.9-4.1	—	4.3-4.4	4	3.9-4.6
Pectoral in head	5.5-7.7	—	5.4-6.6	6	5.6-8.2
Pectoral rays	14	—	14	14 & 15	14 & 15
Vertebrae	98(Gosline)	—	109,109	114	119

Dimensions stated are to the nearest significant figure e.g. 1.42 is quoted as 1.4.   *See page 50

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Kaupichthys diodontus Schultz, 1943

(Plate 12)

Schultz 1943: 50, Pl 6 (Samoa); and 1953: 64 (Marshall Is.) Gosline 1950: 309 (Oahu, Hawaii).

The following description and data are of a specimen 174mm total length, taken from sand near coral below low tide mark by poison at Pinda, northern Mozambique (14°S x 40°40'E) in the western Indian Ocean. This genus has not before been recorded from the Indian Ocean.

Vertebrae 114, 24 preanal. P 14 and 15. Body moderately compressed, the tail more so, tapering sharply posteriorly. Maximum depth of body 22 in the total length, 3 in head. Head to front of gillopening 7.2 in the total length, 1.2 in the trunk. The tail is 2.3 times the rest of the fish, the trunk is 6 in the total length. Distance between levels of origins of dorsal and anal 1.25 times head.

The eye is small, 10 in head, 2.4 in snout. The interorbital is 5.5, the snout 4 in head, from snout tip to rictus 2.5 in head.

The anterior nostrils are tubular, facing downward, on the front of the side of the snout. The posterior nostrils are slits in the upper part of the upper lip at the level of the front of the eye, completely covered by a subtriangular flap from above. The front and sides of the snout are covered with rows of fine papillae, giving a granular effect. Similar papillae run in rows along the sides of the lower jaw and over the chin.

The lateral line is hardly visible in this specimen. The dorsal originates slightly behind the base of the pectoral, the vertical fins are well developed, the longest rays at about mid length are equal to at least half the body depth. The dorsal and anal are confluent with the caudal, which is small but distinct. The gillopening is a small rounded opening below the pectoral base.

The mouth is large, the cleft horizontal, it extends well behind the eye, the lower jaw is slightly the shorter. The tongue is adnate.

The dentition is well developed. The pre-maxillary teeth are in a separate cluster. In front is a transverse curved row of five small teeth, behind that a row of four much stouter, short, conical teeth and a posterior row of five still larger stout conical teeth, the median tooth the largest. Behind these is a space in whose centre is the largest tooth, which is depressible. On the maxilla is an inner series of moderate sized sharp slender conical teeth, graduating smaller posteriorly. Outside these are along the jaw 2-3 series of much smaller close-set teeth graduating smaller externally, the outermost very low, in front there are four irregular series, narrowing to three posteriorly, and all become progressively smaller posteriorly. The vomerine teeth are stout and blunt with rounded apices, slightly hooked backwards, in a single closely adjacent row of about 27 along each side of the vomer, rather narrowly separated. The rows converge posteriorly until the last 2-3 teeth in each row meet medially (see below), behind the end of the lateral dentition, but remain as two rows. In the lower jaw there is on each side a band of conical teeth,

stouter and longer in front, the innermost front five or six are caniniform, though the two rows across the front of the jaw are rather smaller. The teeth along the side of the jaw are much like those in the upper jaw. The inner series is largest, and there are 2-3 external series graduating rapidly smaller outwards, the outermost teeth being minute. There are 2-3 series posteriorly. The inner teeth along the side of each jaw are inwardly depressible. The teeth midway along the lower jaw are neither markedly rounded as shown by Böhlke (1956: fig 1) for females (in **K. atlanticus**), nor hooked, as shown by him for males.

As preserved, uniform greenish brown. The sex of the specimen cannot be certainly determined, the gonads are not defined.

The dentition accords with that described and shown by Böhlke (1956: 67, fig 1,B) for **K. atlanticus**, and by Matsubara and Asano (1959: 293, fig 2,A) for **K. diodontus japonicus**, except that the two rows of vomerine teeth in my specimen converge to become adjacent posteriorly, but do not unite to a single row as shown by Schultz (1943, fig 5, I; and 1953, fig 13, A) for **K. diodontus** from the Pacific. Also the vomerine teeth do not extend back as far beyond the jaw teeth as shown for the Atlantic and Japanese fishes.

In this respect it may be noted that by normal examination the vomerine teeth in this Pinda specimen first appeared exactly as shown by Böhlke, and by Matsubara and Asano, (see above) i.e. not meeting posteriorly. It was only when the palate was fully exposed and dried that the hindmost adjacent series, each of 2-3 much smaller teeth, became apparent, and also the hindmost teeth in the jaw.

A detailed description of the dentition of mid-Pacific specimens is lacking. Schultz (1943: 50, fig 5, I) originally described and showed the lateral teeth as uniserial and the vomerine teeth as confluent to a single medio-posterior series. Later (1953: 65), he corrected these statements in a brief redescription, but reproduced (1953, fig 13, A) the same (erroneous?) dental pattern, which shows the convergence of the vomerine teeth to a single median row, and the lateral jaw teeth in a single series. Examination of numbers may show that while the fundamental pattern of the upper dentition remains constant, there may be comparatively wide variation in the extent and position of especially the vomerine teeth.

In describing **Kaupichthys diodontus japonicus** subsp. nov. Matsubara and Asano (1959: 295) give only the variation in vertebral count as the basis of distinction of their subspecies from the type. While strictly exact measurements in these small eels are difficult, so that there must always be minor variation in quoted data, there is however one small difference, in the relative length of head and trunk, between the Japanese and the mid-Pacific fishes. In mid-Pacific specimens the trunk about equals the head, whereas in the two known Japanese specimens (both ripe females) the trunk is about 1.2 times the head length.

However, in the remote **K. atlanticus** the head is 0.95-1.15 (Av, 1.05) in the trunk, which almost bridges the small gap, and there is nothing else beyond the vertebral count of **K. atlanticus** to justify its

distinction from **K. diodontus**. Also in dentition and position of fins these two forms show remarkable concordance. It might be expected that Philippine fishes should in any divergence accord more closely with those of Japan rather than those of the mid-Pacific. The single Philippine specimen of **K. diodontus** described (Herre 1953: 9) agrees better in head-trunk relationship with those from the mid-Pacific than with those of Japan.

Fig. 1. To show the distribution of **Kaupichthys diodontus**.

However, in its stated head 6.1 in total length the Philippine specimen differs widely from all others. It is possible that head and trunk data were confused. Reversal brings this specimen into line with the remainder, and aligns it rather with those from Japan and Mozambique (see Table I).

Study of the data in Table I above reveals that the specimen now recorded from Pinda agrees in the head/trunk dimension more closely with those from Japan than with those from the mid-Pacific and the Atlantic. The body of the Japanese fishes is somewhat deeper, it is deeper than in any others described, but these are both ripe females and the largest so far discovered.

In the material from over this virtually circumtropical range, while the overall dimensions are largely concordant, in this head/trunk relationship the central Pacific and the western Atlantic specimens tend to fall together, and those of Japan and Mozambique (and probably the Philippines) also fall together, each group differs a trifle from the other in head/trunk dimension.

Böhlke (1956: 66) bases full specific distinction for **K. atlanticus** on wide geographical separation together with the marked difference in vertebral count, which for Pacific specimens is about 98 (Gosline 1950: 312), while for a specimen from the Atlantic it is 119 (Böhlke 1956: 70), each only a single count, no further counts have been published.

The vertebral count of 109 in the two Japanese specimens falls mid-way between these figures, it is chiefly on this difference of 11 vertebrae that Matsubara and Asano claim subspecific rank for the Japanese form. This is however inconsistent, for the Japanese form differs from the Atlantic form by an equal number of vertebrae and as Matsubara and Asano accept **K. atlanticus** as valid, this confers full specific distinction from the Atlantic on the Japanese form.

The specimen from Pinda, an intermediate locality, described above, with a vertebral count of 114, is midway between that of the Japanese and of the western Atlantic fishes.

Variation in vertebral count is sometimes regarded as important in differentiation, but it has been shown that the number of vertebrae in certain species can be affected by variable factors such as temperature and carbon dioxide concentration.. There may be others even more potent correlated with environment.

Considerable variation in vertebral counts in eels is apparently usual. In freshwater eels variation within one species may be as much as 10%, Jesperson (1942: 14) reports vertebrae in **Anguilla marmorata** Q & G, to range over 100-110. Investigation of marine eels has shown that there is a fair degree of variation in this count, e.g. Kanazawa (1958: 238) records variations such as 126-135, 138-147, 140-149 in even restricted numbers (e.g. 9 out of 74 specimens available) of certain species of **Conger** Oken, 1817.

The vertebral count of 98-109 in specimens of **K. diodontus** from the central and western Pacific is probably therefore no more than a normal range of variation (e.g. 100-110 in **Anguilla**).

Apart from the interest of the discovery that **Kaupichthys** occurs in the Indian Ocean, the data from even this single specimen introduce a complication in the proposed systematic relationships of the widely separated forms of, or closely related to, **K. diodontus**.

Specific distinction in eels on vertebral count alone, without other charactérs in support, is at least unusual, and while the proposed structure in this case has not been challenged, it is patently unsound. A difference of 11 vertebrae (98-109) is on the one hand proposed to confer subspecific status, whereas on the other a difference of 10(109-119) confers full specific rank. On this basis the status of the Mozambique specimen, with 114 vertebrae, is a problem.

Full data and vertebral counts of Hawaiian and Philippine specimens of **K. diodontus** may well introduce further complications. Hawaiian fishes in particular often reveal surprising differences, e.g. Kanazawa (1958: 232) reports than **Conger cinereus** Ruppell from Hawaii (**C. c. marginatus**) have 148-152 vertebrae, whereas those from the other parts of the Pacific to Africa (**C. c. cinereus**) have 139-146, again these counts are based on only few specimens. In this case subspecific distinction is based on characters other than vertebral count.

Table I reveals that some data from even few specimens of **K. diodontus** and of **K. atlanticus** each show comparable relatively wide variation in some dimensions (relative axial lengths) and it is possible that this may prove to be linked with unsuspected wide variability in the number of vertebrae.

It might appear venturesome to accept a sluggish sand-dwelling eel from the Western Atlantic as specifically identical with one from so remote an area as the central Pacific. However had Böhlke not investigated the vertebral count he would otherwise have found it difficult to establish **K. atlanticus** as distinct from **K. diodontus**, when they are so similar. And it may be indicated that, though it grows to a larger size and prefers cooler seas, the comparable **Ophisurus serpens** Linn, occurs in the three major oceans, ranging from the Eastern Atlantic and Mediterranean to South and East Africa, Japan and Australia. Vertebral counts of specimens of that eel from different localities might yield results comparable with those above, and would certainly have an important bearing on this problem. (It is noteworthy that neither of these eels has yet been found on Indian shores).

It may be emphasised that data (other than count of vertebrae) such as found in Table I would normally lead to the acceptance of all the specimens examined as representing a single widespread species, **K. diodontus**. With available data it is difficult to see how any differentiation can be other than arbitrary.

Until such time as an obviously necessary detailed study of these eels from all localities can be made, it is suggested that all these closely related forms should be accepted as one circumtropical species, **K. diodontus**. For convenience geographical subspecies might at present be defined as follows:

Locality	Vertebral count. Arbitrary limits	Subspecies.
Central Pacific	98-108	.... **diodontus**
W. Pacific-W. Indian Ocean	109-114	.... **japonicus**
W. Atlantic	· 115-119	.... **atlanticus**

Kaupichthys diodontus is a notable addition to the fauna of the western Indian Ocean. Though we did not find any other species of **Kaupichthys** on East African shores they may well occur there.

I have sought for possible larval forms of **Kaupichthys** among as yet unidentified juvenile specimens collected in East Africa, got by poison in pools and by a light at night. While one from Pinda with pectorals has the low myomere count of about 113, it does not agree otherwise.

K. atronasus Schultz (1953: 65, fig 14, central Pacific), apparently a smaller species, has also been found in Japan (Matsubara and Asano 1959: 29), and it is interesting to compare the data in this case.

Table II.

Data of **Kaupichthys atronasus** Schultz.

	Central Pacific	**Japan**
No. of specimens	2	1
Total length mm	54, 93	111
Sex	—	male
Depth in total length	25-28	21
Head in total length	7.5-7.7	7.4
Head in trunk	1.25	1.2
Tail times rest	2.3-2.5	2.3
Eye in head	14-15(12 in fig)	12.5
Eye in snout	2.6	2.5
Interorbital in head	7-10(6.5 in fig)	7.9
Pectoral rays	10-11	11
Vertebrae	—	110

The vertebral count (110) of only the single Japanese specimen is known, and there is almost exact identity in data of the central Pacific fishes with those of the Japanese fish. The only minor difference, observed also in the case of **K. diodontus**, is that the Japanese fish is somewhat deeper in body. In the absence of vertebral count it is significant that in this case there has been no suggestion of distinction for the Japanese fish. When vertebral counts of the mid-Pacific fishes are known, this may prove a comparable case.

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