



# ichthyologica

the aquarium journal

April, 1966

Volume XXXVII

Number 4

One Dollar

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EDITORIAL

THE  
GOAL  
OF THIS  
JOURNAL

MARTIN R. BRITAN

This is the fourth issue of *Ichthyologica/The Aquarium Journal*. Our first months were filled with the travail of metamorphosis, and the journal showed some of the effects. The old *Aquarium Journal* was one of the most respected and best turned-out of the aquarium magazines aimed at the layman. We hope eventually to be able to say that the new journal, as a scientific and technical periodical, is equally well turned-out and respected. Instead of the layman, the ichthyologist and scientifically conversant aquarist are our targets.

A lot of people seem to have gotten the idea that our content is limited to papers on aquarium fishes and aquarium problems, and that we are interested in publishing only such material. This is

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RATES: \$1.00 per copy in the U.S., \$1.50 per copy in Canada or foreign, \$10.00 for 12 issue subscription but special student rate of \$5.00 is also available. Foreign subscriptions are 60¢ per year additional.

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entirely wrong. The backlog of papers which we had at hand and the fact that our name contains the word "aquarium" are, we think, largely responsible for this (the history of the change of an aquarium magazine into a scientific journal is detailed in our first issue, that of Jan., 1966). We wish here to correct this misconception. We are interested and anxious to publish papers about aspects of ichthyology other than aquarium fishes and aquarium problems. The more papers we have on other subjects, the more we will publish, and the entire broad range of ichthyology and related subjects is our field. We will publish, as part of this broad coverage, articles on aquarium fishes and aquarology, but if we are topheavy in this respect, it is because most of the papers which we have had on hand and most of those we have so far received have been in these areas.

Our publication policy is, we think, liberal. We want papers over as wide a spectrum as possible. While we intend to steadily improve in quality of content, we do not intend to over-edit. There will be no page charge, or other charges of any kind, including for color illustrations, the use of which we strongly encourage, and 250 reprints will be furnished free to each author.

This journal was conceived in the high hope that it would soon become a worthy addition to scientific literature. Our readers and, especially, our contributors can help us to realize this hope and to make this venture a success.

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The Smithsonian Institution and T.F.H. Publications, Inc., are pleased to announce the publication of a reprint, including the color plates, of the Philippine Bureau of Science three Monographs on Philippine fishes: No. 1, Jordan and Richardson's Checklist, 1909, No. 23, A. W. Herre's *Gobius*, 1927; and No. 24, Moosilau's *Pomacentridae*, 1927. These are historical works and are available in a clothbound volume for \$5.50.

Two earlier numbers in this reprint series are: Jordan and Evermann's "The Fishes of North and Middle America," U. S. Nat. Mus. Bull. 47, Vols. 1-4, 1895-1900, \$25.00; and Smith's "The Freshwater Fishes of Siam or Thailand," U. S. Nat. Mus. Bull. 148, 1945, \$2.00.

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THE USE OF  
SYNTHETIC SEA SALTS IN  
MARINE AQUARIA

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Wickliffe, Ohio

In many cases where the use of a synthetic sea salt in order to prepare seawater for use in aquariums has resulted in failure, poor management rather than the salt has been responsible. One should remember that good sea salt alone will not keep marine organisms alive!

The aquarium market is presently well supplied with synthetic salts, some of which are quite unsatisfactory, some good, and some of outstanding merit. One which will produce water capable of keeping delicate marine invertebrates alive for indefinite periods, even through life cycles, as well as sustain saltwater fishes in home aquaria, has been described by Segedi and Kelley.

Natural seawater "spoils" in storage after its removal from the ocean, no matter what is done to prevent it. Storage in the dark does not prevent these changes which eventually make the water less fit for maintaining living things, but does tend to slow down the rate of change. Even freezing the water kept in storage does not help entirely. Immediately after water is brought in from the ocean for use, it starts to undergo striking changes, especially after the introduction of the larger animals such as fish into the aquarium.

The alkaline reserve of the water starts to decrease with a commensurate gradual lowering of the pH. Nitrogen compounds, especially ammonia, which is extremely toxic, begins to appear in solution. Nitrifying bacteria on suspended particles of matter, attached to the sides of the tank, on the bottom, or scattered in the filter bed, oxidize the ammonia to nitrite and then finally to nitrate (relatively harmless), which gradually increases in quantity. The total organic content of the water also builds up, sometimes with a corresponding increase in the bacterial population. Even the chemical structure of the water changes; magnesium content decreases, while that of potassium, calcium, phosphate, and sulfate increases.

These changes, some of which are disastrous to marine animals, take place also in synthetic seawater, but at a much slower rate, possibly due to its relatively limited microbiological population when newly made up, especially insofar as bacteria are concerned. There is a growing opinion that synthetic seawater is more easily kept in storage over long periods of time, perhaps because of its relatively low organic content as compared with natural seawater. The quality of its organic content, too, may be of some significance.

Other advantages of the synthetic material are as follows: the ease with which dry salts can be stored as contrasted with the storage of natural seawater, freedom from particulate contamination by materials such as silt, clay or even industrial wastes, relative stability of the water's physical characteristics, avoidance of possible fluctuations in salinity, savings in travel time and inconvenience necessary by trips to coastal waters, and the distinct advantage in knowing exactly what is in the prepared seawater when the recipe is published by the manufacturer.

Some of these synthetic sea salts do create the proper saltwater solution needed to maintain marine organisms in aquariums of proper design. The outstanding cause of failure, then, in many cases, has been the lack of proper design of the systems and poor management. In general, the greater the volume of water used, the slower the rate of water change and consequently the easier it is to maintain animals. There are other factors, however, which are important.

The filter bed should be of a calcareous nature so that the water is kept alkaline (pH 8.0-8.3). The aquarium should function as a "semi-closed system" with an internal circulation of water allowing for its satisfactory aeration as well as for a continuous passage through a filter bed where bacterial oxidation of nitrogenous waste products takes place. Temperatures, either above or below ambient, should be controlled by means of a refrigeration unit or heater and thermoregulator. Construction of the aquarium and all components should of course be entirely of non-toxic materials.

Proper management requires that circulation of the water through the filter bed never be stopped. Adequate aeration for the fish and filter bed bacterial flora as well as the latter's "food" supply of animal waste products is essential at all times. Indications are that intermittent operation of a filter is never satisfactory. Specific gravity must be kept reasonably constant at 1.020-1.025. The aquarium must never be overloaded with animals or with

uneaten food. Without proper laboratory checks for ammonia, nitrite and nitrate concentrations, it is essential that a very small "load" of fish be introduced at first and gradually increased (over a period of several weeks) in order to allow for the proper growth of a suitable bacterial flora. A too-rapid increase in ammonia concentration from fish excretions in the water and from decomposition of food may very well kill the fish. After there is a large population of nitrifying bacteria present, the ammonia will be converted to other products in the nitrogen sequence almost as fast as it is produced. Partial water changes (about 25%) at monthly intervals in order to dilute the nitrates in solution may be necessary but this depends much on the number of fish present, temperature, and other factors. Direct observations are important here when nitrates cannot be measured.

By not allowing the physico-chemical factors of the aquarium setup to exceed a determined "norm" for the fish (or invertebrates), it is possible to secure a dynamic biological equilibrium in an aquarium and keep marine animals for indefinite periods—very often through life cycles.

#### LITERATURE CITED

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THE FISHES OF THE GENUS *OSTEOGLOSSUM* WITH A  
DESCRIPTION OF A NEW SPECIES FROM THE  
RIO NEGRO

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Specimens of a beautiful black-striped osteoglossid from the Rio Negro basin, Brazil, were presented to the U.S. National Museum by Drs. Herbert R. Axelrod and Martin R. Brittan. After comparing them with specimens of *Osteoglossum bicirrhosum* Vandelli from various localities, it was found that the black-striped osteoglossid represents a new species. They possibly live sympatrically, for the two forms were caught in the same river basins.

I thank the following: for making specimens available to me, Dr. Herbert R. Axelrod, T.F.H. Publications, Inc., Jersey City, New Jersey; Dr. Martin R. Brittan, Sacramento State College; Drs. James Böhlke and James Tyler, Academy of Natural Sciences, Philadelphia; for information on a type, Dr. M. L. Bauchot, Muséum National D'Histoire Naturelle, Paris; for information on Dr. Rodriguez Ferreira, Dr. M. S. Vascancelos, Aquario Vasco da Gama, Lisbon; for illustrations, Smithsonian Institution photographic laboratory; for coloured illustrations, Dr. Herbert R. Axelrod; for translation, Mrs. Janet Robinson.

In the description below, standard length was measured from the tip of closed lower jaw to base of caudal fin and the head length from tip of lower jaw to posterior edge of bony operculum, excluding the membranous flap.

Alexandre Rodriguez Ferreira was the first to indicate the existence of an osteoglossid in the Amazon River. Ferreira collected in the Brazilian Amazon, Matto Grosso and eastern Brazil between 1783 and 1792. About 1800, Vandelli sent some of Ferreira's specimens and illustrations to Lacépède, in Paris, who seemed to have ignored them. Cuvier later found among Lacépède's papers an illustration with the legend *Osteoglossum minus*.

In 1817, John Baptiste de von Spix, a zoologist, and Frederick Karl Philipp de Martius, a botanist, accompanied the Royal party of the Crown Prince of Brazil to Brazil and spent 3 years exploring and collecting the fauna and flora. After returning to Munich, Spix died suddenly before completing the zoological part of the report. In 1827, a year after Spix's death, Martius sent plates and descriptions completed by Spix to Cuvier for evaluation. Among the illustrations was one of an osteoglossid which Spix had intended to name *Ichthosoma bicirrhosum*. Cuvier made brief



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observations and wrote notes on them and urged that the entire collection be described by a capable ichthyologist. Louis Agassiz was commissioned to complete Spix's work.

Cuvier recognized the similarity of *Ichnosoma bicirrhosum* to that of *Osteoglossum minus*. He described the genus *Osteoglossum* in his second edition of the *Regne Animal*, 1829, and credited the name to Vandelli.

About the same time Agassiz changed Spix's manuscript name of *Ichnosoma bicirrhosum* to *Osteoglossum bicirrhosum* and credited the name to Vandelli (Spix and Agassiz, 1829: 46). Evidently this name was changed when Agassiz took the notes which Cuvier had made on Spix's plate XXV of *Ichnosoma bicirrhosum* (Agassiz, 1893: 106).

The second edition of Cuvier's *Regne Animal* appeared during the first three months of 1829 (*Foreign Quarterly Review* for January to March, 1829: 347). The first 82 pages and the first 48 plates of Spix and Agassiz appeared in 1829, and the remainder of the work in 1831 (*Isir von Oken*, 1829: 715). Lurie 1960: 39, stated that the first part of Spix and Agassiz's *Brazilian Fishes* appeared in May, 1829.

#### OSTEOGLOSSUM VANDELLI

*Osteoglossum Vandelli* in Cuvier, 1829: 328 (type-species *Osteoglossum bicirrhosum* Vandelli in Spix and Agassiz, 1829, by subsequent monotypy); Vandelli in Spix and Agassiz, 1829: 46; Boulenger, 1901: 514; Jordan, 1917: 131.

*Ichnosoma* Spix in Cuvier, 1829: 328 (synonym of *Osteoglossum Vandelli*); Spix and Agassiz, 1829: 46 (type-species *Osteoglossum bicirrhosum* Vandelli, by monotypy; an alternative name for *Osteoglossum Vandelli*).

*Ichnosoma* Swainson, 1838: 266 and 287, footnote (misspelling of *Ichnosoma* Spix).

*Ichnosoma* Schomburgk, 1841: 204 (misspelling of *Ichnosoma* Spix).

**DESCRIPTION:** Branchiostegal rays 10, vertebrae 84 to 100 (28 + 59), dorsal fin base long, pelvic fins inserted nearly twice as far from base of caudal fin as from tip of snout.

Body compressed; abdomen trenchant; mouth large, oblique; lower jaw prominent, terminal; teeth on vomer, palatines, pterygoids and basihyal (glossohyal); gill membranes separate, free from isthmus; mandibular barbels present; coracoid forming ventral keel continuous with trenchant abdomen; swimbladder not cellular, pyloric appendages two.

#### Key to the species of *Osteoglossum*

- 1a. Dorsal fin rays 42 to 50; anal fin rays 49 to 58; scales in lateral line 30 to 37; vertebrae 84 to 92.

*O. bicirrhosum* Vandelli

- 1b. Dorsal fin rays 52 to 58; anal fin rays 61 to 67; scales in lateral line 37 to 40; vertebrae 96 to 100.

*O. ferreirai* new species

#### OSTEOGLOSSUM BICIRRHOSUM VANDELLI

##### SILVER ARUANA (Figures 1 and 2)

*Osteoglossum vandelli* Cuvier, 1829: 328 (nomen nudum, Brazil); Spix and Agassiz, 1831, p. 2; tab. A, Fig. 8; tab. C, p. 5 (figures of opened mouth and scales); *Ichnosoma bicirrhosum* Spix in synonymy; Valenciennes, 1846: 294, pl. 571 (description and figure); Bertin 1940: 271 (listed).

*Ichnosoma bicirrhosum* Spix in Cuvier, 1829: 328 (nomen nudum, Brazil); Vandelli in Spix and Agassiz, 1829: 47, pl. XXV (name on plate and in synonymy); Valenciennes, 1846: 304 (description); Jordan, 1917: 132 (listed).

*Osteoglossum bicirrhosum* Vandelli, in Spix and Agassiz, 1829: 47 (original description; type locality, Rio Amazon, Brazil, holotype in Munich collection, 24 inches long); Swainson, 1838: 287, fig. 60 (description); Swainson, 1839: 291 (description); Schomburgk, 1841: 304 (description); Müller and Troschel, in Schomburgk, 1848: 638 (description); Rupunani River, Takutu, Rio Branco, Amapá, British Guiana; Günther, 1868: 378 (description); Pará, Brazil and British Guiana;



Fig. 1.—*Osteoglossum bicirrhosum*, USNM 197802, from Iquitos, Peru. Photo by Dr. Hubert E. Axelrod.

Cope, 1871 (1872): 257 and 291 (Ambyiacu, Peru); Cope, 1878: 695 (listed; Peru); Steindachner, 1882 (1883): 16 (description; Rio Huallaga, Peru); Eigenmann and Bean, 1907: 666 (description; Amazon River between Pará and Manaus); Eigenmann, 1910: p. 453 (listed); Fowler, 1911: 220 (Manacapuru, Brazil; Rio Ambyiacu, Peru); Eigenmann, 1912: 450 (description; Rupununi River, British Guiana); Miranda-Ribeiro, 1920: 7 (Manaus, Brazil); Fowler, 1939 (1940): 221, fig. 1 (Contamana, Peru); Fowler, 1941: 230 (listed); Eigenmann and Allen, 1942: 335 (description; Rio Pacaya, Lago Cashiboysa, Iquitos, Peru); Fowler, 1945: 22 (listed); Fowler, 1948: 28, fig. 21 (synonymy Rupununi River, British Guiana, Contamana, Peru); Sterba, 1959: 42, abb. 13, 15 (description, figures and aquarium notes); Sterba and Tucker, 1962: 61, figs. 13 and 45 (description; aquarium notes); Brittan, 1965: 9, figs. 2 and 3 in color (habitat and description living specimen).

*Ichneuma bicirrhosum* Swainson, 1838: 287 (listed in footnote).

*Osteoglossum aromaticum* Schomburgk, 1841: 205, pl. 12 (original description, type locality Guiana, holotype in very poor condition, in British Museum).—Valenciennes, 1846: 302 (listed).

*Osteoglossum minus* Valenciennes, 1846: 289, 294 (nomen nudum); Castelnau, 1855: 53, pl. 26, fig. 2 (description ascribes name to Vandelli).

*Osteoglossum vandelli* Boulenger, 1901: 514 (emendation of *O. vandelli*); Jordan, 1917: 131 (listed as type species of *Osteoglossum*).

**SPECIMENS STUDIED:** 179 specimens, 36 to 368 mm. in standard length from the following localities: Peru, Iquitos, USNM 197802 (7 specimens); Peru, Rio Ambyiacu, USNM 175881; Peru, Lago Cashiboysa, USNM 86295; Peru, Bretaña, mouth of Rio Pacaya, USNM 167709; Brazil, Pará to Manaus, USNM 52555 (2); Brazil, Manacapuru, USNM 23260; Brazil, Pará, USNM 37787; British Guiana, Rupununi River, ANSP 39749, ANSP 39812, and ANSP 39813; Brazil, Rio Xerisúni, tributary of the Rio Negro, USNM 198123 (161).

**DESCRIPTION:** All characters given as percent of standard length. Tip of snout to anus 45.5 to 53.2, tip of snout to origin of dorsal fin 55.9 to 61.9, length of snout 3.7 to 6.5, diameter of eye 3.1 to 8.7, length of head 19.6 to 26.9, body depth 14.6 to 20.7.

Dorsal fin rays all unbranched, 42 to 50; anal fin rays all unbranched, 49 to 58; pectoral rays 1,6; scales in lateral line to caudal base 30 to 37; predorsal scales 16 to 19.

**COLOR IN ALCOHOL:** Juvenile: head dusky dorsally and white ventrally, white extending to upper edge of operculum; outer edge of eye black; when barbels extended anteriorly, upper part white and membranous part black; body dusky; black humeral spot present, covering 2 or 3 scales just posterior

to head above midside of body; a scale-wide black lateral streak, from ventral edge of humeral spot to midbase of caudal fin; a lighter streak above this dark streak; the white on ventral part of body tapering to base of caudal fin; one white ring encircling body just behind head; basal half of each exposed part of scale dusky and outer half pale, giving the body a checkered effect; vertical fins light dusky, with distal edge of anal fin black; pectoral fins black, outer ray white; pelvic fins white (fig. 2, A, B). Black lateral streak absent in specimens larger than 65 mm. in SL (fig. 2, C).



Fig. 2.—*Osteoglossum bicirrhosum*. A. USNM 197802, 48 mm in standard length, from Iquitos, Peru, showing lateral stripe and humeral spot. B. USNM 197802, 61.5 mm in standard length. C. USNM 257403-F12, 77.5 mm in standard length, from tributary of Rio Negro, Brazil, illustrating absence of lateral stripe, presence of humeral spot, and checkered effect.



Adults: head and body brown dorsally, silvery ventrally; black humeral spot present; lateral streak absent; body scales retain checkered effect; vertical fins pale yellow in alcohol.

COLOR IN LIFE: Adults: color varies; silvery, yellowish, brownish or greenish, paler ventrally (Brittan, *in litt.*).

REMARKS: Valenciennes (1846: 294) recognized *Osteoglossum vandellii* and erroneously attributed the name to Agassiz. He doubtfully recognized *Ichthosoma bicirrhosum* as generically distinct from *Osteoglossum vandellii*. The former had confluent anal and caudal fins. Valenciennes thought that the type specimen of *bicirrhosum* was abnormal, but did not have definite proof. I believe the specimen is abnormal.

The name *Osteoglossum minus* was first mentioned by Valenciennes (1846: 289) when he related the discovery among Lacépède's papers of an illustration by Ferreira with the label of *Osteoglossum minus*. On p. 288, he mentioned that Vandelli had published for Ferreira in the Portuguese scientific collection about the year 1808, and stated that he was unable to obtain this work. On p. 294, *Osteoglossum minus* was again mentioned, and in the footnote the reference Mem. Act. Lisbon was given without date. Castelnau 1855: 53, pl. 26, fig. 2 ascribed the name *Osteoglossum minus* to Vandelli and listed the reference Mem. Acad. Lisbon, following Valenciennes. I have been unable to locate this reference and doubt that it was published.

Fowler (1914: 229 and fig. 1) recorded specimens of *Osteoglossum bicirrhosum* and stated that "Mr. Ogilvie informs me, in lieu of the name of any settlement and town, they were approximately secured in North latitude 2° to 3° and West longitude 50° 20'." The above latitude and longitude is in the Atlantic ocean just north of the mouth of the Amazon river. He listed one specimen 273 mm. and, erroneously, three young with yolk sac (should be two young according to Dr. James Tyler *in litt.*) and illustrated one of the young. Brittan (1965: 11) thought that Fowler's fig. 21 (1948: p. 28), which is the reprinting of the above, may be the young of the new species. I have examined the two young specimens from which it was drawn and find they are the young of *O. bicirrhosum*.

**OSTEOGLOSSUM FERREIRAI NEW SPECIES**  
BLACK ARUANA (Figures 3 and 4)

*Osteoglossum bicirrhosum* Regan 1905: 187 (based on a drawing made by Wallace of a specimen from Rio Negro or its tributaries: Wallace's specimens lost in transit to England).

*Osteoglossum* Brittan, 1965: 5, colored illustration.

HOLOTYPE: USNM 198197, Brazil, Amazonas, Lago de Limão, Rio Branco, tributary of the Rio Negro, caught by fishermen employed by



Fig. 3.—*Osteoglossum ferreirai* from tributary of Rio Negro, Brazil. Photo by Dr. Herbert E. Aarstad.

H. W. Schwartz, Aquario Rio Negro, Ltd., Manaus, Amazonas, April 1964, standard length 64 mm.

PARATYPES: USNM 198198, 5 specimens, same data as holotype; USNM 198077, 297 specimens (of which 4 sent to British Museum Natural History); USNM 257403-F14, 16 specimens, Brazil, tributary of the Rio Negro, caught by fishermen employed by H. W. Schwartz, Aquario Rio Negro, Ltd., Manaus, Amazonas.

DIAGNOSIS: Dorsal fin rays 52 to 57, anal fin rays 61 to 67, scales in lateral line 37 to 40, predorsal scales 15 to 19, vertebrae 96 to 100.

DESCRIPTION: First number for the holotype and numbers in parentheses for the paratypes. Tip of snout to anus 48.5 (42.1 to 48.4), tip of snout to origin of dorsal fin 53.6 (50.7 to 57.8), length of snout 6.4 (5.2 to 6.9), diameter of eye 7.0 (6.4 to 8.2), length of head 22.6 (21.7 to 25.4), tip of snout to posterior edge of maxillary 14.8 (13.8 to 15.9), body depth (13.5 to 14.3), all in percent of standard length.

Dorsal fin rays 55 (52 to 57), anal fin rays 64 (61 to 66), pectoral fin rays 1,6, branched caudal fin rays 13; scales in lateral line to base of caudal fin 39 (37 to 40), transverse scale rows from lateral line to origin of dorsal fin 4, transverse scale rows from lateral line to anus 2, predorsal scales 18 (15 to 19).

Teeth in jaws all conical; upper jaw with a single row along outer edge;



TABLE 1. Some meristic counts on two species of *Osteoglossum*

	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58		
<i>Microlophum</i>																			
Amazon River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
Raposa River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
Rio Xerimati (Rio Negro)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
<i>juvénis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
<i>Microlophum</i>																			
Amazon River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Raposa River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rio Xerimati (Rio Negro)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>juvénis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	30	31	32	33	34	35	36	37	38	39	40								
<i>Microlophum</i>																			
Amazon River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Raposa River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rio Xerimati (Rio Negro)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>juvénis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100		
<i>Microlophum</i>																			
Pera, Equinox (Amazon)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rio Xerimati	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>juvénis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

3—counts of Eigenmann in Fishes of British Guiana, 1912:408.  
 y—counts of Spix and Agassiz, 1829:48, on type of *O. Microlophum* Valenciennes.



Fig. 4.—*Osteoglossum ferreirai*: A, USNM 198197, holotype, 64 mm in standard length, from Lago de Linas, Brazil; B, USNM 227453-F14, paratype, 141 mm in standard length, from tributary of Rio Negro, Brazil, indicating absence of lateral stripe; caudal fin missing.

Vomer with one row; palatine with 3 rows, with a space between each row; dentary with 2 rows of teeth; the two rows are spaced, the teeth are spaced anteriorly in the outer row.

The yolk sac disappears at sizes about 55 to 63 mm. in SL.

COLOR IN ALCOHOL: Juvenile: head black dorsally from tip of snout to occiput; opercle black from dorsal edge of operculum ventrally to lower border of interopercle; opercular membrane behind this hyaline; a black transverse bar from tip of snout through eye to edge of opercle, but not opercular membrane; outer edge of eye black; when barbels extended

anteriorly, upper part white and the membranous lower part black; anterior tip of lower jaw black; remainder of head white; body black, humeral spot absent; one white transverse stripe along midhorizontal length of body, starting behind head and arching dorsally to include posterior basal part of dorsal fin through the upper 3 or 4 rays of caudal fin to posterior tip of that fin; ventral part of body with one white horizontal band from isthmus, and posteriorly tapering to anterior one third of anal fin; a white bar about one scale wide encircling body just behind head, this bar widening on thorax; vertical fins black, posterior part of dorsal fin basally white; fin rays of posterior half of anal fin distally with a touch of white; pectoral fins black, with basal one fourth and outer rays white; pelvics black with outer rays white (see fig. 4, A). Juvenile color pattern evident at length of about 74 mm. SL.

Adult: two specimens 91 and 141 mm. in total lengths (caudal fins missing) without black stripe. Color of these specimens brownish, paler ventrally; vertical fins, pectoral fins and membranous part of barbels black; basal part and outer ray of pectoral fins white; distal edge of anal fin touched with white; brownish sides of body without checkered effect noted on *bicirrhosus* (see fig. 2, B).

*O. ferreirai* retains its striping at a longer length than *bicirrhosus* which loses its stripes when it attains the length of about 65 mm. The lateral stripe in *ferreirai* disappears at somewhere between SL 74 to 100 mm. The stripe of *ferreirai* is much wider, covering 3 scale rows, whereas in *bicirrhosus* it covers only 1 scale row. Also, the young of *ferreirai* have the upper 3 rays of the caudal fin white; *bicirrhosus* does not.

COLOR IN LIFE: Adult: Color is a dark bluish, paler ventrally (Brittan in litt.).

REMARKS: I name the new osteoglossid *Osteoglossum ferreirai*, for Alexandre Rodrigues Ferreira. He was the first one to collect and indicate the existence of an osteoglossid. The many new species he brought back from Brazil gave recognition to others, but not to him. Through unfortunate circumstances his work has been ignored; therefore, I take this opportunity to honor him.

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## FILTRATION OF MARINE AQUARIA

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I have in my possession a small extract, written in a school exercise book in the late nineteen forties, when I was barely growing out of boyhood. It contains a summary of a small fraction of a thesis, of which I never recorded the author's name. As far as I know, the thesis was written for a doctorate in chemistry, and the relevant research was done at the Aquarium of the Amsterdam Zoo during, or shortly after, World War II. If the work described here in this article leads to any improvement in the keeping of tropical marine fishes in home aquaria, much of the credit will have to go to the unknown author of this thesis; this I gratefully acknowledge here. I hope he will read this report.

The section of which I have an extract reads, translated from the Dutch: "As a result of the feeding of the fishes with protein rich foods in marine aquaria a rapid accumulation of nitrogen compounds (NH<sub>3</sub>, NO<sub>2</sub> and NO<sub>3</sub>) takes place. This is the biggest problem, because these compounds are positively dangerous. However, it has been shown that through bacteriological processes the nitrogen content finally is all converted into the NO<sub>3</sub> (nitrate) form in which it is least dangerous, while on the other hand it is possible to produce a spontaneous culture of denitrifying bacteria in a filter as long as carbohydrates in some form or other (at concentration 0.06% glucose equivalent) are present in the water. This denitrification will lead to the formation of free, gaseous nitrogen, which can escape into the atmosphere. Generally speaking storage of sea water in the dark is being advocated for purposes of purification. However, if also a period of exposure to full light is fitted in, the following advantages could accrue:

- (i) Production of carbohydrates in the water so that denitrifying bacteria can establish themselves on the filters.
- (ii) The plants themselves will fix part of the nitrogen and phosphate compounds in the form of organic matter, so removing it from circulation.

PROPOSED TREATMENT OF SEA WATER IN MARINE AQUARIA: AQUARIUM -to- SHALLOW RESERVOIRS IN FULL LIGHT -to- FILTERS -to- DARK CELLARS FOR STORAGE -to- RETURN TO AQUARIUM."

When the author began his early attempts at the keeping of tropical marine fishes in home aquaria, little information was available on methods to deal with the removal of waste products in the water. The popular



aquarium literature available then and now advocates methods of filtration that even to the mind of a relative beginner with some background knowledge of animal and plant physiology appear to be deficient in several aspects. Although there is a notable lack of unanimity amongst the authors of the available popular literature about methods of filtration, at least in detail, all the methods advocated could roughly be characterized as leading to good mechanical filtration by satisfactory removal of suspended solid particles and, in addition, to some biological digestion of residues with the help of bacteria leading to a more or less complete mineralization of food debris and metabolic wastes. Or, referring back to the section of the thesis quoted above, these methods of filtration would under ideal circumstances lead to an almost complete breakdown of nitrogenous wastes into the nitrate form. There is, therefore, obviously no means of preventing nitrate build-up in the tanks, and under the systems advocated this would have to be taken care of by partial replacement of the aquarium water at regular intervals. Furthermore, most of the popular writers advocate a low level of illumination of the tanks to prevent the water in the tanks going green and also to prevent the occurrence of eye disorders in the fishes. It can be remarked that green water could easily be expected to occur under the prevailing condition of steadily increasing nitrogenous residues in the water, and this may explain this attitude. As for eye disorders in the fishes caused by strong light, I just cannot accept this in view of the very brightly illuminated environment these fishes normally live in. Furthermore, my experience with fishes in aquaria seems to indicate that, in the first place, marine fishes have a fantastic recuperative capacity for eye disease, especially the so-called "pop-eye," and, secondly, that the diseases encountered usually are either this "pop-eye" or a cataract-like condition. These disorders are, therefore, most likely bacterial, and have nothing to do with the illumination of the environment.

When I started with the keeping of tropical marine fishes in home aquaria, some 6 years ago, I had no authority to go by, apart from these popular writings. As a result my first attempts were all concerned with various variations and refinements of these methods. For most of the time, I had at least eight marine aquaria in operation of about 10 gallons each and each containing up to four moderate-sized specimens of the more accessible kinds of coral reef fishes from the Pacific area around the Fiji Islands, such as various species of *Chaetodon* or butterfly fishes, blue damselfishes (*Troglodactylus aeneus*), bridled clown (*Amphiprion ephippium*), coral beauty (*Dascyllus aruanus*), threespot dascyllus (*Dascyllus trimaculatus*), electric green reef fish (*Chromis coralina*), golden blenny (*Odonasichthys elisabethae*), and odd specimens of pomacanthids, triggers, surgeonfishes, and gobies. All experiments were made under conditions of the greatest possible uniformity with the exception, of course, of the factor under consideration, and this included



*Dascyllus aruanus*. Photo by Dr. Herbert R. Axelrod.



*Chromis caeruleus*. Photo by Klaus Peyron.



magazines, others have been induced to try the same methods, including my good friend Harold Storck of Suva Harbour Lights Aquarium in the Fiji Islands. It is probable that news of some of their results has already reached the U.S.A. by now. In general, others have been able to confirm good results also, and the rest of this article is drawn to some extent from their experiences in addition to my own experiments.

Basically the method consists of a separate filter tank, either away from the display tank or separated from it by a built-in partition. The bottom of the filter tank is covered with a fine filter medium (I use fine beach sand), and the water passes continuously through this to be returned to the main tank by pump or airlift. There is usually approximately 4 inches of water standing over the filter medium, and this is exposed to as strong a light as

Mr. Lee Ching Eng with an aquarium he keeps with his "natural method". Photo by Edgar Smith, L.C.A.



Three disciflax and a blue demersal live in this tank. The tank receives no aeration or filtration of any kind, but is in full light. All the coral and the sides of the tank were thickly coated with algae. (The glass had to be cleaned immediately before this photo was taken.) These fishes have been in this tank since November 19, 1964. The tank has never been cleaned, nor has any water been changed.

possible. In New Zealand the best results have been obtained with incandescent light, Fiji reports very good results with natural sunlight. Fluorescent light has, so far, not been very satisfactory, although indications are that good results may be obtained with a "Geo-lux" type of tube. Under strong incandescent light, the water in the filter gets quite warm, and a breakdown of circulation can bring it almost to the boiling point. Some care is needed here. Evaporation from the filters is extremely high under those conditions, calling for much water replacement, and this must be avoided by hermetically closing both the tank and the filter. In the filter, I am using Pyrex glass bowls set in an airtight top of plastic-treated hardboard. The Pyrex bowl holds the light bulb, and this enables me to have the bulb working partially below the water surface.

It has been found in all instances that there is a sequence in the establishment of algae that occurs in the same way every time this type of filter is established. The first to establish is a coating of brown algae, mainly on the filter medium. The impression is that these algae are probably single-celled



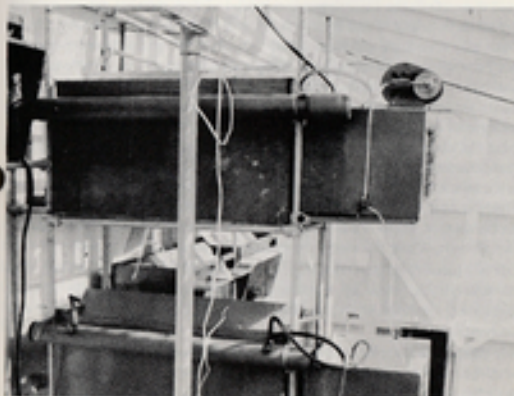
Another experimental tank. Filter medium is behind a partition, exposed to full sunlight through glass back of tank and unshaded greenhouse wall.

and occur free floating in sea water under conditions of adequate light. They are filtered out by the filters and continue to develop on the surface of the filter medium at a very fast rate. Temperatures well over 100°F. do not seem to impede their development. After the filter has been established for a period, green algae will very gradually start to appear and, over a period of about a month, gradually establish dominance. Finally, the whole body of water over the filter will get filled with algal growth. By that time, however, the algae in the higher layers will begin to shade the lower ones, causing death of these and some organic breakdown on the surface of the filter. This could be harmful and should be prevented by removing sufficient algal growth at regular intervals.

The brown algae, growing in the initial establishment period are prodigious producers of nascent oxygen, and often only 48 hours after establishment there will be an almost solid layer of oxygen bubbles lying on the filter medium. I consider this a very important aspect, as this must have quite a considerable disinfectant effect on the water passing through and



Top, the ultraviolet sterilizing setup, showing the cap of the ultraviolet tube and the inlet tube for water coming from the filters. (There are two of these.) At the opposite end are two outlet tubes plus an air vent with an overflow tube right on top. Bottom, general view of the setup for ultraviolet sterilization trial. The top tier is sterilized, the bottom is not.





also greatly influence the processes occurring in the filter medium. On an average, in about a fortnight so many oxygen bubbles will have developed that the algal layer is torn loose from the filter medium and floats to the surface. I then skim it off and let the same sequence occur again. This implies, therefore, that at present I am holding the filter artificially in the brown algae stage. There is some debate going on with others about the correctness of this method, but I feel there is merit in it.

The main display tank should, under this method, be in full light, provided there are adequate shaded hiding places for the fishes. My experimental tanks at present are in almost full sun in a very lightly shaded glasshouse. This constitutes an important safeguard as it means that the moment the filters are unable to cope with the accumulation of waste products the tank will go green. This does not harm the fish in the slightest but constitutes a very visible warning that corrections are required.

Some difficulties are likely to occur with motile algae. These will settle, amongst other places, on the front glass of the tank and when cleaned off will resettle again in a very short time. The filter flow should be fast enough to exceed the speed with which these organisms can propel themselves through the water, as this will prevent them from resettling in the display tanks. Indications are that two standard  $\frac{1}{2}$ -inch airlifts working at full capacity will be adequate for a 12 $\frac{1}{2}$ -gallon tank.

It has been reported to me by Mr. Storck that, when collecting fishes from the reefs in the Fiji Islands in a period of dark weather extending over several days, many of the fishes caught will suffer from skin disease. Most commonly found are a disease called "skin-blotch" and a disorder causing small eruptions in the slime layer. Some fishes are more susceptible to these than others. I have found accidentally that under the filtration method under discussion, these diseases can virtually be turned on and off. A sudden decrease of the light on the filters or total removal of the algal growth will bring the disorder on at once with some fishes, and it will disappear again when conditions are brought back to normal. In relation to this, it must be mentioned that the light over the filters is kept on for 24 hours a day. If this cannot be done for some reason or other, circulation through the filters must be stopped during darkness and ordinary aeration used on the display tank. While the filters are working no aeration is required.

It is necessary to have two filter tanks to each display tank. In this way the aquarist can build up a rotation so that one filter is always in fully operational condition while the other one can be cleared of algal growth and get reestablished.

If disease does strike, some discretion is required with the medications used. The use of copper sulphate is absolutely out of the question. Methylene blue can be used in very weak concentration and only over a short

period, as it interrupts certain light rays that are indispensable for the photosynthesis of the algae. Indications are that antibiotics and sulfa drugs can usually be used safely.

Many fishes will eat the type of algae that grow on the filters under this system quite readily, and, by feeding them in this way, the introduction of further nitrogenous substances can be reduced.

Under this system, there is no need for absolute "hospital" cleanliness as was required under older methods. I am not certain about the limitations yet, but it is possible to have considerable quantities of organic debris on the bottom of the tanks, comparable in amounts to those normally found in freshwater tanks. It is possible that water changes can be eliminated altogether. This will, however, depend to some extent on the amount and the source of water used to replace evaporated water and also on the mineral content of the fish food used. Both could in the long run unbalance the water sufficiently to make a water change necessary.

Determination of the number of fishes that can be accommodated per gallon of tank capacity needs a new approach. Within reasonable limits, the quantity of water available will become immaterial and the yardstick used will probably be a function of filter surface and illumination. Very tentative figures arrived at in my experiments up to date are 5 watts of incandescent light and 12 square inches of filter per inch of fish. This allows many more fishes per tank than was usual in the past.

When using an experimental filter illuminated by daylight, a rather strange phenomenon occurred. The tank in question would go through a daily cycle of becoming clouded and clear. It would be quite milky each morning, but clear very gradually during the day until it was quite clear by nightfall. Then it would be cloudy again in the morning. I have had some difficulty in arriving at a theory to cover this phenomenon. The cycle was too fast to be bacterial. I believe now that it is a calcium cycle. During the day, under influence of high-oxygen conditions, calcium would be solubilized in the filter medium which contained a lot of finely crushed shell, and it would be carried into the tank. During the night, under conditions of low oxygen and high carbon dioxide, the calcium would precipitate out, causing the cloudiness, and this would be gradually filtered out of the water again during the day. This is a situation that may well occur in many instances where daylight is used to illuminate the filters. It makes it necessary to stop the flow through the filters at night and apply ordinary aeration to the tanks. It is also a reason why I tend to favor artificial light for the process.

Electricity consumption can be fairly heavy under this method if separate aquarium heating and illumination is maintained in the colder climates. It can be reduced a little by using as much of the heat of the lamps as possible



to heat the tank. This can be done by having the filter area built into the body of the tank, separated only by a partition. Much of the heat from the filter will then be transmissible to the main tank both through the partition and through the waterflow. I have already heard of a successful experiment where the tank heater has been eliminated, and a thermostat controls both the lights over the filters and the pump transferring the water. This could work well, but light values, etc., must be carefully chosen and fluctuation of the outside temperature over the seasons must be taken into consideration. Otherwise, there may be long periods in the summer when the filters get no light at all. In hotter climates if artificial light is used, some means will have to be found to cool the water on its way back from the filters to prevent overheating of the main tank.

Some experiments I have done seem to make it likely that if light values, filter surface, and flow are carefully chosen the whole process is likely to become self-balancing. An increase in the production of waste material will immediately be offset by an increase in algal growth.

Indications are that amongst some of the most immediate benefits of the method are the facts that the fishes are far less inclined to fight, and that species it had been considered in the past impossible to keep together can become quite compatible. There are also reports that species of fish which in the past could not be made to eat in captivity, can be brought to feed well, even on unaccustomed foods. Mr. Storck reports success from Fiji with the Moorish idol (*Zanclus cornatus*), and I have success with a species of butterfly (*Pseudopomacentrus* sp.) that is allegedly very difficult to acclimate.

The water in the tanks will become completely colorless and very clear once filtration is well established, even after considerable ageing; under previous methods the water would tend to become yellow after a while. This obviates the need for use of activated carbon and is probably caused by the bleaching effect of the nascent oxygen produced on the filters.

On several occasions, I have noticed, as have others, very large quantities of infusoria occurring in tanks run under the system under discussion. They are fairly large infusoria, well above the limits of visibility and very fast moving. They usually occur near the surface in the lightest areas of the tank, and can on occasion become numerous enough to annoy the fish. I have used a small application of malachite green to drastically reduce their numbers. The species involved have not yet been determined.

PSEUDORHEGMA DIAGRAMMA, A NEW GENUS AND SPECIES OF GRAMMISTID FISH, WITH A KEY TO GENERA OF THE FAMILY AND TO THE SPECIES OF THE SUBFAMILY PSEUDOGRAMMINAE

LEONARD P. SCHULTZ

This paper describes a new genus and species of pseudogrammid fish, *Pseudorhegma diagramma*, from the "Hawaiian Islands." It attempts to review and redefine by means of a key the genera referable to the percoid family Grammistidae. My concept of this family, divided into two sub-families, Grammistinae and Pseudogrammminae although close to that of Gosline 1960 (Pacific Sci., 14(1):28-38), differs by including *Asilaccephalus* Temminck and Schlegel and *Diploprion* Cuvier and Valenciennes. Katayama 1959 (Bull. Faculty Education, Yamaguchi Univ., 8(2):105) places *Diploprion* and *Asilaccephalus* together in the subfamily Diploprioninae. However, *Diploprion* and *Asilaccephalus* have an arrangement of the anterior dorsal pterygiophores associated with the first four neural spines fundamentally the same as in *Grammistes* Bloch and Schneider (figures 2 and 3). These two genera have a dorsal fin spine arising from the first and from the second dorsal pterygiophores, but unlike *Grammistes* and *Rypticus* the first dorsal pterygiophore is not reduced in size and does not curve over the distal tip of the third neural spine. In that respect *Asilaccephalus* and *Diploprion* are similar to certain serranid genera illustrated by Katayama 1959 (op. cit. p. 150, fig. 27).

Since the arrangement of the dorsal pterygiophores in *Diploprion* and *Asilaccephalus* are more serranid-like than in *Grammistes* and in *Rypticus*, I cast doubt on the appropriateness of continuing to recognize the Grammistidae as a family separate from the Serranidae. The only character that I know which is common to all grammistid genera herein recognized and not to other serranids is that the inner pelvic ray is membranously attached to the body.

Radiographs<sup>1</sup> of the members of this family show that the neural spines and dorsal pterygiophores form a type of arrangement of the elements not fully illustrated by Katayama 1959 (op. cit. pp. 145-152). Although he figured the anterior vertebrae of *Grammistes sexlineatus* he did not show where the dorsal spines were joined to the dorsal pterygiophores. The anterior dorsal pterygiophore, in front of the third neural spine, curves dorsally over the tip of the latter to join the pterygiophore just behind the third neural spine (figures 1 and 2). In *Asilaccephalus* and *Diploprion* there is little difference between the arrangement of pterygiophores in *Gram-*

<sup>1</sup> I am grateful to Mrs. Fanny Phillips for the excellent radiographs prepared for this study.

mites and the other grammistid genera, except that two dorsal spines arise from the area of fusion of the two pterygiophores in *Grammistus*, whereas only one spine occurs in the other genera, for example *Rypticus* (figure 1).



Arrangement of spines associated with anterior vertebrae. 1-*Rypticus apomacrus*, USNM 30961; and 2-*Grammistus caelimanus*, USNM 109994. Sketches by author. 3-*Diplaptes bilineatus*, USNM 182097, sketch by Dorothea B. Schell.

**Family Grammistidae**

The percoid family Grammistidae, is distinguished by the following combination of characters: Pelvic rays 1,5, with inner ray membraneously attached to the body; opercular membrane attached postero-dorsally to the head sometimes to oppose the base of pectoral fin; opercular spines two or three sometimes flat and blunt; preopercular spines one to five or posterior edge strongly serrate; dorsal fin spines II to IX, and anal I to III, third if present shorter than second; scaly or fleshy sheath at bases of median fins; dorsal pterygiophore just in front of third neural spine joins dorsally the one just behind third neural spine; two dorsal pterygiophores between third and fourth neural spines; two free predorsal pterygiophores, one each near tip of the first and of the second neural spines. Counts of the number of vertebrae are recorded in table 1.

In order to place generically this "Hawaiian" species in the Grammistidae, I have studied the type species and other species of each grammistid genus. Since many of the genera have disjunct or secondary lateral lines, it is necessary to define my use of primary and secondary lateral lines.

The primary lateral line originates at the upper edge of the opercle and extends along the upper side, with or without interruption, usually ending before or at the mid-base of the caudal fin. This is the usual course of the lateral line in most fishes. The secondary lateral line or lines are those that follow some other course, including the peduncular lateral line, which is separated from the primary lateral line by an interruption in the series of scales with pores.

**Key to the genera of the family Grammistidae**

- 1a. Primary lateral line complete to base of caudal fin; scales minute. (Grammistinae)
  - 2a. Dorsal spines II to IV.
    - 3a. Dorsal spines II or III, 21 to 27; anal I, embedded, soft rays 14 to 18; fleshy knob at tip of chin; dorsal fin without a notch. *Rypticus*<sup>a</sup>
    - 3b. Dorsal IV-4,9; anal II,8, with slender spines; preopercular spines several; no fleshy knob on chin; dorsal fins separate. *Rainfordia*<sup>b</sup>
  - 2b. Dorsal spines VI to IX; anal II or III, sometimes embedded; dorsal fin deeply notched.
    - 4a. Anal spines II; preopercular spines three, tip of chin with a small knob.

<sup>a</sup> *Rypticus* Carter, 1829, Regne Animal ed. 2, 2: 144 (type species, *Aethias apomacrus* Bloch and Schneider).

<sup>b</sup> *Rainfordia* McCulloch, 1925, Rec. Australian Mus., 14(2): 319, pl. 16, fig. 3 (type species, *Rainfordia apicalaris* McCulloch, I have not seen a specimen of this species).

TABLE 1. Vertebral counts recorded for certain species of the Gramminidae

Genus and species	Number of Vertebrae														
	abdominal*			caudal					total						
	9	10	11	13	14	15	16	17	18	19	24	25	26	27	28
<i>Grammitis ovalisatus</i>	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anilacocephalus zammitchi</i>	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-
<i>Diploprion bifasciatum</i>	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-
<i>Pyprius japonicus</i>	8	-	-	-	2	7	1	-	-	-	7	1	-	-	-
<i>Grammitis ovalisatus</i>	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-
<i>Pseudogramma polyacantha</i>	51	-	-	-	-	-	-	51	-	-	-	-	-	51	-
<i>Pseudogramma broderi</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pseudogramma abgramma</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Rhagus bermudezi</i>	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Rhagus rhacostomum</i>	11	-	-	-	-	-	-	-	-	-	-	-	-	11	-
<i>Rhagus gregori</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Aporops bilineata</i>	21	-	-	-	-	-	-	-	1	20	-	-	-	-	-
<i>Sarcotia lineata</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1

\* The last abdominal vertebrae counted was the most posterior vertebrae bearing ribs; usually the anal pterygiophores were associated with the haemal spine of the first caudal vertebrae.

- 5a. Anal spines embedded; scales minute embedded; tip of chin with a small fleshy appendage; dorsal rays VII,13 to 15; anal rays II,9. *Grammitis*<sup>4</sup>
- 5b. Anal spines strong, not embedded; scales small, not embedded; tip of chin with a small hard knob, no fleshy appendage; dorsal rays VIII or IX,13 to 16; anal rays II,9 to 12. *Diploprion*<sup>5</sup>
- 4b. Anal spines III, not embedded.
  - 6a. Preopercular spines 3 to 5; dorsal fin rays VIII,11 to 13; anal III,8 or 9; pectoral i,16 or i,17; dermal cirrus on tip of chin. *Papomperca*<sup>6</sup>
  - 6b. Preopercular spine single, blunt; dorsal rays VII,12; anal III,9; pectoral i,13; no dermal cirrus on chin. *Grammitops*<sup>7</sup>
  - 6c. Preopercular edge with numerous strong serrations or spines; dorsal rays IX,11; anal III,9; pectoral ii,13; no dermal cirrus on chin. *Anilacocephalus*<sup>8</sup>
- 1b. Primary lateral line incomplete, ending under soft dorsal fin; secondary lateral line, if present, located on caudal peduncle; scales of moderate size, not embedded; preopercular with one spine. (*Pseudogramminae*)
  - 7a. No enlarged pore in interorbital space over orbits; preopercular spine directed posterodorsally; two lateral lines. *Aporops* Schultz<sup>9</sup>
  - 7b. One or more enlarged pores in interorbital space over orbits; preopercular spine directed posteroventrally.

<sup>4</sup> *Grammitis*, Bloch and Schneider, 1801, *Systema ichthyologiae*, p. 182 (type species, *Grammitis orientalis* Bloch and Schneider - *Pisca sessilosa* Thunberg).

<sup>5</sup> *Diploprion* Kuhl and Van Hasselt in Cuvier and Valenciennes, 1828, *Histoire naturelle des poissons*, vol. 2, p. 137 (type species, *Diploprion bifasciatum* Kuhl and Van Hasselt).

<sup>6</sup> *Papomperca* Günther, 1859, *Catalogue of the Fishes of the British Museum*, 1:149 (type species, *Papomperca ocellata* Günther).

<sup>7</sup> *Grammitops* Schultz, 1953, U.S. Nat. Mus. Bull. (202):386 (type species, *Grammitops ocellatus* Schultz).

<sup>8</sup> *Anilacocephalus* Smith, 1954, *Ann. Mag. Nat. Hist.* (127):869 (type species, *Talolepis asis* Smith).

<sup>9</sup> *Anilacocephalus* Temminck and Schlegel, 1842, *Fauna Japonica, Pisces*, p. 15, pl. 5, fig. 2 (type species, *Anilacocephalus temminckii* Bleeker).

<sup>10</sup> *Aporops* Schultz, 1943, U.S. Nat. Mus. Bull., 180:112 (type species, *Aporops bilineatus* Schultz).



- 8a. A dermal cirrus on upper part of eye; peduncular lateral line present or absent; if present, short.

*Rhagma* Gilbert<sup>15</sup>

- 8b. No dermal cirrus on eye.

- 9a. A single dorsal lateral line.

- 10a. Scales ctenoid on posterior part of body; anal rays III, 15 to 18; dorsal VII, 19 to 22.

*Pseudogramma* Bleeker<sup>11</sup>

- 10b. Scales cycloid; anal rays III, 19; dorsal VII, 23 or 24.

*Suttonia* Smith<sup>12</sup>

- 9b. Two lateral lines; anal rays III, 16 or 17; dorsal VII, 20 or 21.

*Pseudorhagma*, new genus

#### Subfamily Pseudogramminae

Smith 1953 (Ann. Mag. Nat. Hist. (12):548-560) included in the family Pseudogramminae only three genera, *Pseudogramma* Bleeker, *Aporops* Schultz, and *Suttonia* Smith, whereas Böhlke 1960 (Not. Nat. (330):3) recognized *Pseudogramma*, *Rhagma* Gilbert, *Caribhagma* Breder, *Aporops* and *Suttonia*. I agree with Böhlke except that *Caribhagma* is a synonym of *Rhagma*.

Since my assignment of species to certain genera of pseudogramminids differs from previous authors, I have prepared keys distinguishing the species referable to the genera *Aporops*, *Rhagma*, *Pseudogramma*, *Suttonia*, and *Pseudorhagma* of the subfamily Pseudogramminae. These keys distinguish all species known to me that are related to the new *Pseudorhagma* diagramma.

#### Key to the species of Aporops

- 1a. Anal rays III, 16; dorsal VII, 21; maxillary does not reach past rear of eye.  
*japonicus* Kamohara<sup>16</sup>
- 1b. Anal rays III, 18 to 21; dorsal VI or VII, 23 or 24; maxillary reaches past rear of eye.  
2a. Anal soft rays 18 to 20.  
*hilisariis* Schultz<sup>14</sup>
- 2b. Anal soft rays 21.  
*allfrei* Smith<sup>13</sup>

<sup>15</sup> *Rhagma* Gilbert in Jordan and Evermann, 1900, U.S. Nat. Mus. Bull. (47):3169 (type species, *Rhagma thasmanium* Gilbert).

*Caribhagma* Breder, 1927, Bull. Bingham Oceanogr. Coll., 1(1):44 (type species, *Caribhagma gregoryi* Breder).

<sup>11</sup> *Pseudogramma* Bleeker, 1875, Verh. Akad. Wet. Amsterdam, 15(5):24 (type species, *Pseudochromis polyacanthus* Bleeker).

<sup>12</sup> *Suttonia* Smith, 1953, Ann. Mag. Nat. Hist. (12):556 (type species, *Suttonia suttoni* Smith).

<sup>16</sup> *Aporops japonicus* Kamohara, 1957, Repts. Usa Mar. Biol. Sta., 4(1):21 (type locality, Wan, Kikaijima, Japan).

<sup>14</sup> *Aporops hilisariis* Schultz, 1943, U.S. Nat. Mus. Bull., 180:112 (type locality, Hull Island, Phoenix group).

#### Key to the species of Rhagma

- 1a. Anal rays III, 12 to 14; dorsal VII, 15 to 18.  
*gregoryi* Breder<sup>14</sup>
- 1b. Anal rays III, 15 to 20; dorsal VII, 18 to 24.  
2a. Soft anal rays 16 to 19; soft dorsal 19 to 24; pectoral 15 to 18.  
*thasmanium* Gilbert<sup>17</sup>
- 2b. Soft anal rays 15 or 16; soft dorsal 18 or 19; pectoral 14 or 15.  
*bermudensis* Kanazawa<sup>18</sup>

#### Key to species of Pseudogramma

- 1a. Maxillary naked; soft dorsal and soft anal rays reach to base of caudal fin rays; no black spot on body; length of caudal peduncle 1.2 to 1.5 in its height.  
*polyacantha* Bleeker<sup>19</sup>
- 1b. A patch of tiny scales dorsally on rear of maxillary; soft dorsal and soft anal rays reach a little past base of caudal fin rays; a prominent black spot just above lateral line and a little in front of a vertical line through dorsal origin; length of caudal peduncle twice in its height.  
*brederi* Hildebrand<sup>20</sup>

#### Key to the species of Suttonia

- 1a. Anal rays III, 19; dark opercular spot present; side with three lengthwise dark streaks.  
*suttoni* Smith<sup>12</sup>
- 1b. Anal rays III, 20 to 21; no opercular spot; sides plain brownish, without lengthwise streaks.  
*lineata* Gosline<sup>21</sup>

#### Pseudorhagma, new genus

This new genus differs from all other pseudogramminid genera by the following combination of characters: two lateral lines, enlarged pores in the interorbital space, preopercular spine directed posteroventrally and no dermal cirrus on the eye. It may be distinguished from all related genera by means of the keys on preceding pages.

Type species, *Pseudorhagma diagramma*, new species.

<sup>13</sup> *Aporops allfrei* Smith, 1953, Ann. Mag. Nat. Hist. (12):553, fig. 2 (type locality, Kisiu Island, 4°43'S., 39°23'E., and Pemba, East Africa).

<sup>14</sup> *Rhagma gregoryi* Breder, 1927, Bull. Bingham Oceanogr. Coll., 1:44, fig. 22 (type locality, Glover Reef, Atlantic Coast, Honduras).

<sup>17</sup> *Rhagma thasmanium* Gilbert in Jordan and Evermann, 1900, U.S. Nat. Mus. Bull., 47(4):3179 (type locality, Panama, Pacific Coast).

<sup>18</sup> *Rhagma bermudensis* Kanazawa, 1952, Fieldiana, Zool., 34(7):82, fig. 11 (type locality, Bermuda).

<sup>19</sup> *Pseudochromis polyacantha* Bleeker, 1856, Nat. Tijdschr. Nederl.-Indië, 10:375 (type locality, Ternate).

<sup>20</sup> *Rhagma brederi* Hildebrand in Longley and Hildebrand, 1940, Papers Tortugas Lab., 32(14):244, fig. 11 (type locality, Tortugas, Florida).

<sup>12</sup> *Suttonia suttoni* Smith, 1953, Ann. Mag. Nat. Hist. (12):556 (type locality, Pemba Island, East Africa).

<sup>21</sup> *Suttonia lineata* Gosline, 1960, Pacific Sci., 14(1):28, fig. 1 (type locality, Waiwae Coast, Oahu, Hawaii).



Key to species of *Pseudorhagma*

1a. Two broad flat opercular spines; dorsal rays VII,21; anal III,16.

*gulosus* Norman<sup>19</sup>

1b. Three short opercular spines; dorsal rays VII,21; anal III,17.

*diagramma*, new species

Since the peduncular lateral line is the chief character distinguishing *Pseudorhagma* it is important to clarify the confusion concerning its presence or absence in related genera.

The original description of the type species of *Pseudogramma*, *Pseudochromis polyacanthus* Bleeker 1856 (Nat. Tijdschr. Ned. Ind., 10:375) mentions only a single lateral line, whereas in the Atlas Ichthyologique, Bleeker 1878 (9: pl. 389, fig. 3) two lateral lines are figured, the peduncular one being added. Since then confusion has resulted as to the identity of *P. polyacanthus* Bleeker, because Weber and de Beaufort 1931 (Fishes Indo-Australian Archipelago, 6:120, fig. 21) incorrectly describe it with a peduncular lateral line. Perhaps they confused the very abundant *Aporops bilinearis* Schultz with *Pseudogramma polyacanthus*.

In 1943 I described as new *Aporops* (Schultz, U.S. Nat. Mus. Bull., 180:114-116), and distinguished it from the then monotypic genus *Pseudogramma* Bleeker by the presence of a peduncular lateral line and absence of enlarged pores in the interorbital space.

I attempted to correct the error of Bleeker 1878 (op. cit. pl. 389, fig. 3) in my 1943 report (op. cit. p. 115) when I published the following: "Dr. F. P. Koumans kindly examined three of Bleeker's types in Leiden and reports that he did not find a continuation of the lateral line along the midline of the caudal peduncle. The dorsal soft rays of the types of *P. polyacanthus* number 18, 18, 18; anal 16, 15, 16; scales 45, 45, -; according to Dr. Koumans. Dr. de Beaufort reports that the two specimens collected by the Siboga Expedition, 46 and 31 mm. long, have the lateral line developed only anteriorly; the scales number 49 and 51; dorsal rays VII,20; anal III,16." The latter also are *P. polyacanthus*.

Therefore, I concluded (op. cit. pp. 114-115, 1943) that Bleeker's 1856 description was correct and *P. polyacanthus* has only the dorsal lateral line.

*P. polyacanthus* has VII,19 to 22 dorsal rays; III,15 to 18 anal, differing from *Aporops bilinearis* Schultz 1943 (op. cit. p. 112) with VII,23 or 24 dorsal, and III,19 to 21 anal rays. Günther 1860 (Catalogue of the Fishes in the British Museum, 2:258); Günther 1876 (Fische der Südsee, 5(2):159,

<sup>19</sup> *Rhagma gulosus* Norman, 1935, Discovery Repts., 12:10 (type locality, off Annobon, Gulf of Guinea). Dr. P. H. Greenwood kindly examined the holotype of this species and furnished the following counts: Dorsal VII,21; anal III,16; pectoral 15,16; scale rows from cleithrum to caudal fin base 41. The preopercular spine points ventrally.

pl. 98, fig. A); Fowler 1928 (Mem. Bishop Mus., 10:189); Fowler 1931 (U.S. Nat. Mus. Bull. (100)11:3) and Smith 1953 (op. cit. pp. 549-552) describe *P. polyacanthus* with only the dorsal lateral line.

The presence or absence of the peduncular lateral line is an important generic character for the species in the subfamily Pseudogramminae, except for *Rhagma thomasi* Gilbert in which it is present or absent. One specimen, USNM 101626 has 5 pores on one side of the caudal peduncle, but no pore on the other side. Other species of *Rhagma* lack the peduncular lateral line. I have examined a few hundred specimens of *Aporops bilinearis* and find it constantly present, whereas, I have never found the peduncular lateral line on specimens of *P. polyacanthus*. Smith 1953 (op. cit. p. 551) who "examined several hundred specimens" of *P. polyacanthus* never found any indications of the peduncular lateral line.

*Pseudorhagma diagramma*, new species

HOLOTYPE: USNM 160672, "Hawaii," collected by Wm. H. Longley standard length 67.5 mm.

DESCRIPTION: Dorsal rays VII,21; anal III,17; pectoral 16; pelvic I,5, gill rakers 6+10; oblique scale rows from upper edge of opercular opening to midcaudal base 45, with about four more anteriorly to origin of lateral line; pores in dorsal lateral line 38, and in peduncular lateral line 25; scales in a row from dorsal fin posteroventrally to anus 6+1+23; 8 rows of enlarged scales on opercle; vertebrae 9+17.

The following measurements are expressed in thousandths of the standard length: snout tip to rear edge of opercular membrane 393; greatest depth of body 319; length of snout 89; diameter of eye 74; tip of snout to rear end of maxillary 190; width of fleshy interorbital 41; least width of preorbital 27; snout to dorsal fin origin 395 and to anal fin origin 674; least depth of caudal peduncle 129; length of caudal peduncle between vertical lines through rear of base of anal fin and midbase of caudal fin 84; postorbital length of

head 242. Longest ray of: pectoral 245; pelvic 120; caudal 200; soft dorsal 114; and soft anal 114. Length of second anal spine 71, and of third anal spine 46. Longest dorsal spine 67.

Scales cycloid on head, ctenoid on body; bases of median fins covered with scales; snout, premaxillary, and lips of lower jaw naked; maxillary with small patch of very small scales posteriorly; about 17 vertical scale (very small about a third the size of those on the opercle) rows on cheeks; teeth in narrow villiform band on vomer, palatines and jaws; a small canine at front edge of premaxillary on each side of symphysis, inner teeth of jaws depressible; pectoral and median fins rounded posteriorly; pelvic fins pointed, second soft ray longest, no axillary scale at base of pelvis; inner ray of pelvic fins attached by a membrane to body; greatest depth of body near midbase of spiny dorsal; maxillary reaches a little past a vertical line through rear of eye; gill membranes joined to isthmus far forward; an enlarged interorbital pore next to each eye, and a median one opposite rear of orbits; pelvic fins short reaching only halfway to anus; a large broad based sharp spine on upper rear edge of preopercle, directed posteroventrally; opercle with three distinct spines; gill rakers short, some platelike; dorsal lateral line ends at rear of base of soft dorsal fin; peduncular lateral line begins at a vertical line through about base of first soft anal ray; pelvic fins inserted under base of pectoral fin; second anal spine longer than third; anterior nostril tubular; posterior nostril situated at midfront edge of eye; no dermal cirrus on eye; opercle membranously attached to body to opposite pectoral fin base.

**COLOR IN ALCOHOL:** Head and body brown, mottled with darker broad lines, the centers of the blotches lighter; a large black opercular spot, and another smaller one between each pair of nasal openings.

**REMARKS:** The fishes collected by Longley in Pacific waters were received with the labels disintegrated, thus the exact locality was lost. However, the containers when received from the major geographical areas where Longley collected in the Pacific indicated the general locality for the specimens. There is a possibility that some of his Tortugas collections might have been mixed with some of his Pacific collections. He was in the Hawaiian Islands, September 6 to 27, 1926; Pago Pago, Samoa, October 4 to December 7, 1926; Amboina, January 7 to 12, 1927 and Banda Aeria about January 15 to March 15, 1927.

Named, *diagramma* (Greek) in reference to the two lateral lines.

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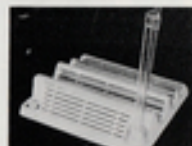
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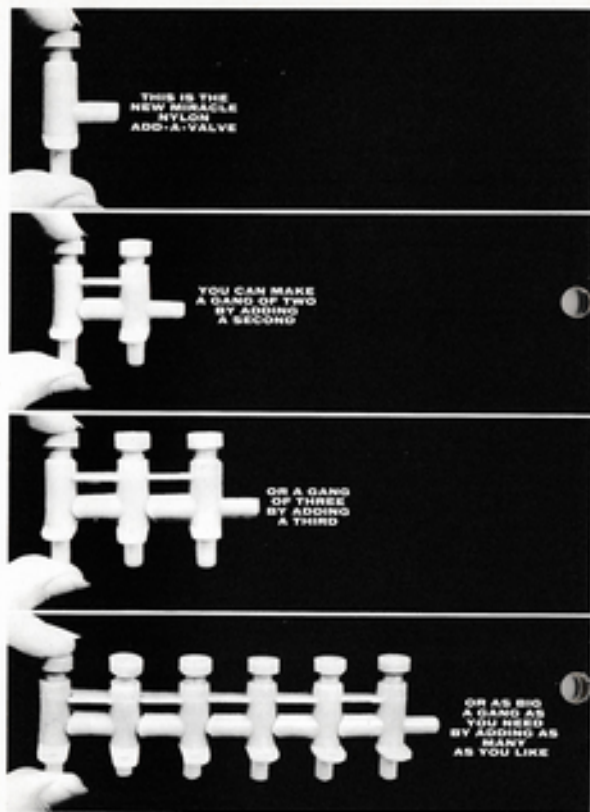


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