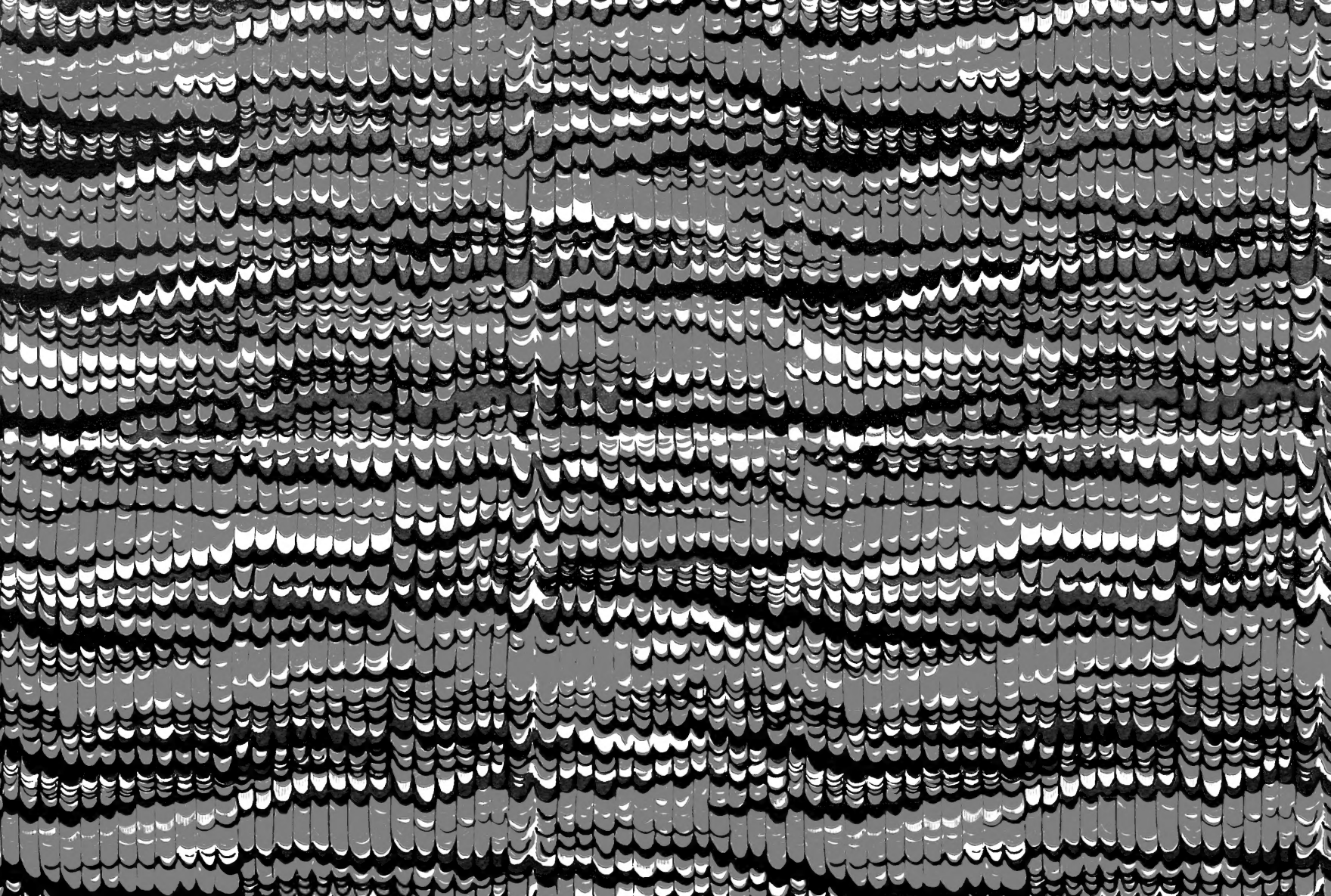

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OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. 3.

W. J. HOLLAND, EDITOR.

THE GYMNOTID EELS OF TROPICAL AMERICA

BY MAX MAPES ELLIS

PITTSBURGH.

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. III.

THE GYMNOTID EELS OF TROPICAL AMERICA.[1]

By Max Mapes Ellis.

(Plates XV–XXIII.)

Introduction.

In 1909 I undertook the identification of the specimens of Gymnotid eels collected by Dr. Eigenmann in British Guiana. Three new species were found, *Sternarchus leptorhynchus, Porotergus gymnotus,* and *Gymnorhamphichthys hypostomus.* The second and third of these represented new genera. Numerous specimens of *Eigenmannia macrops* (Boulenger), a species listed but once before, were also part of this collection. In all five species of Gymnotids were added to the fauna of Guiana.

Subsequently all of the *Gymnotidæ* collected by Mr. John D. Haseman of the Carnegie Museum Expedition to Central South America were received for study. As these collections contained several new species and specimens of many little known species, a revision of the entire family was begun. Mr. Haseman visited many new localities, and his collections were of particular value in the study of the geographical distribution of these fishes.

While engaged in the systematic revision several interesting questions arose. Three in particular may be mentioned: (1) the use of the mental filaments of *Steatogenes elegans* (Steindachner); (2) the relation to their general ecology of the

[1] Contributions from the Zoölogical Laboratory of Indiana University, under the direction of C. H. Eigenmann, No. 116. A thesis accepted as in part fulfilling the requirements for the degree of Doctor of Philosophy, June, 1911.

This paper is a partial report on the Gimbel Expedition to British Guiana and the Carnegie Museum Expedition to Central South America.

frequent injury and subsequent regeneration of the caudal region of the members of this family; and (3) the mode of locomotion.

These questions and others made a study of the living fishes very desirable before the completion of this monograph. This matter was laid before Mr. Jake Gimbel of Vincennes, Indiana, who generously agreed to finance an expedition to British Guiana. In August, 1910, the writer, with Mr. William Tucker, a volunteer assistant, sailed *via* the Quebec Line for Georgetown, British Guiana. Studies of the living *Gymnotidæ* were made in the trenches in and about Georgetown. A trip was made to Hubabu Creek, the first inland fresh-water creek emptying into the Demerara River. The Demerara is still brackish at the mouth of Hubabu Creek. Two excursions were also made to Gluck Island in the Essequibo River opposite Rockstone. This island is about one hundred miles from the coast. Collections were also made in the harbor and on the mud-flats at Georgetown. A new Gymnotid, *Porotergus gimbeli*, was added from Hubabu Creek.

During the spring of 1910, Mr. Bertoni of Puerto Bertoni, Paraguay, sent Indiana University a small collection of fishes from the upper Paraná River. Among these was a specimen of the new species *Gymnorhamphichthys hypostomus*.

The several collections mentioned, as well as the material in the Indiana University Museum, offered an excellent opportunity for a revision of this family. Twenty-two of the twenty-seven known species are in the collections examined, all of the twenty-two being in the collections of the Carnegie Museum. I wish to thank Dr. C. H. Eigenmann for his many helpful suggestions and criticisms. I am deeply indebted to Mr. Jake Gimbel for his generous support of the trip to Guiana, without which certain sections of this monograph could not have been written. I am also under obligations to the Quebec Steamship Line of Quebec and London, and Sproston's Limited of Georgetown, for their grants of transportation, and to Mr. Bernard Conrad of Georgetown, who aided me in many ways during my stay in Guiana.

History of the Literature of the Gymnotidæ.

The first scientific record of any species of this family is that of Georg Marcgraf (1648), who described as "carapo" the species now known as *Gymnotus carapo*. His fish came from Brazil. The name *Gymnotus carapo* was given to this species by Artedi in 1738. He placed it under "Ordo I, Malacopterygii," with the simple description, "*Membrana branchiostega ossiculis quinque. Pinna dorsalis nulla*" (Genera, p. 25, and Synonymia, p. 43). Linnæus under his *Apodes* listed *Gymnotus carapo* and *asiaticus* in the tenth edition, and *Gymnotus carapo, electricus, albifrons, rostratus,* and *asiaticus* in the twelfth edition of the *Systema Naturæ*.

The beginning of real interest in this group of fishes was about forty years before the appearance of the twelfth edition. In 1729 Richter published the first scientific article on the electric eel. This stimulated the study of the *Gymnotidæ*. As a result, scarcely a decade has passed since Richter's paper appeared without the publication of some contribution bearing upon the electric eel or its relatives.

The first step toward segregating the *Gymnotidæ* into a separate family was made by Cuvier (1817) in the *Règne Animal*. He recognized a group, "Les Gymnotes," which he divided into (1) "Les Gymnotes vrais" (the electric eel); (2) "Les Carapes" (*Gymnotus carapo*), and (3) "Les Apternotes" (the Sternarchinæ).

The formal family name was assigned to this group by Bonaparte (1846) in the "Catalogue dei Pesci Europei." Cope, in 1871, restricted the family name *Gymnotidæ* to *E. electricus* and applied the name *Sternopygidæ* to the rest of the group. Gill (1872) replaced the name *Gymnotidæ*, as restricted by Cope, with *Electrophoridæ*, applying the name *Gymnotidæ* to Cope's *Sternopygidæ*. This nomenclature has been used by most subsequent writers.

The family was monographed by Kaup in the "Apodes" of the British Museum in 1856. Steindachner described "Die Gymnotidæ des K. K. Hof-Naturaliencabinetes zu Wien" (Sitzb. d. K. Akad. d. Wissensch., 1. Abth., LVIII, 1868). In 1870 Günther again reviewed the British Museum specimens in Volume VIII of his "Catalogue of the Fishes in the British Museum." In 1905 Eigenmann and Ward published a synoptic revision, "The Gymnotidæ" (Proceedings of the Washington Academy of Sciences, Vol. III, pp. 159–188, 1905). Von Ihering in his "Os Peixes da agua doce do Brazil" (Revista Museu Paulista, Vol. VII, pp. 270–287, 1907), and Schlesinger, in his recent "Die Gymnonoten. Eine phylogynetisch-ethologische Studie" (Zoölogische Jahrbücher, Band 29, Heft 6, 1910), have followed the nomenclature of Eigenmann and Ward almost without change.

Taxonomy.

Order **GLANENCHELI.**

Family GYMNOTIDÆ.

Gymnotidæ Bonaparte, Cat. Metod. dei Pesci Europei, 1846; Kaup, Apodal Fish, 124, 1856; Günther, Cat., VIII, 1, 1870.
Sternopygidæ Cope, Proc. Am. Ass. Adv. Sci., 1871.
Electrophoridæ Gill, Arrangement of the Families of Fishes, 1872.
Gymnotidæ Cope, *l. c.*

Body elongate and eel-like; with or without scales; head naked; dorsal fin wanting, or represented by a dorsal thong; ventrals wanting; anal very long; pectorals small and paddle-shaped; caudal small or wanting; the tail terminating in a cylindrical caudal appendage in the species without a caudal; margin of upper jaw formed by the premaxillary and maxillary; mouth with, or without, teeth; anus never back of the middle of the pectorals, usually well under the head; vertebræ many; shoulder-girdle suspended from the skull; skull with, or without, frontal fontanel, parietal fontanel always present, though much reduced and hidden in two species; symplectic bone present; air-bladder of two parts, the anterior connected with the posterior by a small tube; stomach with a blind sac and pyloric cæca.

The family *Gymnotidæ*, as discussed in this monograph, includes all of the species of the two families, the *Gymnotidæ* and the *Electrophoridæ* as restricted by Gill. The electric eel, *Electrophorus electricus* Linnæus, has been included in this family for two reasons. Its affinities with *Gymnotus carapo* Linnæus are very close, and it is more closely related to the other Gymnotids than to any other group of fishes. The relation of *E. electricus* to *G. carapo* is shown by the following comparison.

I. Characters Common to Both Genera.

Depressed head; body subcylindrical and elongate; teeth large, in one or two rows in each jaw, conical, in sockets; lower jaw slightly projecting; eyes small; no frontal fontanel; parietal fontanel small and almost covered by the overhanging occipitals; posterior air-bladder long and conic; origin of anal fin just below tips of pectorals; anus below gill-opening.

II. Characters Restricted to Electrophorus.

Anal turned up so as to form a false caudal; scales wanting; electric organs well developed.

III. Characters Restricted to Gymnotus.

A small caudal appendage projecting beyond the anal fin; no electric organs, or at least only indications of Hunter's organs; scales present.

It will be seen that the presence of electric organs is the point of largest difference between *Electrophorus* and *Gymnotus* and as pseudo-electric organs are known for other species of the *Gymnotidæ*, it does not seem that *Electrophorus* should stand in a separate family. Plate XVI shows two views of the skull of *G. carapo*. That of *Electrophorus* is the same in almost every detail, except that it is more depressed.

Three subfamilies are recognized. The *Gymnotinæ* just discussed, the *Sternopygin*æ, and the *Sternarchinæ*. The last two named differ from the first especially in two particulars: they are compressed and have both frontal and parietal fontanels. The *Sternopygin*æ differ from the *Sternarchinæ* in the absence of a caudal fin. These two subfamilies parallel each other quite closely in their variations. Plate XV shows an outline of the head of a typical species of each genus of the family. The parallelism of the *Sternopygin*æ and *Sternarchinæ* is particularly evident in the development of long-snouted forms, short-snouted forms, and *toothless* forms. Plates XVII and XVIII show the modification of the skull in the long-snouted *Rhamphichthys rostratus* as compared with the short-snouted *Eigenmannia virescens*, both fishes being of the subfamily *Sternopygin*æ. These plates may be compared with Plate XV as regards the presence or absence of the frontal fontanel.

Boulenger (Archiv für Naturgeschichte, Jahrgang 1904, Bd. I, Heft 2) considers the *Gymnotidæ* as an offshoot from the *Characidæ*. The *Gymnotidæ* seem to

be elongate Characins without dorsal and ventral fins. However, no intermediate forms are known.

Gymnotus carapo Linn. is perhaps the most primitive of the Gymnotids as regards the air-bladder, the skull, and teeth. *Sternarchus albifrons* is, however, more primitive than *G. carapo* in general shape and in the possession of a caudal fin and a dorsal thong. The ancestor of the *Gymnotids* may have been a form combining the primitive characters of both these species.

KEY TO THE SUBFAMILIES AND GENERA OF THE GYMNOTIDÆ.

a. No frontal fontanel; no dorsal filament; no true caudal fin; lower jaw projecting; head depressed; teeth conical, in sockets; posterior air-bladder long, conical; maxillary much reduced. (**Gymnotinæ**).
b. Anal basis extending around the end of the tail, forming a false caudal; electric organs well developed; body not scaled. 1. **Electrophorus.**
bb. Anal basis not extending around the end of the slender cylindrical tail; electric organs wanting; body scaled. 2. **Gymnotus.**
aa. Large frontal and parietal fontanels; lower jaw not projecting, or at most very slightly; teeth, if present, villiform and without deep sockets, generally placed in patches, maxillary moderate to large.
c. No caudal fin; tail beyond the anal fin slender, pointed, and usually cylindrical; no dorsal filament.
d. Snout short, not tubular. (**Sternopygināe**).
e. Orbital margin free; teeth in both jaws; posterior air-bladder long, conic as in *Gymnotinæ*. 3. **Sternopygus.**
ee. Orbital margin not free.
f. Teeth in both jaws; body much compressed; posterior air-bladder small, subspherical. 4. **Eigenmannia.**
ff. Teeth wanting; body subcylindrical; air-bladders separate, the posterior cylindrical.
g. A cylindrical filament in a groove on each side of the mental region; head chubby. 5. **Steatogenys.**
gg. No filaments as above; head rather pointed ..... 6. **Hypopomus.**
dd. Snout produced and tubular; eyes without free orbital margin; very much compressed and elongate; posterior air-bladder small, subspherical.
h. Body entirely scaled ..... 7. **Rhamphichthys.**
hh. Anterior portion of sides naked..... 8. **Gymnorhamphichthys.**
cc. Caudal fin and dorsal filament present; tail rather short; eyes without free orbital margin; air-bladder small, subspherical..... (**Sternarchinæ**).
i. Snout much produced; teeth in both jaws.
j. Snout decurved.....9. **Sternarchorhynchus.**
jj. Snout straight.
k. Mouth large or moderate; gape reaching at least one-third of the distance to the vertical from the eye; snout moderate.....10. **Sternarchorhamphus.**
kk. Mouth very small; gape not reaching more than one-sixth of the distance to the vertical from the eye; snout long.....11. **Orthosternarchus.**
ii. Snout heavy and blunt, not produced.
l. Teeth present in both jaws.
m. Back scaled in front of the origin of the dorsal filament.
n. Gape long; angle of the mouth little if any in front of the eye; snout prominent. 12. **Sternarchus.**
nn. Gape short; angle of the mouth not reaching beyond posterior nostrils. 13. **Sternarchella.**
mm. Back naked to beyond the origin of the dorsal filament; scales along the lateral line large.....14. **Porotergus.**
ll. Teeth of the lower jaw in a single series; upper jaw without teeth....15. **Sternarchogiton.**

lll. Teeth wanting; lower jaw with a distinct V-shaped median groove for the reception of the pointed decurved upper jaw; head rather chubby..... 16. **Adontosternarchus.**

I. Electrophorus Gill.

Gymnotus Linnæus, Syst. Nat., ed. XII, i, 1766, 427.
Electrophorus Gill, Proc. Acad. Nat. Sci. Phila., 1864, 151.

Type, *Gymnotus electricus* Linnæus.

No frontal fontanel; anal basis extending around the edge of the tail and forming a false caudal; electric organs well developed on each side of the lower part of the caudal three-fourths of the body; teeth conical, in one row in each jaw; body very elongate; no scales.

The single species of this genus is the remarkable "electric eel" of South America, variously known as the "Porraki" by the Indians, the "numb-fish" by the English settlers, the "Tembladore" or "Tembladore rayados" among Spanish peoples, and as the "Anguille tremblante" in French Guiana.

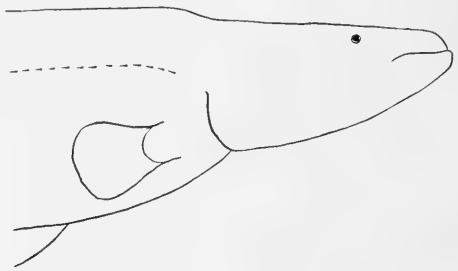


Fig. 1. *Electrophorus electricus* (Linnæus).

1. Electrophorus electricus (Linnæus).

Richter, Mem. Acad. Paris, VII, 1729, 325; de La Condamine, Voy. dans l'Amer. Merid., 1743; idem, Voy. à l'Amazone, 154, 1745 (Para); Ingram, Neue Phys. Belustig., i, 1750, 288; Allemand, Verhand. Maatsch. Haarlem, ii, 1755, 372; Van der Lott, Verhand. Maatsch. Haarlem, D. VI, St. II, 1762 (Essequibo); Bancroft, Essay on Nat. Hist. Brit. Guiana, London, 1769, 191 (Essequibo); Pallas, Spicil. Zool. Petrop., 1769; Bajon, in Rozier, Observ. sur Phys. Hist. Nat., t. III, 47, 1774 (Cayenne); Fermin, Ausführ. Hist. Phys. Kolonie Surinam, Berlin, Bd. ii, 59, 1775 (Surinam); Bajon, Mem. Hist. Cayenne, 1777, ii, 288 (French Guiana); Langguth, Disser. Torpedine, Wittenburg, 1778, 38; Hartsinks, Beschrb. v. Guiana, Berlin, 1784, Vol. 1, 144; Bonaterre, Encyclopedie Methodique, 1787, 22; Van Berkel, Reise nach Rio Berbice, 1789, Th. 1, 220 (British Guiana); Guisan, Obser. Hist. Cayenne, 1789; Rudolphi, Abhandl. Berlin Akad., 1820–21, Physik. Klasse 229; Guerin-Meneville, Iconographie Règne Animal, 1829,

tome I, pl. lxiii, fig. 2; Samo, Electric Eel, Trans. Lond. Elect. Soc., 1841; Hewson, Sydenham Soc., 1846; Hyrtl, Denkschr. K. Akad. Wiss., Nat. Klasse, II, 1851; Appun, Wanderungen Venezuela, Orinoco, British Guiana u. am. Amazon, Bd. I, Jena, 1871, 480.

Gymnotus Seba, Thesaur., III, 108, tab. XXXIV, 1758; Gronovius, Art. Helvet., IV, 1762, 27, tab. 3, fig. i–iii; Musschenbroek, Introd. Philos. Nat. Lugd. Batav., I, 290, 1762; Gronovius, Zoolphyl., 41, No. 169, 1763; Schilling, Neue Abhand. Akad. Berlin, 1770, 68; Musschenbroek, in Rozier, Jour. Phys., 1776, 331; Le Roy, Observ. Mem. Phys., VIII, 331, 1776.

Gymnotus electricus Linnæus, Syst. Nat., ed. XII, Vol. 1, 427, 1766; Williamson, Phil. Trans., LXV, 94, 1775; Garden, l. c., p. 102; Hunter, l. c., p. 395, pls. 1–4; Bloch, Natgesch. Ausländ. Fische, II, 43, taf. 156, 1785; Bryant, Trans. Amer. Philos. Soc., II, 166, 1786; Flagg, Observ. Trans. Amer. Phil. Soc., II, 170, 1786; Guisan, Bull. Sc. Soc. Philom., Vol. I, 32, 1797; Lacépède, Hist. Nat. Poiss., II, 146, pl. 6, fig. 1, 1798; Fahlberg, Kongl. Vetensk. Ak. Ny Handl., Tom. XXII, 122–156, 1801; St. Hilaire, Ann. Mus. Hist. Nat., I, 1–15, 1802; Humboldt, Versuche elect. Fische, 1806; idem, Recuel. Observ. Zool. Anat., Vol. I, 49, 1811; Cuvier, Règne Animal, IV, 236, 1817; Humboldt, Voy. Region Equinox. Nov. Continent, Paris, II, 1819; Guisan, Commt. Gymnoto electrico, Tübingen, 1819; Knox, Edinb. Journ. Sci., I, 96, 1824; Bradley, Charlesworth's Mag. Nat. Hist., II, 668, 1838; Faraday, Philos. Trans., pl. 1, 1839; Schönbein, Beobach. Zitteraales, Basel, 1841; Valentin, Neue Denksch. Allgem. Schweitz. Gesell., VI, pl. 5, 1842; Schomburgk, Fishes Guiana, Part II, 1843, 173 (Rio Negro); Miranda, Exp. sul Gimnoto electrico, Napoli, 1845; Owen, Comp. Anat. Physiol. Vert., part I, London, 1846; Valenciennes, Les Poissons, 110, 1847; Delle Chiaje, Nuov. Ann. Sc. Nat. Bologna, VIII, 5 plates, 1847; Pacini, Sulla electrico Gimnoto, 35, Firenze, 1852; Gronow, ed. Gray, 23, 1854; Kupffer & Keferstein, in Henle & Pfeifer, Zeitsch. f. rat. Med., II, 344, 1858; Jobert, Appareil Poissons Elect., Paris, pl. VII–XI, 1858; Kaup, Apod. Brit. Mus., 124, 1856; *idem*, Wiegm. Arch., XXII, Bd. 1, 1856; Schultze, Abhandl. Naturf. Gesell. Halle, IV, 35, pl. II, 1858; Darwin, Origin of Species, 192, 1859; Steindachner, Gymnotidæ, 14, 1868 (Rio Jacutu; Rio Branco; Rio Guaporé); Günther, Cat. Fish. Brit. Mus., VIII, 10, 1870 (Brazil and Guianas); Wallace, Geograph. Distribution, Lond., Vol. II, 455, 1876; Peters, Mb. Akad. Wiss. Berlin, 1878 (Apuré); Sach, Aus den Llanos, Berlin, 1878 (Apuré); *idem*, Untersuch. am Zitteraal, Leipzig, 1881 (Apuré); Fritsch, Anhang I, Sachs, Zitteraal, 1881; idem, Anhang II; Goeldi, Peixes do Amazonas e Guayanas, 1894; Hargreaves, Fishes of British Guiana, 1904; Pellegrin, Poissons de Guyane Franc., 1908.

Electrophorus electricus Gill, Proc. Acad. Nat. Sci. Phila., 151, 1864; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 61, 1891; Quelch, Nature,

Vol. 55, 508, 1897 (Waini River, Brit. Guiana); von Ihering, Revista Mus. Paulista, 286, 1907 (Amazonia, Guyana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449.

Gymnotus regius Delle Chiaje, N. Ann. Sc. Nat. Bologna, VIII, 1847.

1302 C. M., three, 650 to 825 mm. Tumatumari, Brit. Guiana, Eigenmann.

1754 C. M., 12635 I. U. M., three, 190–580 mm. Creek below Potaro Landing, Brit. Guiana, Shideler.

1755 C. M., one, 460 mm. Pacopoo Pan, Brit. Guiana, Grant.

5100 I. U. M., one, 330 mm. Brazil.

One specimen, Hubabu Creek, Brit. Guiana, Oct. 1, 1910, Ellis.

Head 8 to 9.2; depth 14.5 to 16 in the length to the end of the anal; anal rays 357, 362, 324, in three specimens. Snout about 3.5, interorbital a little less, in the head; eye 5 to 5.2 in the snout, and 15 or 16 in the head.

Body cylindrical, elongate, naked; head depressed; width of the head about equal to, and depth a little less than, the greatest depth of the body; anus a little more than the length of the snout behind the vertical from the eye in front of the pectorals; ventral and dorsal profile almost straight.

Snout heavy and broad; mouth large; gape moderately long, but not quite reaching to below the eye; lower jaw protruding; teeth small, conical, a single row in each jaw; eyes small, without free orbital margin.

Origin of the anal about the length of the head behind the pectorals; anal fin of uniform width and continuing around the end of the tail so as to form a false caudal; pectorals small, fan-shaped, 2.8 to 3.5 in the head.

Ground-color in life olive-green or dark blue to almost black; ventral parts of head and pectoral region light yellow to orange-red; fins dark, fringed with hyaline.

This species is occasionally used for food by the Indians. It is rather generally avoided by the natives on account of the powerful electric shock it can give, that of an eel five feet long being sufficient to knock a man down.

The maximum size for this species, recorded from British Guiana, is seven feet four inches. This specimen was taken by Mr. J. J. Quelch from the Waini River, British Guiana, in 1897, and the skin is now in the Georgetown Museum.

Habitat: Pools and deeply shaded places in small streams and creeks.

Distribution: Orinoco, Guianas, and the Lower and Middle Amazon Systems.

II. Gymnotus Linnæus.

Gymnotus Linnæus, Syst. Nat., ed. X, 246, 1758; ed. XII, 1, 427, 1766.

Type, *Gymnotus carapo* Linnæus.

Size moderate, not exceeding 600 mm. in length. No frontal fontanel; no caudal fin; a caudal filament, no electrical organ; cylindrical anteriorly, somewhat compressed posteriorly; head large and depressed, the top quite flat; gape not reaching the eyes; lower jaw protruding; teeth small, conical, in one row (which

is sometimes a little irregular) in each jaw; eyes small and covered by a membrane, without free orbital margin; scales cycloid and very small; lateral line complete and paralleling the main axis of the body; pectorals small; anal long, its origin back of the vertical from the tip of the pectoral.

A genus of a single species.

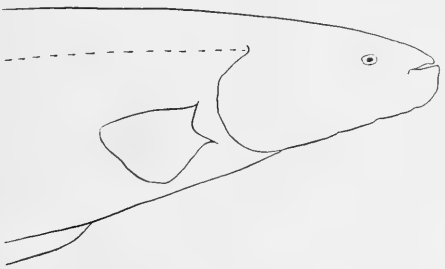


Fig. 2. *Gymnotus carapo* Linnæus.

2. Gymnotus carapo Linnæus.

Carapo Marcg., Hist. Pisc., 170; Willoughby, Hist. Pisc., 115, tab. G 7, fig. 4.

Gymnotus Seba, Thesaur., III, tab. 32, fig. 1.

Gymnotus carapo Linnæus, Syst. Nat., ed. X, 246, 1758; *idem*, ed. XII, i, 427, 1766; Bloch, V, 59, tab. 157, fig. 2; Gronow, Syst., ed. Gray, 22, 1854; Gill, Proc. Acad. Nat. Sci., Phila., 151, 1864; Miller, Bull. Am. Mus. Nat. Hist., Vol. XXIII, 1907 (Los Amates and Puerto Barrios, Guatemala); Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 666, 1907 (Amazon); Meek, Bull. Field Mus. (Zool. Series Pub. No. 124), Vol. VII, No. 5, 1907 (Los Amates and Lake Amatitlan, Guatemala); *idem*, Bull. Field Mus. (Zool. Ser. Pub., 127), Vol. VII, No. 6, 1908 (Lake Amatitlan, Guatemala).

Gymnotus fasciatus Pallas, Spicil. Zool., VII, 35; Schomburgk, Fishes of Guiana, 184, pl. 19, 1843 (Rio Branco).

Carapus fasciatus Cuvier, Règne Animal, ed. I, 237, 1817; Müller and Troschel, Horæ Ichthyol., III, 13, 1849; Castelnau, Anim. Amer. Sud., 85, 1855 (Amazon); Kaup, Apod., 139, 1856; Steindachner, Die Gymnotidæ, 13, 1868 (Caiçara, Cuyaba, Marabitanos, Surinam, Matto Grosso); Günther, Cat., VIII, 9, 1870 (Capim, Bahia, Surinam, British Guiana, Essequibo, Berbice, Trinidad, Is. Grenada, Rio Motaguæ); Hensel, Wiegm. Archiv, 89, 1870 (Guahyba, Porto Alegre); Cope, Proc. Am. Philos. Soc., 1870, 570 (Pebas); Cope, Proc. Acad. Nat. Sci. Phila., 1871 (1872), 257 (Ambyiacu); Lütken, Velhas Flodens Fiske, 247, and XIX, 1874 (Rio das Velhas; Lagoa Santa and Rio San Francisco); Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Boulenger, Proc. Zool. Soc., 1887, 282 (Canelos); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Perugia,

Ann. Mus. Civico Storia Nat. Genova, 2d ser., Vol. X, 56, 1891 (Central Chaco); Eigenmann, Ann. N. Y. Ac. Sci., VII, 1894, 626 (Braret); Eigenmann, *l. c.*, 635 (Rio Grande do Sul); Cope, Proc. Am. Philos. Soc., 1894, 93 (Rio Grande do Sul); Boulenger, Boll. Torino, X, 3, 1895 (Colonia Risso and Villa Rica, Paraguay); Boulenger, Ann. Mus. Civico, Genova, 1898, 127 (Puerto, 14 de Mayo).

Giton fasciatus Kaup in Dumeril, Analyt. Ichthyol., 201, 1856; Jordan and Evermann, Fishes North and Mid. Amer., 340, 1896 (Guatemala to Rio de la Plata); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1894, 530 (Estancia La Armonia; Campo Grande; Arroyo Trementina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 177 (Rio Motagua to Rio Plata); von Ihering, Os Peixes do Brazil, Part 1 A, 278, 1907 (Ilha-de-S. Sebastião; Rio Doce).

Giton fasciatus var *pantherinus* Steindachner, Akad. Anz., Nr. VIII, März, 1908 (Santos).

Gymnotus albus Pallas, Spicil. Zool., VII, 36, Surinam; Bloch and Schneider, 523, 1801.

Carapus albus Kaup, Apod., 140, 1856.

Gymnotus brachyurus Bloch, Taf. 157, fig. 1, 1787.

Gymnotus putaol Lacépède, Hist. Nat. Poiss., ii, 176, 1800.

Gymnotus carapo Bloch and Schneider, 521, 1801.

Carapus brachyurus Cuvier, Règne Animal, I, 237, 1817.

Carapus inæquilabiatus Valenciennes, in d'Orb. Voy. Am. Merid., Poiss., 11, pl. 14, 1847 (La Plata).

1776 C. M., 12622 I. U. M., thirty-four, 80 to 435 mm. Holmia, Eigenmann.

1777 C. M., 12623 I. U. M., thirty-two, 80–340 mm. Nickaparoo Creek, Wm. Grant.

1778 C. M., 12624 I. U. M., eighteen, 65–310 mm. Creek below Tukeit, Eigenmann.

1779 C. M., 12625 I. U. M., fifteen, 80–380 mm. Aruataima, Eigenmann.

1780 C. M., 12626 I. U. M., twelve, 51–90 mm. Tukeit, Eigenmann.

1781 C. M., 12627 I. U. M., six, 59–105 mm. Below Packeoo Falls, Wm. Grant.

1782 C. M., 12628 I. U. M., four, 125–198 mm. Gluck Island, Eigenmann.

1783 C. M., 12629 I. U. M., five, 130–176 mm. Kumaka, Eigenmann.

1784 C. M., 12630 I. U. M., five, 132–205 mm. Mud Flats, Aruka River, Shideler.

1785 C. M., 12631 I. U. M., five, 80–115 mm. Creek on the Barima River, Shideler.

1786 C. M., 12632 I. U. M., seven, 125–162 mm. Above Kumaka, Eigenmann.

1787 C. M., one, 190 mm. Packeoo Falls, Wm. Grant.

1788 C. M., one, 320 mm. Georgetown Trenches, Eigenmann.
1789 C. M., one, 230 mm. Botanic Garden, Shideler.
1790 C. M., one, 240 mm. Chipoo Creek, Wm. Grant.
1791 C. M., one, 260 mm. Maripieru, Wm. Grant.
3089 C. M., four, 130–290 mm. Santarem, Dec. 11, 1909, Haseman.
3090 C. M., two, 140–220 mm. Puerto Suarez, Bolivia, May 6 and 7, 1909, Haseman.
3091 C. M., five, 120–380 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3092 C. M., two, 100–110 mm. S. Luiz de Caceres, May 23, 1909, Haseman (var. *pantherinus*).
3093 C. M., two, 180–240 mm. Cubatoa, Aug. 1, 1908, Haseman.
3094 C. M., one, 130 mm. Aqua Quente, Nov. 27, 1908, Haseman.
3095 C. M., two, 75 and 95 mm. Raiz do Serra, Rio Mogy, July 26, 1908, Haseman.
3096 C. M., one, 90 mm. Iporanga, São Paulo, Dec. 1, 1908, Haseman.
3097 C. M., one, 160 mm. Morretes, Jan. 3, 1909, Haseman.
3098 C. M., one, 180 mm. Penredo, March 22, 1908, Haseman.
3099 C. M., ten, 100–220 mm. Rio das Velhas, May 13, 1908, Haseman.
3100 C. M., fifteen, 50–130 mm. Campos, June 14, 1908, Haseman.
3101 C. M., ten, 60–145 mm. Entre Rios, July 2, 1908, Haseman.
3102 C. M., two, 130–140 mm. Cacequy, Jan. 31, 1909, Haseman.
3103 C. M., two, 110–200 mm. Cachoeira, Jan. 29, 1909, Haseman.
3104 C. M., three, 130–170 mm. Rio Parahyba, Haseman.
3105 C. M., five, 170–210 mm. Rio Coite, Nov. 6, 1907, Haseman.
3106 C. M., four, 110–170 mm. Xiririca, São Paulo, Dec. 5, 1908, Haseman.
3107 C. M., two, 140–143 mm. Rio Ribiera da Iguape, Dec. 15, 1908, Haseman.
3108 C. M., one, 180 mm. Uruguayana, Feb. 7, 1909, Haseman.
3109 C. M., one, 230 mm. Lagoa Feia, Tocas, June 27, 1908, Haseman.
3110 C. M., one, 130 mm. Aqua Quente, Nov. 22, 1908, Haseman.
3111 C. M., two, 130–210 mm. Barra da Pirahy, July 12, 1908, Haseman.
10299 I. U. M., one, 195 mm. Corumbá.
10062 I. U. M., one, 280 mm. Arroya Trementina.
11239 I. U. M., one, 180 mm. Puerto Barrios, Guatemala.
11307 I. U. M., two, 140–150 mm. Trinidad.
10061 I. U. M., one, 205 mm. Campo Grande.
4896 I. U. M., two, 105–145 mm. Rio Grande do Sul, von Ihering.
1937 I. U. M., one, 150 mm. Rio Paraguay.
11238 I. U. M., one, 150 mm. Los Amates, Guatemala.
11240 I. U. M., five, 110–150. Near Los Amates, Guatemala.
Five specimens, 100–250 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
3112 C. M., one, 150 mm. Hubabu Creek, Oct. 1, 1910, Ellis.

Head 7.25 (old individuals) to 11 (young specimens), depth 8.5 to 14 in the length to the end of the anal; anal rays 200 to 260.[2]

Snout 2.5 to 3; interorbital 2.25 to 3 in the head; eye 4 (young) to 7 in the snout, 4.25 to 6 in the interorbital, 10 to 6 in the head.

Body cylindrical; head depressed; width of the head 1.25 to 1.6, depth of the head at the base of the occipital process 1.3 to 1.8 in the greatest depth; anus near the vertical from a point the length of the snout behind the eye; dorsal profile almost straight; ventral profile slightly convex.

Snout very slightly pointed in young specimens, blunt in adults; mouth rather large; gape straight, reaching about two-thirds of the distance to almost below the eye; upper jaw included; caudal peduncle one-half the length of the snout or less; pectorals 2.25 to 3 in the head; origin of the anal behind pectorals on the vertical from a point about 1.5 times the snout behind the head.

Ground-color of alcoholic specimens varies from a light slate-gray in young specimens to a light orange in adults; a series of transverse white stripes crossing the body in young individuals, which widen and become yellow with age so that the adults are yellow, barred with black; dorsal parts washed with a dark chocolate-brown containing numerous black spots; fins translucent, mottled with black or brown.

In life the body is a translucent flesh-color or pale yellow, varying to a distinct pink in the parts rich in blood. The stripes and markings are blue or green, giving the fish a purplish or olive-green cast. This color may be deepened or lightened slightly by the expansion and contraction of the chromatophores.

The general marking of the species varies considerably, specimens from clear water being darker and more striped than those from muddy water. Some specimens from Guatemala and from the Upper Paraguay are almost without markings.

This fish is eaten throughout South and Central America, but is only prized as a food-fish in Guatemala, where it is rather rare. The Guiana Indians, who know it as the "Warradeela" or "Warraderra,"—Tiger-fish, consider it very good and take it often when poisoning fishes in the dry season, though it is rarely used for food by the whites of Guiana. It is also frequently used for food in Paraguay.

Through Brazil it is variously known as "Felis onca," "Ardea cocoi," "Jacana jacana" and "Carapo." It sometimes reaches the length of three feet.

Habitat: Small, shaded creeks, in slow water.

Distribution: Guatemala, south to the Rio de La Plata, and west to the Andes.

[2] Barima	208	217	218	224	256
Kumaka	212	224	228	240	254
Aruataima	200	215	216	230	260
Nickaparoo	211	217	225	240	260
Holmia	207	220	225	235	245

III. Sternopygus Müller and Troschel.

Gymnotus (in part) Linnæus, Syst. Nat., ed. XII, i, 427, 1766.
Sternopygus Müller and Troschel, Horæ Ichthyol., III, 13, 1849.

Type, *Gymnotus macrurus* Bloch and Schneider.

Readily distinguished from all the other Gymnotids by the free orbital margin. A frontal fontanel, a caudal filament, no caudal; snout short; head large, gape moderate, curved downward and back; jaws equal, or nearly so, upper overhanging on the sides; teeth minute, conical, in two patches more or less confluent (becoming a single patch in older individuals) on the upper jaw, and a single large patch on lower jaw; air-bladder long and conical. Size moderate to rather large; body compressed; maximum depth in the region of the pectorals. Scales cycloid, rather small; lateral line complete, following axis of the body. Origin of the anal in the pectoral region; caudal peduncle moderately long.

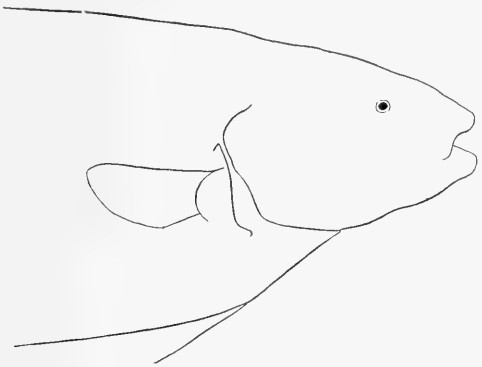


Fig. 3. *Sternopygus macrurus* (Bloch and Schneider).

Species of Sternopygus.

a. Snout pointed, upper profile nearly straight; anal not exceeding three hundred rays. . . . . **macrurus.**
aa. Snout very blunt, upper profile distinctly convex; anal having more than three hundred rays. **obtusirostris.**

3. Sternopygus macrurus (Bloch and Schneider).

Gymnotus macrurus Bloch and Schneider, 522, 1801.
Sternopygus macrurus Müller and Troschel, Horæ Ichthyol., III, 14, 1849; Kaup, Apod., 137, 1856; Steindachner, Die Gymnotidæ, ii, 1868 (Surinam; Rio Branco; Borba; Caiçara); Cope, Proc. Acad. Nat. Sci. Phila., 1871, 257, 1872 (Ambyiacu); *id.*, Proc. Am. Philos. Soc., 1878, 57 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Orinoco, south to Paraguay; Rio das Velhas).
Sternopygus carapus Günther, Cat., VIII, 7, 1870; Lütken, Velhas Flodens

Fiske, 247, and XIX, 1875 (Rio das Velhas); Peters, Mb. Akad. Wiss. Berlin, 1877, 473 (Apuré); Steindachner, Fisch-f. Magdalenen Str., 4, 1878 (Pará); Boulenger, Proc. Zool. Soc., 1887, 282 (Canelos); Steindachner, Flussf. Südam., II, 44, 1881 (Amazon from Pará to Teffé; Xingu at Porto do Moz; Lake Manacapuru; Rio Branco; Borba; Caiçara; Essequibo; Surinam; Maroni River in Guiana); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Perugia, Ann. Mus. Civico Storia Nat. Genova, Ser. 2, Vol. X, 56, 1891 (Central Chaco); Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 626 (Marajo); Boulenger, Trans. Zool. Soc., XIV, 38, 1896 (Paraguay).

Gymnotus carapus Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 175 (Orinoco, south to Paraguay; Rio das Velhas); von Ihering, Os Peixes do Brazil, Part 1 A, 284 (Venezuela, Amazonas, Brazil Central).

Gymnotus æquilabiatus Humboldt, Recueil d'Observat., Zool. et Anat. Comp., i, 46, pl. 10; Kaup, Apod., 142, 1856; Günther, Cat. VIII, 7, 1870; Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 176 (Magdalena and Guayaquil).

Sternopygus æquilabiatus Müller and Troschel, Horæ Ichthyol., III, 15, 1849; Steindachner, Fisch-f. Magdalenen Str., 53, pl. XIV, fig. 1, 1878 (Magdalena River); *id.*, Fisch-f. Cauca and Guayaquil, 36 and 50, 1880 (Cauca and Guayaquil); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Boll. Univ. Torino, XIII, 1898 (Rio Guayas); Steindachner, Denkschr. Acad. Wiss. Wien, LXII, 59, 1902 (Rio Magdalena at Baranquilla); Starks, Proc. U. S. Nat. Mus., XXX, 1906 (Guayaquil); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Magdalena and Guayaquil).

Gymnotus æquilabiatus nigriceps von Ihering, Os Peixes do Brazil, Part 1 A, 285 (Maranhao).

Sternopygus æquilabiatus nigriceps Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Maranhão).

Carapus macrourus Cuvier, Règne Animal, ed. I, II, 237, 1817.

Carapus arenatus Eydoux and Souleyet, Voy. Bonite, Zool., I, p. 210, pl. 8, fig. 2, 1836.

Carapus sanguinolentus Castelnau, Anim. Am. Sud. Poiss., 85, pl. 32, fig. i, 1855 (Urubamba or upper Ucayale).

Sternopygus marcgravii Reinh., Vidensk. Meddel. Naturh. Foren. Kjöbenh., 1852; and Wiegm. Arch., 1854, 180.

1764 C. M., 12541 I. U. M., 104, 155–500 mm. Botanic Garden, Shideler.

1765 C. M., 12592 I. U. M., eighteen, 200–400 mm. Georgetown Trenches, Eigenmann.

1766 C. M., 12593 I. U. M., ten, 150–450 mm. Creek below Potaro Landing, Eigenmann.

1767 C. M., 12594 I. U. M., nine, 65–390 mm. Amatuk, Eigenmann.
1768 C. M., 12595 I. U. M., ten, 118–212 mm. Wismar, Eigenmann.
1769 C. M., 12596 I. U. M., eight, 111–212 mm. Crab Falls, Eigenmann.
1770 C. M., 12597 I. U. M., six, 90–100 mm. Erukin, Eigenmann.
1771 C. M., 12598 I. U. M., three, 115–378 mm. Warraputa, Eigenmann.
3113 C. M., one, 170 mm. Rio das Velhas, May 13, 1908, Haseman.
3114 C. M., three, 190–200 mm. Salto das Cruzes, Rio Tieté, Sept. 22, 1908, Haseman.
3115 C. M., one, 220 mm. Campos, June 15, 1908, Haseman.
3116 C. M., four, 300–350 mm. Penedo, March 22, 1908, Haseman.
3117 C. M., one, 400 mm. Joazeiro, Rio San Francisco, Nov. 28, 1907, Haseman.
3118 C. M., one, 450 mm. Pirapora, Dec. 15, 1907, Haseman.
3119 C. M., seven, 130–380 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3120 C. M., five, 110–175 mm. Rio Jaurú, June 2, 1909, Haseman.
3121 C. M., four, 90–260 mm. Caceres, May 24, 1909, Haseman.
3122 C. M., six, 130–430 mm. Santarem, Dec. 15, 1909, Haseman.
3123 C. M., one, 155 mm. Bastos, June 26, 1909, Haseman.
6316 I. U. M., one, 240 mm. South America.
5091 I. U. M., one, 280 mm. Isl. of Marajo, Brazil.
10300 I. U. M., two, 130–270 mm.
1772 C. M., 12599 I. U. M., six, 128–350 mm. Mud Creek, Aruka River, Shideler.
1773 C. M., 12600 I. U. M., two, 180–195 mm. Konawaruk, Eigenmann.
1774 C. M., one, 430 mm. Issora Rubber Station trenches, Shideler.
1775 C. M., one, 215 mm. Waratuk, Eigenmann.
Ten, 250–370 mm. Georgetown, Sept. 30, 1910, Ellis.
Fourteen, 190–300 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
3124 C. M., three, 200–250 mm. Hubabu Creek, Oct. 1, 1910, Ellis.

Head 6.8 to 7.25, depth 7 to 7.3 in the length to the end of the anal; anal rays 245–299.[3]

Snout 2.75 to 3, interorbital about 3 in the head; eye 3.75 to 4 in the snout, about 4 in the interorbital, and 10 to 13 in the head.

Compressed; width of the head 2 to 2.25, depth of the head in the occipital region 1.8 to 1.5 in the greatest depth; anus about twice the eye behind the vertical from the eye; dorsal profile weakly convex, ventral slightly more convex than

[3] Seventeen specimens taken at random have the anal rays as follows:
Botanic Garden, 256, 270, 270, 277, 278.
Georgetown Trenches, 249, 254, 263, 264, 271, 290.
Potaro Landing, 245, 250, 265, 272, 269.
Issora Rubber Station, 273.

dorsal. Snout heavy, rather pointed, but truncate at the tip; mouth moderate, gape reaching about half-way to the eyes; jaws equal, lower included on the sides.

Caudal peduncle 4.5 to 5 in the total length; pectorals about twice the snout behind the eye.

Ground color of preserved specimens stone-gray to buff; body closely pigmented with minute purple spots, which are more abundant dorsally; a yellowish white lateral streak of variable intensity and width (being almost wanting in some specimens) beginning a little ventrad of the lateral line, at a point about half the total length from the head and continuing well out on the caudal appendage; generally a blue-black spot about twice the size of the eye at the origin of the lateral line; head rather dark above; fins hyaline.

Living specimens are quite translucent, so much so that the backbone and viscera may be seen in outline. The muscles are clear, transparent, appearing bright red on account of the blood contained. With the blue chromatophores and yellow epidermis the general color of the fish changes to orange quite readily. (See Color-changes.) Some specimens from Potaro Landing and others from Aruka and Amatuk were very much darker than the average. Since the ground-color was darker (a dark blue) the lateral stripe appeared more strikingly white in these specimens.

S. macrurus is eaten by the natives and travellers, although it is not a market-fish. It has a very good flavor and rather solid meat. The species of *Sternopygus* and those of *Eigenmannia* are not differentiated by the natives, since the living fishes look very much alike; in fact *Sternopygus macrurus* and *Eigenmannia virescens* can scarcely be separated at a glance in the field. Accordingly these fishes are all grouped under one name: "Cuchillo" or "Cuchilla" in the Spanish-speaking countries, and "Sabre" in French Guiana on account of their "knife-like" shape. Similarly the coolies and natives of British Guiana know these fishes as the "Loga-Loga" or "Laga-Laga." In Ecuador the names "Raton negro" and "Bio" are given to *Sternopygus* alone. The maximum size as given by Humboldt is about three feet.

Habitat: Streams in open or savannah country, trenches, and ditches on plantations.

Distribution: Orinoco, Guiana, Amazons, Rio San Francisco, Rio Magdalena, and west coast of Ecuador.

4. **Sternopygus obtusirostris** Steindachner.

Sternopygus obtusirostris Steindachner, Flussf. Südam., II, 43, pl. II, fig. 3, 1881 (Amazon at Teffé, Lago Alexo, Manacapuru, Rio Madeira, Rio Puty); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450.

Gymnotus obtusirostris Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 177 (Amazons and Rio Puty); von Ihering, Os Peixes do Brazil, Part 1 A, 286 (Rio Amazonas, *curso media*).

The following is extracted from Steindachner's original account.

"Snout 3 in the head; eye 7.5 to 10.5 in the head, 2 to almost 4 in the snout, depth of the head about 1.4 (more than 1.3) in the length of the head; head 9.5 to 11 in total length.

"Eye with a free lid, its diameter in young individuals twice the interocular distance, in old specimens about three times the interocular.

"Anal begins slightly in front of the vertical from the base of the pectoral and contains more than three hundred rays.

"The head of this species is noticeably deeper, the snout shorter in profile and more strongly arched than in *Sternopygus carapo* = (*Sternopygus macrurus*)."

It seems quite probable that this species may be but a variety of *Sternopygus macrurus*.

Distribution: Middle Amazons and Rio Madeira; north coast of Brazil.

IV. Eigenmannia Jordan and Evermann.

Sternopygus Müller and Troschel, Horæ Ichthyol., III, 13 (Species).
Cryptops Eigenmann, Ann. N. Y. Acad. Sci., VII, 626 (*humboldtii*). (Preoccupied.)
Eigenmannia Jordan and Evermann, Fishes North and Mid. Amer., I, 341, 1896 (Substituted for Cryptops).

Type, *Sternopygus humboldtii* Steindachner.

Distinguished from *Sternopygus* by the absence of a free orbital margin. With fontanels; no caudal; snout short. Size moderate, not exceeding 400 mm. in length; body elongate and compressed; maximum depth and thickness in the region of the pectorals; head moderate to small, and rather short; gape small, curved downward and back; jaws equal, the lower included on the sides; teeth in two lateral patches in the lower jaw and two almost confluent median patches in upper jaw; mouth rather small; eyes medium, covered by a transparent membrane. Scales cycloid; lateral line complete. Origin of anal back of the vertical from the origin of the pectorals; caudal appendage moderate to quite long.

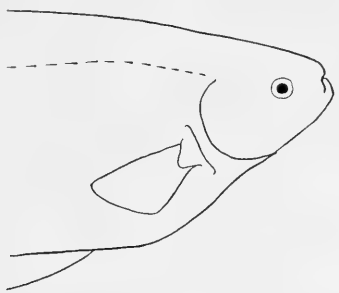


Fig. 4. *Eigenmannia virescens* (Valenciennes).

Species of Eigenmannia.

a. Maxillary shorter than diameter of the eye; eye large; caudal filament long and ribbon-like, equal to about half the total length without the head. . . . . **macrops.**

aa. Maxillary about equal to the diameter of the eye; eye medium; caudal filament cylindrical, less than half the length of the anal. . . . . **virescens.**

aaa. Maxillary about twice the diameter of the eye; eye small; caudal filament less than half the length of the anal. . . . . **troscheli.**

5. Eigenmannia macrops (Boulenger). (Plate XXII, fig. 1.)

Sternopygus macrops Boulenger, Ann. Mag. Nat. Hist. (6), XX, 305 (Potaro River, British Guiana).

Eigenmannia macrops Eigenmann and Ward, 1905, Proc. Wash. Acad. Sci., Vol. VII, p. 172 (Potaro(?) River, British Guiana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Potaro, British Guiana).

1804 C. M., 12601 I. U. M., thirty-two, 165–200 mm. Rockstone, Eigenmann.
1805 C. M., 12602 I. U. M., twelve, 165–180 mm. Tumatumari, Eigenmann.
1806 C. M., 12603 I. U. M., twelve, 125–150 mm. Crab Falls, Eigenmann.

Head 8.25 to 9; depth 6.6 to 7.5 in the length to the end of the anal; anal rays 170–194.[4]

Snout 3.2 to 3.4, interorbital about 3.3 in the head; eye equal to or a little greater than either the snout or the interorbital and 3 or a little less in the head.

Body and head compressed; width of the head 2.25 to 2.5, depth of the head in the occipital region 1.6 to 1.8 in the greatest depth; anus on, or slightly in front of, the vertical from the posterior margin of the eye; dorsal profile almost straight; ventral profile of the head sloping caudad at an angle of 45°; the body tapering; snout short and pointed; mouth very narrow; gape quite short; upper jaw overlapping lower; teeth present in both jaws; eyes large, greater than maxillary.

Caudal peduncle narrow, ribbon-like, equal to about half the total length without the head; pectorals about twice the eye; origin of the anal slightly behind the base of the pectorals, on a vertical from a point about the length of the snout behind the head.

Ground-color pale yellowish brown to almost yellow; origin of the anal rays, the scales of the lateral line and most of the dorsal scales more or less outlined with black; a narrow median dorsal streak of dark brown or black; top of head blue-black; fins hyaline.

Living fishes of this species are quite translucent, the viscera and backbone being visible in outline. General color pink to light red, due to the blood showing through the colorless muscle tissue.

This species, the "Loga Loga," has no food value, being too small. The largest specimen known is 200 mm., taken by Dr. Eigenmann from Rockstone, British Guiana. It is known only from the interior streams of British Guiana.

[1] Rockstone.	176	178	179	181	194
Tumatumari.	170	174	182	183	184

6. **Eigenmannia virescens** (Valenciennes).

Sternarchus virescens Valenciennes, in d'Orb., Voy. Am. Merid., Poiss., ii, pl. 13, fig. 2, 1847.

Sternopygus virescens Müller and Troschel, Horæ Ichthyol., III, 14, 1849 (Guiana); Kaup, Apod., 137, 1856; Steindachner, Die Gymnotidæ, 12, 1868 (Matto Grosso, Rio Negro, Guaporé, Marabitanos, Irisanga); Günther, Proc. Zool. Soc., 1868, 229 (Xeberos); Günther, Cat., VIII, 7, 1870 (Surinam, Lagoa Santa, Xeberos); Cope, Proc. Am. Philos. Soc., 1870, 570 (Pebas, Rio Paraná); Cope, Proc. Acad. Nat. Sci. Phila., 1871, 257 (Ambyiacu); Lütken, Velhas-Flodens Fiske, 247 and XIX, 1875 (Lagoa Santa and Rio das Velhas); Peters, Mb. Ak. Wiss. Berlin, 1877, 473 (Apuré); Steindachner, Fisch-f. Magd. Stromes, 55, pl. XIV, fig. 4, 1878; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Cope, *l. c.*, 1894, 93 (Rio Grande do Sul); Boulenger, Trans. Zool. Soc., XIV, 38, 1894 (Descalvados).

Cryptops virescens Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 626; Eigenmann, *l. c.*, 635 (Rio Grande do Sul); Boulenger, Boll. Torino, X, 3, 1895 (Colonia Risso, Paraguay); Boulenger, Ann. Mus. Civico, Genova, 1898, 127 (Puerto 14 de Mayo).

Eigenmannia virescens Eigenmann and Norris, Revista Mus. Paulista, IV, 549 (Piracicaba); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 530 (Arroya Trementina, Paraguay); Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 172 (Rio Magdalena to Rio de la Plata, east of the Andes); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Rio Magdalena to Rio de la Plata, east of Andes).

Sternopygus lineatus Müller and Troschel, l. c., III, 14, 1849, Lake Amucu in Guiana; Kaup, Apod., 138; Steindachner, Die Gymnotidæ, 261, 1868.

Cryptops lineatus Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 635 (Rio Grande do Sul).

Sternopygus tumifrons Müller and Troschel, Horæ Ichthyol., III, 14, 1849 (South America).

Sternopygus microstomus Reinhardt, Vidensk. Meddel. Naturh. For. Kjöbenh., 1852 or Wiegm. Arch., 1854, 181.

Sternopygus limbatus Schreiner and Ribeiro, Arch. Mus. do Rio de Janeiro, XII, 6, 1902 (Amazonas).

Sternopygus humboldtii Steindachner, Fisch-f. Magd. Str., 55, pl. XIV, 1878 (Magdalena); *id.*, Flussf. Südam., I, 21, 1879 (Mamoni R. at Chepo); *id.*, Fischfauna Cauca and Guayaquil, 36, 1880 (Cauca); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Steindachner, Denk. Akad. Wiss. Wien, LXXII, 147, 1902 (Baranquilla on Rio Magdalena).

Cryptops humboldtii Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Marajo).

Eigenmannia humboldti Jordan and Evermann, Fishes North and Mid. Amer.,

341, 1896; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 172 (Marajo, Magdalena, and Mamoni); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Marajo, Magdalena, Mamoni).

1744 C. M., 12605 I. U. M., one hundred and fifty-five, 105–300 mm. Botanic Garden, Georgetown, Shideler.
1745 C. M., 12606 I. U. M., twenty-six, 105–300 mm. Georgetown Trenches, Eigenmann.
1746 C. M., 12607 I. U. M., twenty-four, 110–180 mm. Demerara, Eigenmann.
1747 C. M., one, 80 mm. Rupununi, Grant.
1748 C. M., 12608 I. U. M., four, 120–150 mm. Warraputa, Eigenmann.
1749 C. M., 12609 I. U. M., five, 80–135 mm. Chipoo Creek, Grant.
1750 C. M., one, 190 mm. Wismar, Eigenmann.
1751 C. M., 12610 I. U. M., three, 80–160 mm. Maripicru, Grant.
1752 C. M., 12611 I. U. M., two, 130–190 mm. Creek below Potaro Landing, Shideler.
1753 C. M., one, 100 mm. Kangaruma, Shideler.
1742 C. M., 12604 I. U. M., twenty-nine, 155–290 mm. Wismar, Eigenmann.
1743 C. M., one, 130 mm. Kumaka, Demerara, Eigenmann.
3125 C. M., three, 125–230 mm. Aregua, Lake Ipacary, April 18, 1909, Haseman.
3126 C. M., one, 190 mm. Buenos Ayres, Feb. 20, 1909, Haseman.
3127 C. M., seven, 200–350 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3128 C. M., fourteen, 120–420 mm. Santarem, Dec. 12, 1909, Haseman.
3129 C. M., four, 105–300 mm. San Joaquim, Sept. 4, 5, and 6, 1909, Haseman.
3130 C. M., two, 150–195 mm. Sapina, São Paulo, July 23, 1908, Haseman.
3131 C. M., eight, 115–250 mm. Uruguayana, Feb. 7, 1909, Haseman.
3132 C. M., two, 150–230 mm. Corumbá, April 27, 1909, Haseman.
3133 C. M., one, 210 mm. Rio Mamoré, Sept. 19, 1909, Haseman.
3134 C. M., one, 275 mm. Puerto Suarez, Bolivia, May 6 and 7, 1909, Haseman.
3135 C. M., eight, 50–150 mm. Mogy Guassú, Aug. 25, 1908, Haseman.
3136 C. M., nine, 65–190 mm. Rio das Velhas, May 13, 1908, Haseman.
3137 C. M., thirteen, 100–188 mm. Pirapora, Dec. 15, 1907, Haseman.
3138 C. M., five, 100–130 mm. Sete Lagoas, May 5, 1908, Haseman.
3139 C. M., one, 175 mm. Lagoa Feia, June 16, 1908, Haseman.
3140 C. M., one, 125 mm. Salto das Cruzes, Sept. 22, 1908, Haseman.
3141 C. M., two, 130–145 mm. Cidade de Barra, Dec. 23, 1907, Haseman.
3142 C. M., one, 110 mm. Banhurii, Oct. 17, 1908, Haseman.
3143 C. M., four, 135–140 mm. Itapura, Sept. 27, 1908, Haseman.

3144 C. M., six, 160–205 mm. Campos, June 14, 1908, Haseman.
3145 C. M., one, 120 mm. Villa Bella, Rio Beni, Oct. 5, 1909, Haseman.
3146 C. M., four, 120–210 mm. São João de Barra, June 22, 1908, Haseman.
3147 C. M., six, 120–220 mm. Puerto Suarez, May 6 and 7, 1909, Haseman.
3148 C. M., nine, 50–150 mm. Santa Ritta, Jan. 24, 1908, Haseman.
3149 C. M., five, 110–190 mm. Barrieras, Lagoa of Rio Grande, Jan. 4, 1908, Haseman.
3150 C. M., two, 80–100 mm. Mogy Mirim, Creek of São Paulo, Haseman.
3151 C. M., four, 90–130 mm. Rio Jaurú, June 2, 1909, Haseman.
3152 C. M., three, 95–105 mm. Bastos, June 26, 1909, Haseman.
3153 C. M., one, 85 mm. Bebedouro, Sept. 1, 1908, Haseman.
3154 C. M., two, 90–100 mm. Bogularoa, near mouth of Rio Preto, Haseman.
3155 C. M., five, 100–150 mm. Lagoa de Paranagua, Jan. 16, 1908, Haseman.
3156 C. M., one, 100 mm. São Antonio da Rio Madeira, Aug. 11, 1909, Haseman.
3157 C. M., five, 105 to 140 mm. Caceres, May 24, 1909, Haseman.
3158 C. M., eleven, 65 to 190 mm. No label, Haseman.
3159 C. M., seven, 105–165 mm. Lagoa Pereira, Dec. 23, 1907, Haseman.
3161 C. M., two, 110–160 mm. Januaria, Dec. 12, 1908, Haseman.
3160 C. M., fourteen, 145–215 mm. Joazeiro, Nov. 28, 1907, Haseman.
3162 C. M., seven, 150–190 mm. Penedo, March 22, 1908, Haseman.
5088 I. U. M., one, 275 mm. Island of Marajo.
10303 I. U. M., one, 250 mm. Corumbá.
4895 I. U. M., two, 170 and 180 mm. Rio Grande do Sul.
10056 I. U. M., one, 125 mm. (estimated). Matto Grosso.
9281 I. U. M., one, 180 mm. Piracicaba.
10302 I. U. M., five, 60 to 80 mm. Corumbá.
10783 I. U. M., one, Santos, São Paulo, Brazil.
Thirty-five, 160–320 mm. Georgetown, Sept. 26, 1910, Ellis.
Five, 200–300 mm. Hubabu Creek, B. G., Oct. 1, 1910, Ellis.
3163 C. M., two, 210–230 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
3348 C. M., one, 250 mm. San Luiz de Caceres, May 23, 1909, Haseman.
3349 C. M., one, 110 mm. Villa Hays, Paraguay, April 13, 1909, Haseman.

Head 7 to 10.5; depth 5.2 to 7 in the length to the end of the anal; anal rays 185 to 224;[5] snout 3 to 3.25, interorbital 2.1 to 3.1 in the head; eye 1 to 2 in the snout, 1.25 to 3 in the interorbital and 3.5 or 6 to the head.

[5] Anal rays in twenty-six specimens.

Botanic Garden	185	188	194	197	
Warraputa	190	191	194		
Georgetown	187	196	197	198	
Wismar	208	210	218	220	224
Kumaka	210				
Joazeiro	200	208	212	216	
Penedo	207	211	212	216	220

Body and head compressed; width of the head 2.25 to 2.4, depth of the head, at base of the occipital process, 1.5 to 2 in the greatest depth; anus on or slightly behind the vertical from the posterior margin of the eye; dorsal profile regularly and moderately convex; ventral profile varying from rather weakly convex to markedly so.

Snout heavy, short and blunt; mouth moderate; gape short to medium; jaws about equal, the lower included on the sides, teeth present in both jaws; eyes small to medium. Caudal peduncle 3.25 to 4.75 in the total length; origin of the anal below, or slightly behind, the origin of pectorals; pectorals about 1.2 in the head.

Ground color of alcoholic specimens, buff; dorsal and dorso-lateral parts more or less overlaid with greenish brown, belly lighter; the lateral line and three stripes which parallel it dark (any or all of these stripes which are ventrad to the lateral line may vary considerably in width and intensity, may even be wanting); a black bar at the origin of each anal ray; fins hyaline; caudal peduncle blue-gray above and pale yellow below.

In life *Eigenmannia virescens* is quite translucent, and is of a bright reddish color. The head and pectoral regions are orange to yellow and the caudal appendage greenish. This species is capable of changing color to some extent (See discussion of color).

The markings of the different individuals vary considerably according to the presence or absence of the dark blue stripes above the anal fin. Specimens from clear water usually show well developed stripes and have the head much darker than those found in muddy water, and may have the anal fin fringed with dusky. The chromatophores are more numerous over the entire body of those from clear water.

This species is classed among the food-fishes, though it is not much sought after by the white people. The coolies of British Guiana seem particularly fond of this fish, which, with the other *Sternopygin*æ, they call the "Loga-Loga." In addition to the name "Cuchillo" or "Cuchilla" applied to it by most Spanish-speaking creoles, it is known as "Macana" and "Raton blanco" in the United States of Colombia and Venezuela, and "Tuviras" in Brazil. It is found abundantly in the trenches and ditches on the plantations, where it feeds among the weeds. Its natural habitat is in the small streams which flow through savannah or open country in the lowlands.

Because of its large range several varieties have been described as separate species, but these intergrade. "*Humboldti*" of Steindachner may be a distinct variety. It is found along the west coast and in the Rio Magdalena system. Specimens answering its description have been taken in Guiana and Brazil.

Distribution: Rio Magdalena and west coast south over the whole of eastern South America to the Rio de la Plata.

7. Eigenmannia troscheli (Kaup). (Plate XXII, fig. 2.)

Sternopygus troscheli Kaup, Apod., 139, 1856; Steindachner, Die Gymnotidæ, 12, 1868 (Barra do Rio Negro); Günther, Cat., VIII, 8, 1864; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Fisch-f. Magd., 56, 1878 (note); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Eigenmannia troscheli Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 174, 1905 (Amazonas from Manaos to Peru); Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 666, 1907 (Lower Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910 (Amazons, from Manaos to Peru).

Sternopygus axillaris Günther, Cat., VIII, 8, 1864 (Para); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Eigenmannia axillaris Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 174 (Para).

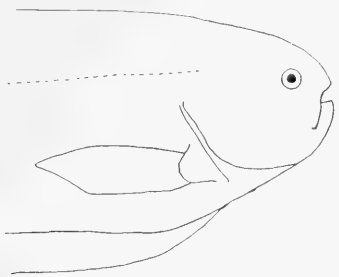


Fig. 5. *Eigenmannia troscheli* (Kaup).

3164 C. M., three, 100–180 mm. San Joaquim, Sept. 5, 1909, Haseman.

Head 7.25 to 8, greatest depth 6.25 to 7.25 in the length to the end of the anal; anal rays 210, 220, 224.

Snout 3.75 to 4, interorbital 3 to 3.75 in the head; eye 2 or a little more in the snout, not quite 2 in the interorbital, 8 or 9 in the head.

Body compressed; head chubby; width of the head 2.25 to 2.5, depth of the head in the occipital region 1.25 to 1.4 in the greatest depth of the body; anus little behind the vertical from the posterior margin of the eye; dorsal profile weakly convex; ventral profile distinctly convex in the pectoral region.

Snout blunt and broad; mouth small; gape quite short, not equalling the diameter of the eye in length; maxillary long, equal to twice the diameter of the eye; jaws about equal, the lower projecting slightly, if at all; teeth in four or five rows around the edge of each jaw, villiform and curved inward slightly.

Caudal peduncle 3.25 to 3.6 in the total length; pectorals 1 to 1.2 in the head; origin of the anal just below the origin of the pectorals.

Ground-color uniform yellowish; top of head and mid-dorsal region, also parts of the caudal portion of the body, more or less sparsely covered with minute black dots; fins hyaline, anal rays very weakly colored with a clear light brown.

Distribution: Lower, Middle, and Upper Amazons.

V. Steatogenes Boulenger.

Steatogenes Boulenger, Trans. Zool. Soc. London, XIV, 1898.

Type, *Rhamphichthys elegans* Steindachner.

With fontanels; no caudal; snout short; distinguished from all the other Gymnotids by the presence of a small cylindrical filament of tissue in a groove on each side of the mental region; otherwise as in *Hypopomus*. Size rather small, not exceeding 250 mm. Fore part of body heavy, caudal portion tapering rapidly into the caudal filament; head chubby; gape short; teeth wanting; mouth rather small; eyes small, covered by a transparent membrane. Scales cycloid, lateral line complete and straight.

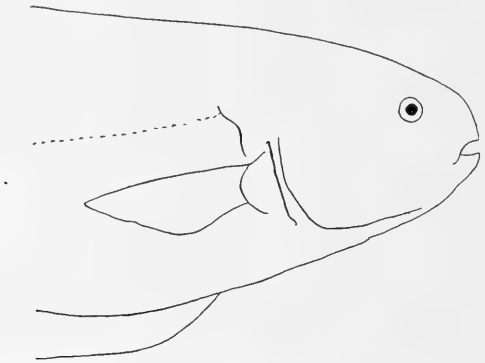


Fig. 6. *Steatogenes elegans* (Steindachner).

8. Steatogenes elegans (Steindachner).

Rhamphichthys (*Brachyrhamphichthys*) *elegans* Steindachner, Fisch-f. Cauca and Guayaquil, 37, 1880 (Barra do Rio Negro).

Brachyrhamphichthys elegans Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Steatogenys elegans Boulenger, Trans. Zool. Soc., XIV, 428, 1898 (Rio Jurua); Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 171 (Barra do Rio Negro); Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Barra do Rio Negro and Guiana).

Rhamphichthys (*Brachyrhamphichthys*) *mirabilis* Steindachner, *l. c.*, pl. IX, figs. i, and ia.

3165 C. M., nine, 120–140 mm. Santarem, Dec. 15, 1909, Haseman.
Six, 110–130 mm. Kumaka, Sept. 12, 1910, Ellis.
1756 C. M., 12614 I. U. M., three, 75–192 mm. Kumaka, Eigenmann.
1757 C. M., one (broken, length estimated 150 mm.). Wismar, Eigenmann.

Head 8.25 to 8.5, depth 5.25 to 5.5 in the length to the end of the anal; anal rays 160, 164, 175 (Kumaka); snout 3.3 to 3.7, interorbital 3, or a little more, in the head; eye 1.5 to 1.75 in the snout, 1.7 to 2 in the interorbital, and about 5 in the head.

Compressed back of the head, which is round and chubby; width of the head about 2.5, its depth in the occipital region 1.6 to 2 in the greatest depth; anus on or a little behind the vertical from the eye; dorsal profile convex; ventral profile abruptly convex to origin of the anal, beyond this very slightly convex.

Snout heavy, blunt; mouth moderate; gape short, not reaching to below the eyes; jaws equal; eyes small; a cylindrical filament about twice the length of the snout, having its origin near the pectoral, lying in a groove on each side of the mental region, both filaments united in median line at the edge of lower lip.

Caudal peduncle not over 2.8 in the total length; pectorals 1 to 1.2 in the head; origin of the anal below that of the pectorals or a little caudad.

Ground-color of preserved specimens dark golden brown, a series of twelve to twenty irregular bands of dark red-brown, starting from the median dorsal line and crossing both the body and the anal fin (these bands are more or less confluent in the region of the lateral line); small golden brown spots on the median dorsal line at the junction of the dark bands from the sides; top and sides of the head almost black, with numerous pale yellow streaks crossing them; cheeks lighter; pectorals mottled with black; anal with numerous brown spots in the yellow interspaces between the brown cross-bands.

This species which, in a general way, resembles the young of *Gymnotus carapo* is sometimes called by the same name, "Warradiera." It is also known by the name "Corybu." It inhabits small streams in densely wooded places and is occasionally used as food cooked with rice by the Indians.

Distribution: Barra do Rio Negro, British Guiana, and Lower Amazon.

VI. Hypopomus Gill.

Hypopomus Gill, Proc. Acad. Nat. Sci. Phila., 1864, 152.
Brachyrhamphichthys Günther, Cat., VIII, 6, 1870, *artedi.*

Type, *Rhamphichthys mülleri* Kaup.

With fontanels; no caudal; snout short; size small; body elongate and rather cylindrical, tapering posteriorly, maximum depth and thickness back of the pectorals; head small, chubby, and conical; mouth and gape small; teeth wanting; eyes

moderate, covered by a transparent membrane. Scales small, cycloid; lateral line straight, complete, rather obscure in caudal region. Origin of anal about the length of the pectoral behind the vertical from the gill-opening; caudal appendage long and slender.

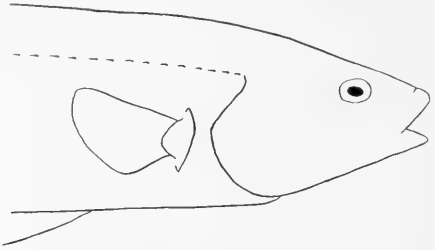


Fig. 7. *Hypopomus brevirostris* (Steindachner).

Species of Hypopomus.

a. Caudal peduncle 4.5 to 5 in the total length; length of the head just equal to, or usually less than, the greatest depth of the body; head somewhat truncate, 8.25 to 9.25 in the length to the end of the anal; eye about 2.5 in the interocular distance ..... **brevirostris.**

aa. Caudal peduncle 3 to 3.5 in the total length; length of the head just equal to, or usually greater than, the greatest depth of the body; head somewhat pointed, 7.5 to 10 in the length to the end of the anal; eye not more than 2 in the interocular distance..... **artedi.**

9. **Hypopomus brevirostris** (Steindachner).

Rhamphichthys brevirostris Steindachner, Die Gymnotidæ, 6, pl. II, fig. 2, 1868 (Guaporé); Günther, Cat., VIII, 6, 1870; Steindachner, Fisch-f. Cauca and Guayaquil, 37, 1880 (Santarem, Cauca, Rio Guaporé); Perugia, Ann. Mus. Civico Storia Nat. Genova, Ser. 2, Vol. X, 56, 1891 (Central Chaco); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 38 (Descalvados).

Brachyrhamphichthys brevirostris Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Lower Amazon and Itaituba on the Tocantins).

Hypopomus brevirostris Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 530 (Campo Grande, Arroyo Chagalalina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 170, 1905 (Cauca, Amazon and tributaries, Paraguay); von Ihering, Os Peixes do Brazil, 1907 (Amazonas); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (Cauca, Guiana to Paraguay).

10055 I. U. M., two, 140 and 150 mm. Campo Grande.
10057 I. U. M., two, 50 and 65 mm. Arroyo Chagalalina.
10054 I. U. M., one, 140 mm. Matto Grosso.
5097 I. U. M., six, 70–105 mm. Itaituba, Brazil.
5095 I. U. M., two, 90 and 100 mm. Lower Amazon.

3166 C. M., one, 90 mm. Cacequy, Jan. 31, 1909, Haseman.
3167 C. M., two, 75–80 mm. Rio Boa Ventura, June 16, 1909, Haseman.
3168 C. M., two, 65–120 mm. Villa Hays, Paraguay, April 13, 1909, Haseman.
3169 C. M., one, 120 mm. Rio Mamoré, Sept. 19, 1909, Haseman.
4894 I. U. M., eighteen, 75–140 mm. Rio Grande do Sul.
3170 C. M., one, 80 mm. Puerto Suarez, Sept. 19, 1909, Haseman.
1792 C. M., 12615 I. U. M., four, 57–165 mm. Mud Creek, Aruka, Shideler.
1793 C. M., 12616 I. U. M., two, 100–165 mm. Chipoo Creek, Shideler.
1794 C. M., 12617 I. U. M., two, 95–105 mm. Pacopoo Pan, Wm. Grant.
1795 C. M., 12618 I. U. M., four, 118–160 mm. Nickaparoo Creek, Wm. Grant.
1796 C. M., one (broken), 80 mm. Savannah Landing, Eigenmann.
12635 I. U. M., one, 95 mm. Creek below Savannah Landing, Eigenmann.
1797 C. M., one, 117 mm. Twoca Pan, Rupununi, Wm. Grant.
1798 C. M., one, 70 mm. Kumaka, Eigenmann.

Head 8.25 to 9.25, greatest depth 7 to 9 in the length to the end of the anal; anal rays 220 to 260; snout 3.3 to 3.7, interorbital about 3 in the head; eye 2.5 in the interorbital, 2.5 to 3 in the snout, and about 6 in the head.

Body rather cylindrical, though slightly compressed caudad; head chubby, somewhat conic; width of head 2 to 2.5, depth of head in occipital region about 1.75 in greatest depth; anus twice the diameter of the eye behind the vertical from the eye; dorsal profile of the head distinctly slanting, of the body weakly convex; ventral profile regularly convex.

Snout short and truncate; mouth small; gape very short; eyes moderately small; jaws equal.

Caudal peduncle 4.5 to 5 in the total length; pectorals 1.5 to 2 in the head; origin of the anal about the length of the snout behind the origin of the pectorals.

Ground-color buff, overlaid with chocolate-brown; dorsal parts dark; ventral lighter; numerous bands of dark brown crossing the body but not the anal; lateral line buff; head dark; fins bluish white to hyaline; rays more or less black.

Distribution: Rio Magdalena, Guianas, Amazons south to Rio de la Plata.

10. **Hypopomus artedi** (Kaup).

Seba, Thesaur., III, tab. 32, fig. 2.
Rhamphichthys artedi Kaup, Apod., 128, 1856 (Mona); Günther, Cat., VIII, 6, 1870.
Brachyrhamphichthys artedi Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.
Rhamphichthys mülleri Kaup, Apod., 129, 1856 (French Guiana); Günther, Cat., VIII, 6, 1870.
Hypopomus mülleri Gill, Proc. Acad. Nat. Sci. Phila., 1864, 152.

Brachyrhamphichthys mülleri Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Hypopomus artedi Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 170, 1905 (French Guiana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (French Guiana).

3171 C. M., one, 150 mm. Iguapé, Rio Ribeira, Dec. 15, 1908, Haseman.
3172 C. M., fourteen, 50 to 160 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3173 C. M., thirty-three, 85–265 mm. Campos, June 14, 1908, Haseman.
3174 C. M., one, 180 mm. Uruguayana, Feb. 7, 1909, Haseman.
3175 C. M., four, 130–180 mm. Lagoa Feia, Tocas, June 27, 1908, Haseman.
3176 C. M., three, 70–110 mm. Bragança, Dec. 19, 1909, Haseman.
3177 C. M., two, 55–140 mm. Rio Jaurú, June 2, 1909, Haseman.
3178 C. M., three, 90–130 mm. Santarem, Dec. 15, 1909, Haseman.
3179 C. M., eleven, 55–130 mm. Caceres, May 24, 1909, Haseman.
3180 C. M., eight, 45–120 mm. Bastos, June 26, 1909, Haseman.
3181 C. M., one, 120 mm. Corumbá, April 27, 1909, Haseman.
1799 C. M., 12619 I. U. M., two, 155–165 mm. Lama Stop-Off, Eigenmann.
1800 C. M., 12620 I. U. M., four, 170–174 mm. Wismar, Eigenmann.
1801 C. M., 12621 I. U. M., two, 80–160 mm. Gluck Island, Eigenmann.
1802 C. M., one, 175 mm. Kumaka, Eigenmann.
1803 C. M., one, 130 mm. Christianburg, Eigenmann.

Head 7.5 to 8.25, greatest depth 10 or 11 in the length to the end of the anal; snout 2.9 to 3.5, interorbital 5 to 6 in the head; eye about 2.5 in the snout, 1.8 in the interorbital and 5.8 to 6.8 in the head.

Body compressed and elongate, slightly subcylindrical towards the head; head conic and a little produced; width of the head 1.75 to 2, depth of the head in the occipital region 1.3 to 1.5 in the greatest depth; dorsal profile of the head slightly sloping, of the body almost straight; ventral profile of the head and body somewhat convex.

Snout conic, a little truncate at the tip; mouth medium; gape short; upper jaw barely projecting; eyes small; cheeks round and full.

Caudal filament 3 to 3.5 in the total length; pectorals 1.75 to 2 in the head; origin of the anal about on the vertical from the tip of the pectorals.

Ground-color light buff to straw yellow; dorsal parts and the caudal peduncle crossed by several bands of rather bright brown, which fade out near the middle of each side; ventral parts almost without markings, or with numerous blotches of pale brown; top of the head dark brown; sides of the head and mental region speckled with brown; fins hyaline, rays more or less brown.

Distribution: Guianas, Amazon, Parana.

VII. Rhamphichthys Müller and Troschel.

Gymnotus Linnæus (in part), Syst. Nat., ed. XII, i, 427, 1766.

Rhamphichthys Müller and Troschel, Horæ Ichthyol., III, 15, 1849.

Type, *Gymnotus rostratus* Linnæus.

With fontanels; no caudal; snout long; size moderate to quite large; body very elongate and quite compressed; head moderate, tapering into a long, tubular snout; gape short; mouth small; eyes moderately small and covered by a transparent membrane. Scales cycloid and minute; lateral line complete, straight; origin of the anal in front of the vertical from the gill-opening; caudal appendage large and scaly.

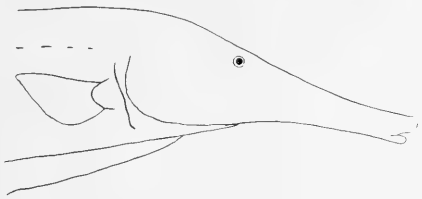


Fig. 8. *Rhamphichthys rostratus* (Linnæus).

11. **Rhamphichthys rostratus** (Linnæus).

Seba, Thesaur., II, tab. 69, fig. 3, and III, 99, tab. 32, fig. 5.

Gymnotus Gronovius, Mus. Ichthyol., no. 73, 1754; id., Zoophyl., No. 167.

Gymnotus rostratus Linnæus, Syst. Nat., ed. XII, i, 428, 1766; Bloch and Schneider, 522, tab. 106, 1801; Gronow, Syst., ed. Gray, 22, 1854.

Carapus rostratus Cuvier, Règne Animal, II, 237, 1817.

Rhamphichthys rostratus Müller and Troschel, Horæ Ichthyol., III, 15, 1849 (Guiana); Günther, Cat., VIII, 5, 1870 (Surinam); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 168 (Guianas to Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Guianas and Amazon).

Gymnotus longirostris Lacépède, Hist. Nat. Poiss., II, 178, 1800.

Rhamphichthys schomburgkii Kaup, Apod., 135, 10, 1856; Steindachner, Die Gymnotidæ, 10, 1868 (Rio Negro).

Rhamphichthys marmoratus Castelnau, Anim. Amer. Sud. Poiss., 86, pl. 46, fig. 2, 1855 (Uruguay); Kaup, Apod., 132, fig. 7, 1856; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Itaituba); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 168 (Orinoco and Guianas to Rio de la Plata); Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (Guiana, Orinoco to Rio de la Plata).

Rhamphichthys pantherinus Castelnau, Anim. Amer. Sud. Poiss., 86, pl. 46, fig. 3, 1855 (Lake near the Ucayale); Kaup, Apod., 131, fig. 6, 1856; Günther, Cat., VII, 5, 1870; Peters, Mb. Akad. Wiss. Berl., 1877, 473 (Apuré); Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Fisch-f. Cauca and Guayaquil, 38, 1880 (Manacapuru, Matto Grosso, Surinam, Uruguay, La Plata, Para, Obidos, Xingu, Rio Negro, Ucayale); Perugia, Ann. Mus. Civico Stor. Nat. Genova, ser. 2, vol. X, 55, 1891 (Asuncion and Rio Maciel at Buenos Aires).

Rhamphichthys lineatus Castelnau, Anim. Amer. Sud. Poiss., 87, pl. 47, fig. 1, 1855 (Tributary of Ucayale); Kaup, Apod., 130, fig. 5, 1856.

Gymnotus rostratus (*non* Linnæus) Steindachner, Die Gymnotidæ, 8, 1868, in part (Matto Grosso, Surinam).

Rhamphichthys schneideri Kaup, Apod., 136, fig. 11, 1856 (Cayenne).

Rhamphichthys reinhardtii Kaup, Apod., 132, fig. 8, 1856; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon).

Rhamphichthys blochii Kaup, Apod., 133, fig. 9, 1856; Günther, Cat., VIII, 5, 1860 (Para); Steindachner, Fisch-f. Cauca and Guayaquil, 38, 1880 (Rio Negro, Manacapuru, Para); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 38 (Paraguay); Boulenger, Trans. Zoöl. Soc., XIV, 428, 1898 (Rio Jaurú).

1761 C. M., 12612 I. U. M., three, 580–900 mm. Wismar, Eigenmann.

3344 C. M., one, 300 mm. Berlin, Rio Mamoré, in Bolivia, Sept. 15, 1909, Haseman.

3348 C. M., three, 390–470 mm. San Joaquim, Sept. 5 and 6, 1909, Haseman.

3346 C. M., one, 630 mm. Santarem, Dec. 15, 1909, Haseman.

3347 C. M., one, ? damaged. Santarem, Dec. 15, 1909, Haseman.

Head 6 to 8; greatest depth 11.3 to 12 in the length to the end of the anal; anal rays 410, 444, 469; snout 1.5 to 1.8, interorbital 8.5 to 9.5 in the head; eye 12 to 16 in the snout, 2.25 to 3 in the interorbital, 18 to 22 in the head.

Compressed and very elongate; width of head 2.3 to 2.5, depth of head in the occipital region 1.5 to 2 in the greatest depth; anus on or in front of the vertical from the eye; dorsal profile sloping to the occiput, then almost straight; ventral profile quite straight except for a slight concavity in the mental region.

Snout long, tubular, and tapering; mouth small and slightly below the overhanging upper jaw; gape short and decurved, about 1.5 times the eye; lower jaw included, upper forming the extreme tip of the snout, slightly expanded and blunt on the end, teeth wanting; cheeks full and round; operculum rather prominent; eyes small.

Caudal peduncle 3.5 to 4 in the total length; pectorals 2.75 in the head; origin of the anal about three times the eye behind the vertical from the eye.

Ground-color chocolate to a yellow-brown; ventral parts lighter; numerous

blotches of dark brown and black dorsally; many irregular bands of dark brown spots and blotches crossing the body and anal; anal heavily marked with black and brown spots over a background of cream-white; head dark, mottled with large black and small bluish white spots; mental region almost white, pectorals spotted with black, brown, and white; caudal peduncle dark chocolate-brown, banded with black.

This species is quite variable in size, markings, and length of snout. It is very highly prized as a food-fish. It lives among the roots of the "Mucka Mucka" and a species of Calladium which grow up from the water. It frequents the smaller and more open streams, although it is taken less often in the larger ones. From the contents of the stomachs examined it seems to live almost entirely on mud-inhabiting insect larvæ and worms.

Kaup records this fish as attaining the size of six feet. No such specimens were seen and from the accounts of the fishermen questioned it seems rarely to exceed four and a half feet.

The names of "Band Fish" and "Wabri" were given it by my Guiana coolies.

Distribution: South America, except the Magdalena and Brazilian coastal streams.

VIII. Gymnorhamphichthys genus nov.

Type, *Gymnorhamphichthys hypostomus* Ellis.

Distinguished from all the other Gymnotids except the electric eel by the absence of scales from the anterior part; scales few, confined to the caudal regions; snout straight and produced; other points much as in *Rhamphichthys*. This genus contains but a single species.

12. **Gymnorhamphichthys hypostomus** Ellis. (Plate XXIII, fig. 2.)

Ellis, in Eigenmann, Fishes of British Guiana, Mem. Carn. Mus., Vol. V, p. 436, 1912.

Type, 3182 C. M., 215 mm. San Joaquim, Sept. 5, 1909, Haseman.

Cotypes:

3183 C. M., one, 180 mm. Rio Mamoré, Sept. 19, 1909, Haseman.
12641 I. U. M., two, 140–145 mm. Konawaruk, Eigenmann.
3184 C. M., two, 75 and 115 mm. Bastos, Rio Mamoré, Aug. 3, 1909, Haseman.
3185 C. M., one, 80 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
12642 I. U. M., one, 125 mm. Puerto Bertoni, Alto Parana, Bertoni.
12613 I. U. M., three, 95–100 mm. Tumatumari, Eigenmann.

Head 4.8 to 7.1, depth 12.4 to 13.6 in the length to the end of the anal, anal rays 165–210.

Snout 1.6 to 2; interorbital 8 to 14 in the head; eye 7 to 14 in the snout.

Body compressed, slender and quite elongate; width of the head 2 to 2.5;

depth of the head in the occipital region 1.2 to 1.4 in the greatest depth of the body; anus on or a little behind the vertical from the posterior margin of the eye; dorsal and ventral profiles tapering very slightly and almost straight. Snout produced, straight and tubular (the length varies with the size, the largest having the longest snout, hence the range of the measurements in which the head and snout figure). Mouth small, inferior; gape short, from 5 to 8 in snout; jaws almost equal but lower included by the hood-like upper, so that the opened mouth appears under the upper jaw; teeth wanting.

Caudal peduncle 3.5 to 4.5 in the total length; pectorals 1.8 to 2.8 in the head; origin of anal on or very slightly behind, the vertical from the origin of the pectorals.

Ground-color buff; snout and top of head more or less completely covered with black, especially the distal half of the snout; a number of irregular black blotches down the middle of the back, and a second row of black spots more or less confluent with the dorsal ones in the region of the lateral line; caudal appendage completely encircled by two or three black bands (all the black markings vary with the size of the fish, smallest specimens being almost without markings). Fins hyaline.

Distribution: Guiana, Lower Amazon, and Paraná.

IX. Sternarchorhynchus Castelnau.

Sternarchorhynchus Castelnau, Anim. Am. Sud. Poiss., 1856.
Rhamphosternarchus Günther, Cat., VIII, 4, 1870 (*oxyrhynchus*).

Type, *Sternarchorhynchus mülleri* Castelnau.

With fontanels; a caudal fin; snout produced, decurved; size rather small, not exceeding 300 mm. in length; body compressed and slightly elongate, very slender in caudal region; head medium, conical, and produced; gape very small; teeth in both jaws; eyes small and covered by a membrane. Scales cycloid; lateral line complete; origin of anal distinctly in front of the vertical from origin of the pectorals; anal long, widest near the middle of the body and narrowing near both head and tail; caudal fin small, terminal, and fan-shaped, slightly scaled at the base.

13. **Sternarchorhynchus oxyrhynchus** (Müller and Troschel).

Sternarchus oxyrhynchus Müller and Troschel, Horæ Ichthyol., III, 16, pl. II, figs. 1 and 2, 1849 (Essequibo); Kaup, Apod., 127, 1856; Günther, Cat., VIII, 4, 1870 (British Guiana); Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua).

Sternarchorhynchus oxyrhynchus Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 167 (Guiana and Rio Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910 (Guiana).

Sternarchorhynchus mülleri Castelnau, Anim. Amer. Sud. Poiss., 1855.

Sternarchus mormyrus Steindachner, Die Gymnotidæ, 5, pl. 1, fig. 3 (Marabitanos); Günther, Cat., VIII, 4, 1870 (Peruvian Amazon); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 666 (Lower Amazon); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 167 (Marabitanos, Peruvian Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Peruvian Amazon).

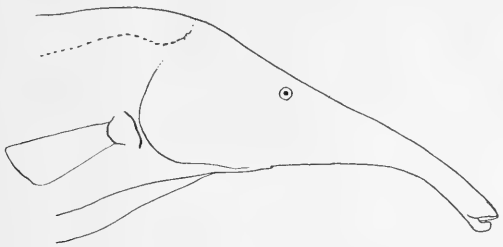


Fig. 9. *Sternarchorhynchus oxyrhynchus* (Müller & Troschel).

Sternarchus (Rhamphosternarchus) curvirostris Boulenger, Proc. Zoöl. Soc., 1887, 282, pl. XXIV (Canelos).

Sternarchorhynchus curvirostris Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1881, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 167 (Canelos); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Canelos).

3186 C. M., three, 235–260 mm. Santarem, Dec. 12, 1909, Haseman.
3187 C. M., one, 290 mm. Pará, Jan. 22, 1910, Haseman.
1807 C. M., one, 185 mm. Warraputa, Eigenmann.
1808 C. M., 12590 I. U. M., four, 165–240 mm. Amatuk, Eigenmann.

Head 4.8 to 6.9, depth 9.6 to 9.8 in the length to the end of the anal; anal rays 168–215.[6] Snout 1.6 to 1.8, interorbital 13 to 18 in the head; eye equal to the interorbital, 8.5 to 9 in the snout, 13 to 14 in the head.

Body and head compressed; width of head 2.75 to 4, depth of head in the occipital region 1.25 to 1.9 in the greatest depth of the body; anus on, or a little

[6] The number of anal rays of the specimens examined and of the type are

Amatuk, Brit. Guiana	168	168	170	174
Warraputa, Brit. Guiana	180			
Santarem, Brazil	192	196	197	
Para, Brazil	194			

In addition to this list Eigenmann & Bean record specimens of *Sternarchorhynchus mormyrus* from the lower Amazon with 191 to 194 rays (size not given).

in front of, the vertical from the eye; dorsal and ventral profiles behind the head almost straight.

Snout long, tubular, decurved, of small diameter and tapering; mouth small, terminal; gape 1.5 to 2 in the eye; lower jaw included on the sides, slightly projecting in front; teeth small to medium, conical, in two irregular median patches in upper jaw and two irregular series on lower jaw; eyes quite small; mucous pores abundant on the head.

Caudal small, fan-shaped, terminal, 2.5 times the eye; pectorals about 2.75 in the head; origin of the anal about three times the eye behind the vertical from the eye.

Ground-color a uniform bistre to dark brown; head and dorsal parts darker; lateral line hyaline; fins hyaline, rays faintly outlined with dark brown.

The type of *oxyrhynchus* was examined by Dr. C. H. Eigenmann. His notes follow.

"Type in the Berlin Mus. 470 mm. No. 4086, Guiana, Schomburgk.

"Head 6.9 in the length to the end of the anal; anal 215; interorbital 18 in the head. Width of the head near 4 in the greatest depth; depth of the head 1.9 in the greatest depth; anus in front of the vertical from the anterior margin of the eye; gape at least as long as the eye; teeth of both jaws large, recurved, in a single series on the sides, in an irregular double series toward the front."

From a comparison of the anal rays, the size and the shape of the head and snout it seems that *Sternarchorhynchus curvirostris* (Boulenger) and *Sternarchorhynchus mormyrus* (Steindachner) are synonymous with *Sternarchorhynchus oxyrhynchus* (Müller and Troschel), the variations being in part due to the size of the fish.

X. Sternarchorhamphus Eigenmann.

Type, *Sternarchus mülleri* Steindachner.

With fontanels; a caudal fin; snout produced, straight; mouth large; size medium to large; body very elongate and much compressed; maximum depth in, or just behind, the pectoral region; head moderately large to medium, pointed and produced; gape rather straight; small conical teeth in both jaws; eyes small and covered by a membrane; scales cycloid; lateral line complete and quite straight; anal long, growing narrower caudad; caudal very small.

14. **Sternarchorhamphus mülleri** (Steindachner).

Sternarchus (*Rhamphosternarchus*) *mülleri* Steindachner, Flussf. Südam., III, 15, pl. V, fig. 4, 1881 (Para).

Sternarchorhynchus mülleri Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchorhamphus mülleri Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 166 (Pará); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Pará).

3188 C. M., two, 430 and 500 mm. Alcoboca, Rio Tocantins, Jan. 10, 1910, Haseman.

3189 C. M., three, 400–425 mm. Pará, Jan. 22, 1910, Haseman.

Head 8.5 to 9.5, greatest depth of body 9.75 to 10.75 in the length to the base of the caudal; anal rays (Pará) 248, (Alcoboca) 239, 254, 263 (other Pará specimens had regenerated caudals). Snout 1.6 to almost 2; interorbital 6.5 to 8.5 in the head; eye 12 to 15 in the snout and 3 to 5 in the interorbital.

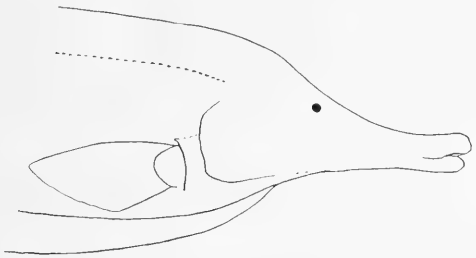


Fig. 10. *Sternarchorhamphus müllcri* (Steindachner).

Body quite compressed and elongate; head compressed and somewhat produced; width of the head 3 to 3.8; depth of the head in the occipital region 1.5 to almost 2 in the greatest depth of the body; anus about the diameter of the eye in front of the vertical from the anterior margin of the eye; dorsal profile almost straight, sloping slightly from the origin of the dorsal filament; ventral profile behind the head weakly convex.

Snout produced, tubular, almost straight, slightly upturned and slightly enlarged toward the tip; mouth medium; gape straight, oblique to the axis of the head and equal to about one fourth of the snout; jaws equal, both rounded in front; lower included on the sides; teeth small, villiform, in a band of three or more series around the lower jaw and a band of two or more series on the side and six or seven series in the middle on the upper jaw.

Caudal fin quite small, 3 to 4 in the snout; pectorals a little more or less than 2 in the head.

Ground-color tawny to dark brown; entire body overlaid more or less with fine violet dots, especially in the region of the lateral line, the dorsal and lateral portions of the head, and the dorsal portion of the body; anal and pectorals bright yellow margined with black; caudal pale yellow; a dark patch at origin of lateral line; scales small, larger in the region of the lateral line; middorsal region unscaled.

Known only from the lower Amazon.

15. **Sternarchorhamphus macrostomus** (Günther).

Sternarchus macrostomus Günther, Cat., VIII, 4, 1870 (Xeberos).

Rhamphosternarchus macrostomus Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon).

Sternarchorhynchus macrostomus Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchorhamphus macrostomus Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 166 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Peruvian Amazon).

"Snout produced into a long, nearly straight tube, the small eye being midway between the roots of the pectoral and the extremity of the snout. Cleft of the mouth wide; more than half the length of the snout. Mandible with a series of fine teeth on each side. Vent somewhat behind the vertical behind the eye; anal fin commencing in front of the gill-opening; the greatest depth of the body is two-thirds the length of the head; scales on the back and ventral parts very small, those in the middle of the side of moderate size; uniform blackish-brown; posrior part of the anal and caudal black with whitish markings. A. 202." (From Günther.)

This species is found only in the upper Amazon.

XI. Orthosternarchus genus nov.

Type, *Sternarchus tamandua* Boulenger.

Distinguished from the other Sternarchinæ by the long dorsal thong which has its origin above or slightly behind the pectorals, by the long, straight, tubular snout and by the minute eyes and very short gape. Other characteristics much as in *Sternarchorhamphus*.

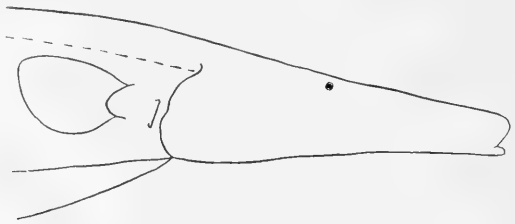


Fig. 11. *Orthosternarchus tamandua* (Boulenger).

16. **Orthosternarchus tamandua** (Boulenger).

Sternarchus tamandua Boulenger, Trans. Zoöl. Soc., XIV, 427, Plate XLII, 1898 (Rio Jurua, tributary of the Amazon).

Sternarchorhamphus tamandua Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 166, 1905 (Rio Jurua); von Ihering, Os Peixes do Brazil, Part 1 A,

1907 (Rio Jurua); EIGENMANN, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Rio Jurua).

"Snout produced into a long, nearly straight tube, the length of which equals 4 times its least depth; mouth very small with several rows of minute teeth; eye extremely minute, a little nearer the opercular cleft than the end of the snout. Depth of body half length of head; a very strongly developed adipose fin runs along the whole length of the body from which it is easily detached; pectoral one-third the length of the head; vent under chin; anal 220, originating a little in advance of gill-opening, its longest rays more than one-half depth of body; scales very small, larger on the upper half of the body than on the lower; lateral line 85. Tail in the unique specimen has been injured during life and bears a short regenerated caudal fin. Uniform yellowish white. Total length 400 mm."
(From Boulenger.)

XII. STERNARCHUS Bloch and Schneider.

Sternarchus BLOCH AND SCHNEIDER, 497, tab. 94.
Apternotus LACÉPÈDE, II, 208.

Type, *Sternarchus albifrons* (Linnæus).

With fontanels; a caudal; snout short; back scaled; gape large; size moderate, not exceeding 500 mm.; body elongate and compressed; maximum depth and thickness in the region of the pectorals; head large, sloping and naked; gape straight, long and parallel to the long axis of the body; lower jaw included by the fleshy sides of the upper; teeth in two rows in lower jaw, two or more rows or patches in upper; eyes small, covered by a membrane. Scales cycloid; lateral line complete and quite straight; back scaled; pectorals never equal to more than one-half the greatest depth; origin of the anal on or a little in front of the vertical from the gill-opening; anal long but not reaching the caudal, of rather uniform height; caudal rather small.

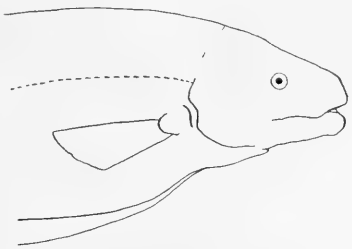


FIG. 12. *Sternarchus albifrons* (Linnæus).

SPECIES OF STERNARCHUS.

a. Scales small, 11 to 16 rows above the lateral line.
b. Snout rather pointed, interorbital distance more than 5 in the head.
c. Greatest depth of the head 1.25 to 1.5 in its length; interorbital 3 or less than 3 in the snout. **brasiliensis.**

cc. Greatest depth of the head 1.8 to 2 in its length; interorbital 4 or more in the snout. **leptorhynchus.**

bb. Snout blunt, interorbital distance less than 4.75 in the head.

d. Rather slim; flesh-color to light gray, entirely covered with numerous fine dark chromatophores. **hasemani.**

dd. Robust; ground-color dead black; two white bands circling the body, one at the base of the caudal, and another near the end of the anal; forehead more or less white..... **albifrons.**

aa. Scales above lateral line large, in not to exceed eight rows..... **bonaparti.**

17. Sternarchus brasiliensis Reinhardt.

Sternarchus brasiliensis Reinhardt, Vidensk. Meddel. Naturh. Foren. Kjöbenh., 1852, or Wiegm. Arch., 1854, 182 (Rio das Velhas); Günther, Cat., VIII, 3, 1870 (Rio das Velhas); Steindachner, Flussf. Südam., III, 14, 1881 (Rio das Velhas); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 61 (Rio das Velhas); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 162, 1905 (southeastern Brazil); von Ihering, Os Peixes do Brazil, Part 1 A, 1907 (Rio Piracicaba; Rio Sapucay; Rio Tieté); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Rio San Francisco, Paraná and Paraguay).

Sternarchus albifrons Eigenmann and Norris, Revista Museu Paulista, IV, 349, 1900 (Piracicaba); not of Linnæus.

3190 C. M., two, 250–290 mm. Pirapora, Dec. 15, 1907, Haseman. (Pirapora is on the Rio San Francisco, just above the mouth of the Rio das Velhas.)

Head 7.25 to 8, depth about 9.25 in the length to the end of the anal; anal rays 184 and 194. Snout 2.3 to 2.4, interorbital a little more than 5.5 in the head; eye 2 to 3.1 in the interorbital, about 6.25 in the snout, and 13 or 14 in the head; 11 to 16 rows of scales above lateral line.

Body and head compressed; width of the head 2 to 2.25, depth of the head at the base of the occipital process about 1.25 in the greatest depth; anus on the vertical from a point twice the eye behind the eye; dorsal profile weakly convex, ventral almost straight; top of head sloping rather abruptly.

Snout moderate, rather cylindrical and truncate on the end; mouth large; gape long, almost reaching the vertical from the eye; lower jaw included in the sides; jaws about equal, both with teeth; eyes small.

Caudal 1.2 to 2 in the snout; origin of the anal on, or in front of, the vertical from the gill-opening; pectorals about 2 in the head.

General color dark brown, lighter ventrally; caudal black with a white spot at its base; anal and pectorals hyaline.

This species seems to have arisen in the Serra da Matto da Corde, in the State of Minas Geraes, Brazil, as it is found only in and about these mountains.

It is known only from the Rio das Velhas, the upper Rio San Francisco and the portions of the Rios Piracicaba, Sapucahy, and Tieté nearest the Serra da Matto da Corde.

18. **Sternarchus leptorhynchus** Ellis. (Plate XXII, fig. 4.)

Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 439.

1762 C. M., type, 260 mm. Amatuk, Eigenmann.
12588 I. U. M., cotype, 160 mm. (Length estimated; specimen broken.) Amatuk, Eigenmann.
1763 C. M., cotype, 98 mm. Warraputa, Eigenmann.

Head 4.9 to 5.2, greatest depth about 6.75 in the length to the end of the anal; anal rays 158–160; snout 2.2 to 2.3, interorbital 6.5 to 7.5 in the head; eye about 9 in the snout, 20 to 22 in the head, and 3 to 4 in the interorbital; 13 to 15 rows of scales above the lateral line.

Compressed and elongate; width of the head 3 or a little more, depth of the head in occipital region 1.3 to 1.5 in the greatest depth of the body; anus about 4 orbital diameters behind the vertical from the eye; dorsal profile of the head and anterior sixth of the body abruptly sloping ventrally, dorsal profile of the remainder almost straight; ventral profile very weakly convex or almost straight.

Snout heavy, rather long and slightly rounded; mouth large; gape reaching to just below the eyes; jaws equal, the lower included; teeth minute, conical, and few, in two irregular, somewhat incomplete rows along each side of the lower jaw and in two irregular patches on the upper jaw.

Caudal 3.8 to 4, pectorals 2 to 2.25 in the head; origin of the anal about the length of the snout behind the vertical from the eye.

Color a uniform, dark seal-brown; a dirty white spot at the origin of the caudal; a more or less interrupted pale yellow streak running along the median dorsal line from the tip of the snout to middle of the back or farther (this streak is a distinct band in the smallest specimens); lips cream-white; fins hyaline; rays outlined with dark brown.

Known only from British Guiana.

19. **Sternarchus hasemani** sp. nov.[7] (Plate XXIII, fig. 1.)

3191 C. M., type, 170 mm. to base of caudal. Santarem, Dec. 15, 1909, Haseman.
3192 C. M., cotypes, nineteen, 150–200 mm. (length not definite as all have the caudal region in various stages of regeneration). Santarem, Dec. 15, 1909, Haseman.

Head 1 to 1.25 in the greatest depth of the body; snout 2.8 to 3.5 in the head; interorbital 1.2 to 1.5 in the snout, about 3 in the head; eye 4 to 5 in the snout, 10 to 12 in the head; 11 to 15 rows of scales above the lateral line.

Body compressed; head somewhat conic; width of the head 2.3 to 3, depth of

[7] Named for Mr. John D. Haseman, who collected all of the specimens of this species.

the head in the occipital region 1.5 to 1.75 in the greatest depth of the body; anus about the diameter of the eye behind the vertical from the posterior margin of the eye; dorsal profile almost straight; ventral profile convex.

Snout heavy and blunt, mouth moderately large; gape somewhat curved downward, long, almost reaching the vertical from the anterior margin of the eye; jaws equal, lower included on the sides; teeth in two irregular rows in each jaw; eyes medium, covered by a membrane; nostrils prominent, the anterior nares projecting slightly as little tubercles; upper posterior margin of the operculum somewhat angulate; first few scales of the lateral line quite prominent.

Pectorals 1.3 to 1.6 in the head; origin of the anal on, or slightly in front of, the vertical from the gill-opening.

Ground-color pale buff; body completely covered with extremely fine brown dots, causing a brownish shade; top of head lighter, with a more or less distinct white band running from middle of snout to beyond the occipital region; sides and under parts of the head heavily covered with minute blue-black dots; fins smoky to almost black, being colored irregularly.

The caudal fin and a portion of the caudal region of all of the specimens examined were in various states of regeneration.

20. **Sternarchus albifrons** (Linnæus).

Gymnotus albifrons Linnæus, Syst. Nat., ed. XII, i, 428, 1766; Pallas, Spic. Zool., VII, 36, tab. 6, fig. i, 1769; Bonaterre, Tabl. Encycl. des Trois Règnes Natura, Poiss., 37, pl. 24, fig. 82, m. 3, 1788.

Sternarchus albifrons Bloch and Schneider, 497, tab. 94; Castelnau, Anim. Amer. Sud. Poiss., 91, pl. 45, fig. 1, 1855; Kaup, Apodes, 126; Steindachner, Sb. Akad. Wiss. Wien, LVIII, 1868, 249 (Cuyabá); Günther, Cat., VIII, 2, 1870 (Pará, Santarem); Peters, Mb. Ak. Wiss. Berlin, 1877, 473 (Apuré); Cope, Proc. Am. Philos. Soc., 1878, 282 (Canelos); Steindachner, Flussf. Südam., III, 13, pl. 5, fig. 6, 1881 (Manacapuru, Teffé, Obidos); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 61; Perugia, Ann. Mus. Civico Stor. Nat. Genova, Ser. 2, Vol. 4, 55, 1891 (Asuncion); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 37 (Descalvados); Boulenger, Boll. Torino, XIII, 1898 (Rio Zamora, Ecuador); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 30 (Arroyo Trementina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 162 (Orinoco, Amazons, Paraguay); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Guiana, Amazons, Paraguay).

Apteronotus passan Lacépède, Hist. Nat. Poiss., II, 209, pl. 6, fig. 3, 1800.

Sternarchus lacepedii Castelnau, Anim. Amer. Sud. Poiss., 93, pl. 45, fig. 3, 1855 (Surinam).

Sternarchus maximilliana Castelnau, l. c., 93, pl. 45, fig. 4, 1855.

3193 C. M., one, 400 mm. Pará, Jan. 22, 1910, Haseman.

10058 I. U. M., one, 290 mm. Arroyo Trementina.
One, 180 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
1760 C. M., 12589 I. U. M., six, 105–285 mm. Creek below Potaro Landing, Eigenmann.

Head 5.8 to 6.2; depth 5 to 5.5 in the length to the end of the anal; A. 155, 158, 164, 168, 170 respectively; snout 2.7 to 2.9, interorbital 3.25 to 3.5 in the head; eye 3.25 to 3.5 in the snout, 2.8 to 3 in the interorbital, 8.5 to 9 in the head; 11 to 13 rows of scales above lateral line.

Compressed and slightly elongate; width of the head 2.5 to 2.8, depth of head in occipital region 1.25 to 1.5 in the greatest depth; anus on, or a little behind, the vertical from the posterior margin of the eye; dorsal profile rather straight back of the head which slopes ventrally; ventral profile slightly concave, except below the pectorals, where it is somewhat convex.

Snout heavy, truncate and rather short; mouth large; gape reaching to just below the eyes; jaws strong, lower included on the sides; teeth minute and conical, in two irregular rows in lower jaw and two circular patches (one on each side of the median line) in the upper jaw.

Caudal about 5, pectorals 1.2 to 1.4 in the head; origin of the anal in front of the pectorals, about 4 times the eye behind the vertical from the eye.

Ground-color of preserved specimens dead black; a dirty white band about 1.5 times the eye in width extending, in the median dorsal line, from the tip of the snout to the top of the head; two cream-white bands completely encircle the fish, the first beginning at about the 130th anal ray and continuing to the end of the anal, the second a smaller one at the origin of the caudal; anal opening, and sometimes the extreme tip of the caudal, white; eye in alcoholic specimens a bright China blue; fins and rays dead black.

In living specimens the white bands vary from rose-pink, or heliotrope, to red, and the eyes are quite red, the black parts being olivaceous.

This fish is regarded by some of the natives of Guiana with superstition. It is thought to be often inhabited by a ghost of some departed person or evil spirit. It is called "Cheeogaa" by these Indians. Natterrer gives the name "Man tschiogaa" as that of the Indians near Cuyabá. The Brazilians call it "Tovira cavallo."

Habitat: Small creeks.

Distribution: Orinoco, Guianas, Amazons, Ucayale, Rio Paraguay, and Rio Paraná.

21. **Sternarchus bonapartii** Castelnau.

Sternarchus bonapartii Castelnau, Anim. Amer. Sud. Poiss., 92, pl. 45, fig. 2, 1855 (Amazon); Kaup, Apod., 126, 1856; Günther, Cat., VIII, 3, 1870; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Flussf. Südam., II, 42, 1881 (Manacapuru); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash.

Acad. Sci., VII, 1905, 163 (Amazons); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazons).

Sternarchus macrolepis Steindachner, Flussf. Südam., III, 14, pl. V, fig. 7, 1881, near Barra do Rio Negro and Lake Manacapuru; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 163 (Amazon near Rio Negro and Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazon, Rio Negro, Guiana).

3194 C. M., one, 95 mm. Rio Mamoré, Sept. 19, 1909, Haseman.

3195 C. M., one, 160 mm. (estimated, caudal portion gone and partly regenerated). Santarem, Dec. 15, 1909, Haseman.

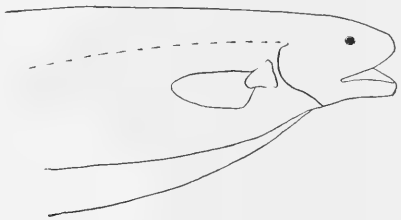


Fig. 13. *Sternarchus bonapartii* Castelnau.

Head 5.75 to 6, greatest depth of the body 8.75 to 9 in the length to the base of the caudal; anal rays 163; a maximum of 8 rows of scales above the lateral line.

Snout 2.5 to 2.75, interorbital 4.25 to 4.7 in the head, eye 4 to 4.5 in the snout; about 2 in the interorbital, and 11 or 12 in the head.

Body and head compressed, depth of head in the occipital region about 1.3, width of the head a little more or less than 2 in the greatest depth of the body; anus a very little behind the vertical from the posterior margin of the eye; dorsal profile of the head weakly convex; dorsal part of the body sloping very slightly, ventral profile almost straight.

A comparison of *Sternarchus bonapartii* and *Sternarchus macrolepis* Steindachner with the above specimens shows *macrolepis* to be synonomous with *bonapartii*.

Distribution: Lower and Middle Amazons and Rio Ucayale.

XIII. Sternarchella Eigenmann and Ward.

Sternarchella Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 163. Type, *Sternarchus schotti* Steindachner.

Like *Sternarchus*, the gape short; size rather small to medium; body rather compressed; gape not reaching beyond the posterior nostril; eyes small, covered

by a membrane, nearer the tip of the snout than to the gill-opening; small teeth in both jaws. Scales cycloid, moderately large.

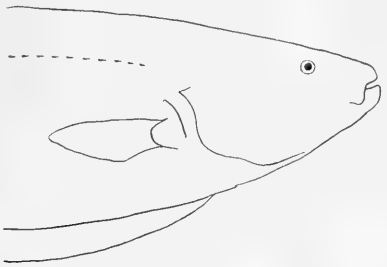


FIG. 14. *Sternarchella schotti* (Steindachner).

SPECIES OF STERNARCHELLA.

a. Depth of head 1.5 to 1.25 in its length; gape moderate, reaching to below posterior nostril . . . . . **schotti.**
aa. Depth of head equal to its length; gape short, just reaching to below the anterior nostril. . . . . **balænops.**

22. Sternarchella schotti (Steindachner).

Sternarchus schotti STEINDACHNER, Die Gymnotidæ, 4, pl. 1, figs. 1 and 2, 1868 (Barra do Rio Negro); GÜNTHER, Cat., VIII, 3, 1870; COPE, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); STEINDACHNER, Flussf. Südam., II, 42, pl. 2, fig. 2, 1881 (Manacapuru); EIGENMANN AND EIGENMANN, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchella schotti EIGENMANN AND WARD, Proc. Wash. Acad. Sci., VII, 1905, 164 (Amazons); EIGENMANN AND BEAN, Proc. U. S. Nat. Mus., Vol. 31, 665, 1907 (Lower Amazon); VON IHERING, Os Peixes do Brazil, Part 1 A, 1907; EIGENMANN, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazons).

3196 C. M., five (all with the caudal region more or less mutilated), length estimated 130 mm. more or less. Santarem, Dec. 15, 1909, Haseman.

Snout 3.1 to 3.4, interorbital 5.25 to 6 in the head; eye 3 to 4 in the snout, about 2 in the interorbital, and 10 to 12 in the head; depth of the head in the occipital region 1.5 to 1.75 in the length of the head.

Body and head compressed, both rather elongate; anus between the vertical from the eye and that from the posterior nares; dorsal profile almost straight; ventral weakly convex in the pectoral region.

Snout straight or very slightly sloping and rather blunt; mouth moderately large; gape curved and short, not reaching beyond the vertical from the posterior nares; jaws about equal, the lower appearing longer when the mouth is open, and included by the upper on the sides when closed; teeth quite small, in two semicircular rows in each jaw.

Origin of the anal on or slightly in front of the vertical from the origin of the pectorals; pectorals 1.3 to 1.5 in the head.

Ground color pale straw-yellow; mid-dorsal region and top of head quite dark, being almost completely covered with minute black dots, lateral portions of the dorsal region less heavily dotted; sides very sparsely sprinkled with fine dark brown dots; origins of the anal rays faintly outlined with minute spots; cheeks with a very few rather prominent dark brown dots; fin-membranes hyaline, rays more or less brownish.

This species is found only in the Amazon system.

23. **Sternarchella balænops** (Cope).

Sternarchus balænops Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchella balænops Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 164 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Peruvian Amazon).

"Profile oblique, with a depression between the orbits; snout short and much narrowed; lower jaw large, projecting beyond the upper both anteriorly and laterally, enclosing the latter somewhat as in a whalebone whale. The fissure of the mouth is short, only reaching the vertical line from the anterior nostril. Eyes small, without free border, much nearer the snout than the gill-opening, one-twelfth the length of the head, which latter enters the length without the caudal fin, 8.5 times. The depth at the base of the dorsal thong is equal to the length of the head. Anal radii 171. Scales very large, in only nine longitudinal rows at the base of the dorsal thong. Color olivaceous, with a pale dorsal band which reaches the dorsal thong, and a pale narrow band on each side near the dorsal band. Length 165 mm.; length to origin of anal 20 mm.; length to base of dorsal thong 96 mm.

"This species resembles remotely the *S. Schotti* of Steindachner, but differs from it and from all the other species in the much enlarged mandible and large scales." (After Cope.)

XIV. Porotergus Ellis.

Porotergus Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., V, 1912, 440.

Type, *Porotergus gymnotus* Ellis.

Distinguished from the other *Sternarchinæ* by the absence of scales along the middle of the back to beyond the middle of the dorsal thong; gape rather long, almost reaching vertical from the eye; scales in region of lateral line quite large; body rather elongate.

Species of Porotergus.

a. Head 7 to 7.75 in the length to the base of the caudal; snout 2.2 to 2.5 in the head; anal rays 130 to 150. *gymnotus.*

aa. Head 8.5 to 10.25 in the length to the base of the caudal; snout 2.5 to 3 in the head; anal rays 175 to 180. *gimbeli.*

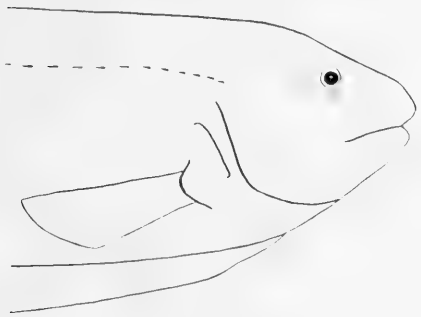


FIG. 15. *Porotergus gimbeli* Ellis.

24. **Porotergus gymnotus** Ellis. (Plate XXIII, fig. 4.)

Porotergus gymnotus ELLIS, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 441.

1759 C. M., type, 70 mm. Amatuk, Eigenmann.
12636 I. U. M., cotype, two, 68 and 85 mm. Amatuk, Eigenmann.
1758 C. M., cotype, one, 62 mm. Konawaruk, Eigenmann.

Head 6 to 6.5, greatest depth 6.2 to 6.7 in the length to the end of the anal. Anal rays 130–147[8]; snout 2.2 to 2.5 in the head, interorbital about the same; eye 5 or 6 in the snout and 12 to 14 in the head; 5 to 8 rows of scales above the lateral line; mid-dorsal space naked and abundantly supplied with mucous pores.

Compressed and slender; depth of the head in occipital region 1.25 to 1.5 in the greatest depth; anus not quite the length of the snout behind the vertical from the eye; dorsal profile behind the head almost straight, the head sharply sloping; ventral profile slightly convex, save in the mental region, where it is rather concave.

Snout heavy and somewhat truncate; mouth moderately large; gape straight, not quite or barely reaching below the eye; jaws stout, lower included on the sides; teeth few, small, conical, in two irregular interrupted rows, the inner one of the lower jaw represented by but three or four teeth, two small patches of not over six teeth each in the upper jaw.

Caudal 2.8 in the head, pectorals 1.3; origin of the anal a little in front of the gill-opening.

Ground-color dark golden brown, darker dorsally; scales, anal rays, and parts of the head outlined with dark brown; upper parts of the head and back, also a spot at the origin of the lateral line, almost black; cheeks brown with numerous

[8] Type, Amatuk, 138. Cotypes, Amatuk, 140, 141. Cotype, Warraputa, 147. Cotype, Konawaruk, 130.

minute yellowish dots; lips, the openings of the mucous canals in mid-dorsal region, the anus, and a small spot at origin of caudal, yellowish; fins hyaline.

Distribution: Essequibo basin, British Guiana.

25. **Porotergus gimbeli** sp. nov.[9] (Plate XXIII, fig. 3.)

Porotergus gimbeli Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 441.

3197 C. M., type, 200 mm. Pará, Jan. 22, 1910, Haseman.
3198 C. M., cotypes, two, 170–240 mm. Pará, Jan. 22, 1910, Haseman.
Cotype, one. Hubabu Creek, B. G., Oct. 1, 1910, Ellis.

Head 8.5 to 10.25; greatest depth of the body 8.25 to 9 in the length to the base of the caudal; anal rays, type, 175; cotypes, 178, 167, 180.

Snout 3 to 3.6, interorbital 4 to 5 in the head; eye 3 to 3.5 in the snout, 2 to 2.8 in the interorbital and 11 to 14 in the head; lateral line prominent, extending out on the caudal. Snout rather short and blunt; mouth moderately large; jaws equal when closed; the lower included; teeth small, conical and few in each jaw; eyes small.

Body and head compressed, body rather elongate; width of the head 2.5 to 3.1, depth of the head in the occipital region 1.3 to 1.6 in the greatest depth of the body; anus on the vertical from the eye; scales moderately large and prominent; a mid-dorsal band extending to the end of the dorsal filament with numerous mucous pores and without scales; dorsal profile very weakly convex or almost straight; ventral profile somewhat convex.

Caudal fin 1.8 to 2.5, pectorals 1.2 to 1.5 in the head; origin of the anal the diameter of the eye or a little more in front of the vertical from the gill-opening; scales extending well out on the caudal.

Ground-color rather light yellowish brown; dorsal portions, especially the naked dorsal band, overlaid with dark brown; most of the scales somewhat outlined with brown; ventral parts lighter; a series of oblique blackish brown stripes alternating with the anal rays extending dorsad from the edge of the anal base about half way to the lateral line; mouths of the mucous pores and the under parts of the head a clear, pale yellow or buff; anal hyaline; pectorals hyaline to dusky, the first two or three rays usually distinctly brown; caudal base whitish, the scaled portion of the caudal almost black, the outer margin hyaline.

Distribution: Lower Amazon and British Guiana.

A specimen, No. 2972, from Santarem, 190 mm., with head 7.5, snout 3; A. 175, probably belongs here.

[9] Named for Mr. Jake Gimbel, whose generosity made the Gimbel Expedition to British Guiana possible.

XV. Sternarchogiton Eigenmann and Ward.

Sternarchogiton Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 164, 1905.

Type, *Sternarchus nattereri* Steindachner.

Distinguished by the absence of teeth in the upper jaw, otherwise like *Sternarchus*.

A genus of a single species.

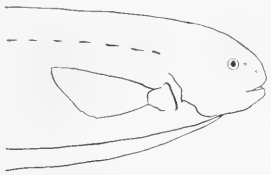


Fig. 16. *Sternarchogiton nattereri* (Steindachner).

26. Sternarchogiton nattereri (Steindachner).

Sternarchus nattereri Steindachner, Die Gymnotidæ, 3, pl. II, fig. 1, 1888 (Barra do Rio Negro); Günther, Cat., VIII, 3, 1870; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua).

Sternarchogiton nattereri Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 165, 1905 (Barra do Rio Negro; Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Barra do Rio Negro).

"Length of the head about 12, depth of the body a little more than 8 in the total length; snout 3.5, pectoral 1, the caudal about 2 in the length of the head; anal rays 197; the pointed pectoral with 16 rays; the almost completely scaled caudal with 18 or 19 rays. Scales of the lateral line and the neighboring ones larger than the others.

"Upper jaw without teeth, those of the lower small and in a single row." (After Steindachner.)

Distribution: Middle and Upper Amazons.

XVI. Adontosternarchus genus nov.

Type, *Sternarchus sachsi* Peters.

Distinguished from all other *Sternarchinæ* by the absence of teeth from both jaws, and by the peculiar V-shaped groove in lower jaw into which the beaklike upper fits.

A genus of a single species, *A. sachsi*.

27. **Adontosternarchus sachsi** (Peters). (Plate XXII, fig. 3.)

Sternarchus sachsi Peters, Mb. Akad. Wiss. Berl., 1877, 473 (Apuré); Sachs, Aus den Llanos, Berlin, 1878, 153, fig. 279; Sachs, Unters. am Zitteraal, Leipzig, 1881, 13 (Apuré); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchogiton sachsi Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 165 (Orinoco); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Orinoco).

3199 C. M., six, 110–170 mm. San Joaquim, Sept. 5, 1909, Haseman.
3200 C. M., fifty-one, 95–125 mm. Santarem, Dec. 12, 1909, Haseman.

Head 8.25 to 10, greatest depth of the body 7.8 to 9.7 in the length to the base of the caudal; anal rays, 154, 156, 168, 170, 176, 185.

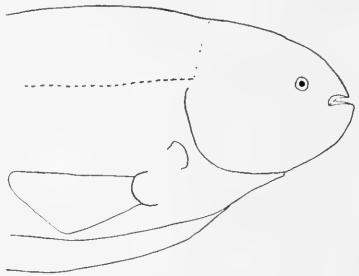


Fig. 17. *Adontosternarchus sachsi* (Peters).

Snout 3.2 to 3.5 in the head; interorbital equal to or very slightly longer than the snout; eye 2.75 to 3 in the snout, about 11 in the head.

Body moderately elongate; head compressed; width of the body 3.25 to 3.75; depth of the head 1.3 to 1.6 in the greatest body depth; anus about the length of the snout behind the vertical from the eye; dorsal profile almost straight; ventral profile rather regularly convex.

Snout pointed, quite short and curved downward; mouth rather small; gape moderate, bow-shaped and just reaching the vertical from the posterior nares; nares prominent, anterior about midway between the eye and tip of the snout, posterior not quite touching the upper anterior margin of the eye; upper jaw included, lower projecting very slightly and having a distinct V-shape notch in its center for the reception of the upper jaw, its lateral edges flare upward; scales small, larger in region of lateral line.

Caudal, which is scaled for some distance out from the base, 1.8 to 2.3, pectorals 1 to 1.4 in the head; origin of the anal on or a little in front of the vertical from the gill-opening.

Ground-color brownish gray to light yellow; body rather uniformly colored with minute dark brown dots, which are most abundant dorsally; fins hyaline, except the origin of the caudal and the outer edge of the extreme caudal portion of the anal; these regions smoky.

This species is found in the Orinoco, the Madeira, and Amazon.

Geographical Distribution.

The *Gymnotidæ* are restricted to the fresh-water of portions of Central and South America. They range from the Rio Motagua, in Guatemala to the Rio de la Plata, east of the Andes. They are also found on the western coast of Colombia and Ecuador. The distribution of this family is given in the table according to river-systems. The "Lower" Amazon includes the main Amazon stream up to Manaos, the Rios Tapajos, Xingu, Tocantins and their tributaries; the "Middle" Amazon is applied to the Amazon stream from Manaos to the mouth of the Içá, Rio Negro, Jurua, and their tributaries. The Rio Madeira, although a part of the Lower Amazon system, is considered separately, as it is through this river and its branches that the Amazon fauna has probably reached the Paraguay-Paraná.

Species.	Central America.	West Indies.	Rio Magdalena.	Rio Orinoco.	Guianas.	Lower Amazon.	Middle Amazon.	Marañon. Upper Amazon.	Rio Ucayale. Peruvian Amazon.	Ecuador. West Coast.	Brazil, North Coast.	Rio San Francisco	Uruguay and Brazil Southeast Coast.	Rio Madeira.	Rio Paraguay.	Rio Parana.	Rio de la Plata.
1. *Electrophorus electricus* (Linn.)				×	×	×	×							×			
2. *Gymnotus carapo* Linn.	×	×		×	×	×	×	×			×	×	×	×	×	×	×
3. *Sternopygus macrurus* (B. and S.)			×	×	×	×	×	×	×	×	×	×	×	×	×	×	
4. *Sternopygus obtusirostris* Steind.							×				×			×			
5. *Eigenmannia macrops* (Boulenger)					×												
6. *Eigenmannia virescens* (Val.)			×	×	×	×	×	×				×	×	×	×	×	×
7. *Eigenmannia troscheli* (Kaup)						×	×	×						×			
8. *Steatogenys elegans* (Steindachner)					×	×	×										
9. *Hypopomus brevirostris* (Steind.)			×		×	×						×	×	×	×		×
10. *Hypopomus artedi* (Kaup)					×	×					×		×	×	×		×
11. *Rhamphichthys rostratus* (Linn.)				×	×	×	×	×	×					×	×		×
12. *Gymnorhamphichthys hypostomus* Ellis					×									×		×	
13. *Sternarchorhynchus oxyrhynchus* (M. and T.)					×	×	×	×									
14. *Sternarchorhamphus müller*i (Steind.)						×											
15. *Sternarchorhamphus macrostomus* (Günther)								×									
16. *Orthosternarchus tamandua* (Boulenger)							×										
17. *Sternarchus albifrons* (Linn.)				×	×	×	×	×	×					×	×	×	
18. *Sternarchus brasiliensis* Reinhardt												×					
19. *Sternarchus leptorhynchus* Ellis					×												
20. *Sternarchus hasemani* Ellis						×											
21. *Sternarchus bonaparti* Castelnau						×	×		×					×			
22. *Sternarchella schotti* (Steind.)						×	×		×								
23. *Sternarchella balænops* (Cope)									×								
24. *Porotergus gymnotus* Ellis					×												
25. *Porotergus gimbeli* Ellis					×	×											
26. *Sternarchogiton nattereri* (Steind.)							×										
27. *Adontosternarchus sachsi* (Peters)				×		×								×			
Total	1	1	3	7	15	17	14	8	6	1	4	5	5	13	7	5	5

Three species, *Gymnotus carapo*, *Eigenmannia virescens* and *Sternopygus macrurus* are found throughout almost the entire range of the family. Four others, *Hypopomus brevirostris*, *Hypopomus artedi*, *Rhamphichthys rostratus* and *Sternarchus albifrons*, have an almost equally wide distribution. The remaining species are confined largely to the Amazon system and the Guianas. Twenty-four of the twenty-seven species are found in some part of the Amazon system and fifteen species are listed from the Guianas. The combined Amazon and Guiana faunas include all of the species of the family with the single exception of *Sternarchus brasiliensis*. This species is known only from the Rio San Francisco and its tributaries and is restricted to the higher parts in the region of the Sierra Matta da Corde.

The *Gymnotidæ* are largely lowland fishes as is shown by the steady decrease in the number of species as the Amazon is ascended. This of course may be due in part to incomplete exploration. In places when the faunal survey has been quite complete, however, they are largely found in the lowland. Of the fifteen species known from British Guiana all are found in the lowland, while but two, *Gymnotus carapo* and *Eigenmannia virescens*, have been taken on the plateau.

Locomotion and Musculature.

I. *Locomotion.*

The method of swimming, particularly the use of the long anal fin, of the *Gymnotidæ* has been discussed several times. No final conclusion has been reached, however. In 1774 Alexander Garden described the method of swimming of the electric eel. He worked at Charleston, S. C., with five specimens which had been shipped him from Surinam. The motion of the fish, according to Garden, was the result of an undulating movement of the anal fin. This has subsequently been shown to be correct by Sachs. Unfortunately Lacépède misquoted Garden in his "Histoire Naturelle des Poissons" published in 1800, by ascribing the undulating motion not only to the anal fin but to the body of the eel as well. As a result of this the exact use of the anal fin remained in doubt until the careful work of Sachs (Zitteraal, 1881). He described the swimming of the electric eel in detail as follows:

"Die Zitteraale sind ausnehmend gewandte Schwimmer und zwar schwimmen sie gewöhnlich nicht durch Schlängeln des Schwanzes, wie Lacépède annimmt, sondern einzig und allein unter Anwendung der weichhautigen, dem Kiel eines Schiffes gleichenden Afterflosse, welche durch die Brustflossen in geringemgrade unterstützt wird. Die Bewegung der Afterflosse besteht in einer wellenförmigen Schlängelung; läuft die Wellen von vorn nach hinten so wird der Fisch vorwärts bewegt, läuft sie umgekehrt, so schwimmt er rückwärts; die Bewegung ist geradlinig oder bogenförmig, je nachdem der Körper des Fisches ausgestreckt oder gekrümmt ist" (p. 104, l. c.). Sachs neglected to observe the method of swimming of the

other *Gymnotids* and was unable to say whether the method described for *E. electrophorus* was common to all.

In his phylogenetic-ethologic study of the *Gymnotidæ*, Schlesinger (1910) states that the use of the anal fin described by Sachs must be general throughout the family. He bases his conclusion entirely on a morphologic comparison between the Mormyrid *Gymnarchus* and the Gymnotids *Electrophorus* and *Gymnotus*. In a footnote he adds that Dr. Franz Steindachner told him that he had seen living Gymnotidæ in Brazil swimming in the method described.

While in British Guiana in the summer of 1910 I had opportunity to study the motion of a number of species in their normal environment. Three species in particular were examined, *Eigenmannia virescens* and *Sternopygus macrurus*, which are abundant in the trenches in and about Georgetown, and *Gymnotus carapo* in Hubabu Creek. Several other species were also seen alive. In every case two methods of swimming were observed, (1) the use of the anal fin alone, and (2) the use of the anal aided by the body proper or the pectorals or both.

When at rest the Gymnotids face the current of the stream, the entire body and caudal appendage being in a straight line and the pectorals laid back against the body. The anal fin was kept moving just enough to counteract the motion of the stream, and the pectorals gave an occasional stroke. The movements of the anal fin were similar to those described by Sachs for the electric eel. From the cephalad end of the anal fin a series of undulating waves passed caudad so that a longitudinal section of the entire anal fin in motion resembles a fairly regular sine curve. There were usually six of these waves traversing the fin at any one time, rarely five or seven. The speed of the wave varies with the speed of the current of the stream—always being just sufficient to maintain the position of the fish. If the current varied in direction the fish responded at once with a stroke of one or both of the paddle-shaped pectorals, which kept the long axis of the fish parallel to the direction of the current. Otherwise the pectorals were not used. During these resting periods the caudal appendage streams out behind the fish.

If a resting fish were slightly disturbed it merely increased the speed of the waves traversing the anal and moved away. If frightened (all of the *Gymnotidæ* were very easily frightened) it swam rapidly away by the same motion of the anal fin, the use of the pectorals being more frequent in guiding the fish. If it became necessary for the fish to make a sudden turn, the entire body was slightly curved in the desired direction. This curving of the body together with the rapid use of the pectorals enables these long fishes to make quite abrupt turns.

The second method of swimming involved the use of the entire body as well as the fins. When the fish was being pursued, the anal fin moved, as before, in a series of rapid waves, but in addition the entire body was at the same time moved in a serpentine fashion. In this way it was able to swim very rapidly. An individual would move the anal fin rapidly in the peculiar manner of swimming when held in the air.

While experimenting with these fishes the caudal appendage of several was removed. This seemed in no way to influence the speed or method of swimming. When a large portion of the anal fin was cut off the fish swam by means of the pectorals. If the pectorals alone were removed, the fish swam by the use of the anal fin and body motion together. This was probably due to an effort to guide itself, since the guiding is done almost entirely by the pectorals. The anal could be used for either backward or forward movement.

II. *Anal Musculature.*

The muscles moving the anal fin, the muscles *pinnalis analis externalis* and *pinnalis analis internalis*, together with the muscles *lateralis imus* and the *interhæmal* spines compose the thin compressed region just above the anal fin. These muscles, as well as the *interhæmal* spines, are directed ventro-caudal at an angle of five to ten degrees to the long axis of the fish, hence in a cross-section of the body the obliquely cut ends of several show in the anal region. There is a pair of *pinnales analis externalis* and *pinnales analis internalis* for every anal ray. The *externales* are the larger of the two. These muscles have their origin in the skin on each side and their insertion on a lateral process on each side of the *dermohæmal* spine (anal ray). The *internales* arise from the dorsal portion of the *interhæmal* spine and are inserted on the top of the *dermohæmal* spine on each side of its articulation with the *interhæmal* spine. The *interhæmal* spine is a slim, straight bone, with its dorsal end pointed. On its ventral end it bears an enlarged rounded head, and two smaller knobs a little lower down. These knobs lie in the median cephalo-caudal line. The *dermohæmal* spine has a cup-shaped articulation on its dorsal end which fits around these three heads of the *interhæmal* spine in the nature of a ball and socket joint. The presence of the two small heads on the *interhæmal* spine in the cephalo-caudal line allows the *dermohæmal* spine only a limited motion in that direction, but a free movement laterally. The undulating movement of the anal fin results from the alternate contraction of the right *internalis* and *externalis* and then the left. Fig. 18 shows the anal musculature of *E. virescens* on a large scale. The muscles may be seen in Plate XIX, figs. 19, 20, 21, 22, 23, which are entire cross-sections. In the cross-sections, however, the anal musculature is drawn in the same plane as the trunk musculature and the ventro-caudal slope is disregarded, so that the entire muscle may be seen.

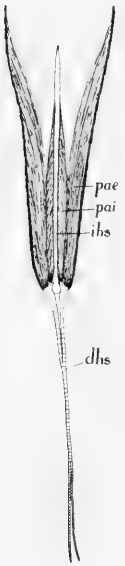


FIG. 18. Anal musculature. *Eigenmannia virescens* (Val.) *pae, pinnalis externalis; pai, pinnalis analis internalis;* ihs, interhæmal spine; dhs, dermohæmal spine.

III. *Trunk Musculature.*

The disposition of the muscles in the trunk is much the same for all species of the *Gymnotidæ*, although the individual muscles vary in size and shape with the presence or absence of the pseudo-electric organs. The trunk muscles are all paired, one on each side of the median line. Naming them in order dorsoventrally they are, *notalis externalis, notalis internalis, dorsalis, lateralis superior, lateralis inferior, ventralis,* and *lateralis imus.* The nomenclature of Fritsch is followed as far as given, *notalis* is a new name. (See Plate XIX, figures 19, 20, 21, 22, 23.) The region near the dorsal end of the *interhæmal* spine, which is not occupied by other tissue, is filled with fat cells and connective *tissue.* On Plate XIX, fig. 20, the pseudo-electric organs are to be noted.

Electric Organs of the Gymnotidæ.

I. *Electrophorus electricus* (Linnæus).

The electric eel is the only species of this group which has been demonstrated to possess electric power. Richter in 1729 published the first scientific account of this species in the Paris Academy. His account was soon followed by many others. The earliest English description of this fish is that of Edward Bancroft in his "Natural History of Guiana," 1769. This contains an interesting account, which is here quoted:

"There is one, however, of the Eel tribe which deserves particular attention, and which I shall beg leave to call the Torporific Eel, till it is distinguished by a more proper name.

"This fish is a native of fresh water and is most commonly found in the River Essequibo, being usually about three feet in length, and twelve inches in circumference near the middle. It is covered with a smooth skin of a bluish lead color, very much like that of sheet lead which has been long exposed to the weather, being entirely destitute of scales. The head equals in size the largest part of the body, but is somewhat flat on the upper and lower sides, and its upper surface is perforated with several holes, like those of a Lamprey Eel. The upper and lower jaws extend in equal distance, terminating in a semi-oar-shape, and forming a wide mouth without teeth. On the back part of the head are two small fins, one on each side, much like the ears of a horse, are either elevated or depressed as the fish is pleased or displeased. From about eight inches below the head, the body gradually diminishes in size to the tail, which ends in a point, without a fin. Under the belly is a fleshy fin, about half an inch in thickness and near three inches wide, extending from the head to the point of the tail, but diminishing in width as the body diminishes in size; this, with the two fins on the head are all that I found on the body of this eel, which would be nearly round if deprived of the belly fin. This fish frequently respires and elevates his head above the surface of the water every four or five minutes. But the most curious property of the Torporific Eel is

that when it is touched either by the naked hand or by a rod of iron, gold, silver, or copper, etc., held in the hand, or by a stick of some particular kind of heavy American wood, it communicates a shock perfectly resembling Electricity, which is commonly so violent, that but few are willing to suffer it a second time" (p. 190 *et seq.*).

This is a fair description of the eel and its shock. The most noticeable error in Bancroft's statement is that the eel is toothless. As soon as it became rather generally known that this fish actually possesses the power of giving a severe shock, it was taken up by quacks of all sorts. Several doctors in the Guianas at once claimed remarkable cures to have resulted from the proper use of the electric eel. One man in particular, Van der Lott of Georgetown, was especially active in urging the use of the electric eel in the treatment of disease. Various other people from time to time have suggested this use and even today there is an idea extant that a piece of the electric eel's skin, worn about the limb affected, will remove rheumatism. Many of the accounts of the electric eel relate strange tales of its uses and properties. The story of Humboldt has become classic. This represented the Indians driving horses into the pool inhabited by the electric eels which were eventually caught as they floated on the surface after having exhausted themselves by shocking the horses. Sachs relates the use of the dried vertebræ of the eel by the Indians in childbirth. He also states that the belief is current that a cock once shocked by an electric eel is capable of shocking anything else for the remainder of the day; that persons chewing tobacco are immune from being shocked; and that a person shocked in the leg is apt to become permanently lame.

With the advances in science the electric fishes were more carefully investigated and among those who studied the electric eel was Faraday. He gave the first accurate estimate of the power and nature of the shock of this fish after experimental work with a 101.6 cm. specimen in captivity at the Adelaide Gallery. He found an average shock from this fish to be equal to that from a battery of fifteen Leyden jars with a surface of 2.258 square meters loaded to their maximum (p. 8, Exp. Researches).

In 1876–9 Dr. Carl Sachs made a series of observations and experiments upon the electric eel in its natural environment. This work was done in Venezuela on the Rios Apuré and Orinoco. Unfortunately, he lost his life shortly after his return to Europe, before he had worked up his valuable data. Bois-Reymond published his notes in 1881 in "Untersuchungen am Zitteraal" (Leipzig). The following discussion of the electric eel is based in part on this book.

1. *Anatomy.*

There are three pairs of electric organs in *E. electricus*, the large electric organs, the secondary organs or the organs of Hunter, and the bundles of Sachs. The large organs and the organs of Hunter both begin a short distance behind the viscera and run nearly the whole length of the fish. The bundles of Sachs are

found only in the posterior half of the fish. The large organ of each side is more or less quadrant shaped in cross-section, and is of greatest diameter about a centimeter back of its origin. It tapers gradually back of this point becoming more nearly circular in cross-section until it disappears a few centimeters from the end of the tail. It lies on each side of the hæmal spine above the anal fin musculature and below the muscle *ventralis*. In the region of its maximum size the top of each organ is on a level with the vertebral centra, but as the caudal end is approached, the dorsal portion of each organ lies more and more ventrad.

The organ of Sachs consists of a series of bundles of fibers which resemble both muscle and electric tissue. From the middle of the body to the caudal end of the large electric organs, the organs of Sachs lie on the *dorso-lateral* surface of the latter, just below the muscle *ventralis*. The bundles of this organ wrap around the large electric organ obliquely in a latero-ventral direction. They extend farther ventrad as the caudal extremities of the large organs are neared. They finally close over the ends of these. The organs of Sachs increase in diameter caudad.

The organs of Hunter are triangular in cross-section and much smaller than either of the other two pairs of organs. They are in the anal fin region and lie between the muscles *pinnalis analis externalis* and the muscles *pinnalis analis internalis*. Dorsally they are separated from the large organ by the remnants of the muscles *lateralis imus*. They taper off as their caudal ends are approached and terminate a few centimeters in front of the ends of the large organs. Plate XIX, figs. 21, 22, 23 represent cross-sections of the electric eel showing these points.

Both the large organs and the organs of Hunter are composed of plates of tissue which run parallel to the large axis of the fish. In the large organs these plates are more or less arched ventrally in cross-section. In the small organs they are almost flat. The number of these plates seem to be rather constant in each organ, regardless of the size of the fish. Bois-Reymond (in Sachs, Zitteraal, p. 32) gives the following table:

Observer.	Body Length.	Plates in Large Organ.	Plates in Small Organ.
Sachs	31 cm.	30	14–19
Knox	48.5	32	17
Pahlberg	68.5	32	13
Hunter	71	35	15
Kupffer and Keferstein	120	31	Not given
Humboldt	Not given	36	20
Sachs	Not given	30	14–19

According to Sachs, who confirmed in general the work of Pacini, the large electric organs are made up of minute units about .14 mm. broad, which lie at right angles to the long axis of the plates. Each unit is divided near the center by a vertical partition. On the anterior face of this are several papillæ which do not reach the wall of the unit. On the posterior face are fewer papillæ which reach out to the wall of the unit. Between the latter are several minute papillæ. It is

on this side that each unit receives its nerve-fibers. It is not, however, intended here to discuss the microscopic structure.

Aside from the electric organs the anatomy of the electric eel is very similar to that of the other *Gymnotids*.

2. *Nature and Strength of Electric Shock.*

Sachs states that the electric shock may be received in four ways.

1. By completing an electric arc.
2. By conduction.
3. Direct contact.
4. From the water in which the eel is discharging shocks.

1. Sachs considers an arc to be completed if the electric eel is touched at two points. He found the maximum shock was received when the connections were made just behind the head and at the end of the tail. This of course included the entire mass of electric tissue. Sachs accidentally made such an arc with an eel three and one-half feet long. Its head fell on one foot and its tail on his other leg. The contact lasted for about thirty seconds, during which time Sachs was unable to move. He experienced great pain the rest of the day and soreness of the limbs for some time afterward. Humboldt tells of stepping on a four foot eel in such a way as to make a head and tail connection and being instantly knocked down by the shock received. Dr. Eigenmann relates that all of the fishes taken in a haul of a large seine were killed by an electric eel, which was among the catch, while the seine was being pulled in. The experiments of Sachs showed that the strength of the shock varied directly with the amount of the electric tissue included in the arc.

2. and 3. Direct contact in but a single place on the fish is also capable of transmitting a shock, if the ground completes the circuit. A severe shock can be received if the eel is only touched by a finger. In the same way the shock can be inflicted through wet wood, cordage, metal, or any other conductor. Glass and rubber are insulators against it.

4. The limit of the effectiveness of the shock in water has never been determined. Sachs gives several cases of the transmission of the shock in this way. Mules are often knocked from their feet while fording small streams frequented by the eels, without actually being struck by them. Natives attempting to get out of a boat into the water are frequently unable to get either in or out after touching the water if an eel is near by, until the shock ceases. On account of such occurrences the natives regard these eels with great fear and hatred, killing them when opportunity offers. While experimenting with eels in wooden troughs, Sachs found they were able to kill frogs, fishes, and freshwater shrimps (contrary to the idea that the last mentioned form is immune) at a distance of several feet.

A careful count of the number of shocks given by a single eel was made by

Sachs. During one hour this eel gave 150 distinct shocks and by actual measurement the last was as strong as the first. Humboldt stated that after a few shocks the eel became exhausted and it took both food and rest to recuperate its electric power. Sachs found no evidence of such a condition.

The shock of the electric eel readily decomposes potassium iodide, as has been shown by its effect on potassium iodide starch-paper.

3. *Origin of Electric Organs.*

Fritsch concluded (Sachs' Zitteraal, 355 *et seq.*), after a comparison of the musculature of electric eels and the other *Gymnotids*, that the large electric organs have originated through the metamorphosis of the *lateralis imus* muscles. This view is substantiated in several ways. The muscle *lateralis imus* occurs on both sides of the median line in the other *Gymnotids* in precisely the position occupied by the large electric organs in the electric eel, in which this pair of muscles are wanting. Along the ventral side of each of the large electric organs is a small strip of muscular tissue, which is continuous with the electric plates. This is probably an unmetamorphosed remnant of the muscle *lateralis imus*. The origin of Hunter's and Sachs' organs has not been definitely worked out. The remaining musculature is the same in all *Gymnotids*. It is known that the electric organs of several of the other electric fishes (*Torpedo, Malopterus*, etc.) are metamorphosed muscle tissue.

II. *Eigenmannia virescens* (Valenciennes).

Sachs (*l. c.*, p. 69) recorded in his notes an observation on pseudo-electric or electric tissue in *Sternopygus* (*Eigenmannia*) *virescens*. As this portion of the notes was not worked up before his death it is not clearly understood. He wrote:

"Der dem electrischen Organ von *Gymnotus* entsprechende Theil zeichnet sich durch regelmässige Streifung in Zwischenräumen von 1 $^{mm.}$ aus. Der Durchschnitt hat ein entschieden an *Gymnotus* erinnerndes Verhalten. Die betreffende Stelle (a) ist durchscheinend und von horizontalen Septis durchzogen, Die mikroskopische Untersuchung fällt wegen der Schwierigkeit des Gegenstandes ungenügend aus. Es werden jedoch Formelemente, etwa ähnlich dem Durchschnitt der Platten von *Malopterurus*, mit runden Kernen und einfach buchend, nachgewissen. Andererseits finden sich gewaltige Mengen dicker markhaltiger Nervenfasern mit reichen büschelförmigen Verzweigungen. Der Zusammenhang der (etwaigen) beiden Elemente aufzuklären gelingt aber nicht in befriedigender Weise."

This is accompanied by a figure which is reproduced in Plate XIX, Fig. 24. Fritsch, after a careful examination of specimens of this species, doubts the existence of these elements. The region marked "α" by Sachs was occupied, in the specimens I examined, by connective tissue fibers and the edge of the two lateralis muscles. *Eigenmannia virescens* is the only other *Gymnotid* besides *E. electricus* to which electric tissue has been ascribed.

III. *Steatogenys elegans* (Steindachner).

In the original description of this species Steindachner[10] notes a pair of cylindrical filaments which lie in grooves on each side of the mental region and a second pair of skinny flaps, one of which projects from a groove on each side above the pectorals. Boulenger[11] placed this species in a separate genus because of these peculiar filaments. Neither of these pairs of filaments has been studied farther, since very few specimens of this species have been collected.

Specimens of this species in the collections made by Dr. Eigenmann and by Mr. Haseman make a detailed study of these filaments possible, and subsequently I obtained six specimens while in British Guiana. Only a short account of these organs is given here, as they are to be more fully described in a separate paper.

The mental filaments begin near the lower margin of the pectorals, curving downward and inward until the middle of the mental region is reached. They terminate side by side about two millimeters from the edge of the lower pair. Each filament is covered for its entire length, except at its termination, by a thin transparent membrane. About a millimeter from the tip of each filament this membrane separates, leaving a median, oval area exposed. In preserved specimens this membrane may easily be torn and the entire filament lifted out of the containing groove to its attachment below the pectoral. The filaments are about twelve millimeters long and half a millimeter in diameter. In life they are transparent, but when preserved they become fatty in appearance and show numerous opaque cross-bands. These bands are plate-like structures, which cross the cylindrical filaments at about right angles, and on both surfaces bear small papillæ. The plates in the specimens so far examined vary in number from sixty-eight to eighty in each filament. On the proximal (i. e., dorsal) edge of each filament a large nerve runs the entire length of the filament and distributes its fibers to the plates. The space between the plates is crossed about midway by a very delicate partition. The lateral filaments, called skinny flaps by Steindachner, are much like the mental filaments. Each lies in a groove, which begins just above and behind the origin of the pectorals and curves upward and backward from its base, a thinner portion extends downward behind the pectorals to the origin of the ventral filament. The histological structure of these filaments shows many points of similarity with that of the electric tissue of the electric eel. For the present, at least, these structures are considered as electric, or pseudo-electric, organs.

IV. *Other Pseudo-electric Organs.*

A paired organ made up of long fibers was found in *Sternarchus albifrons* (Linnæus) and *Sternarchus hasemani* sp. nov., running from just behind the viscera to about the middle of the caudal region. The two halves of this organ lie in the

[10] Steindachner, Fish-Fauna Cauca-Guayaquil, 1880, p. 37.

[11] Boulenger, Trans. Zool. Soc., Lond., XIV, 1898, p. 428.

* A Study of the Submental Organs of *Steatogenys elegans*, etc., by Annie Lowrey. *In press.* Miss Lowrey finds the submental organs to agree histologically with the electric tissues of *E. electricus.*

center of the animal just below the *lateralis inferior* muscles and above the *ventralis* muscles. In cross-section each half is roughly trapezoidal and about the size of the muscle *lateralis inferior*. Macroscopically these two masses resemble electric tissue. Their histological structure is to be discussed in another paper.

Two other much smaller bundles of tissue, which did not seem to be muscles, were found between the muscles *ventralis* and *imus* near the median line, not only in *Sternarchus albifrons* and *Sternarchus hasemani*, but also in *Gymnotus carapo* (Linnæus) and *Adontosternarchus sachsi* (Peters).

These bundles were not so clearly defined as the first mentioned organs, and may be nothing more than muscle fibers. See Plate XIX, Fig. 20.

Food of the Gymnotidæ.

References to the food of this group of fishes are few. Specific records were found only for the electric eel. Kaup, in 1856, made a general statement concerning the probable food of the fishes of the genus *Rhamphichthys* and from time to time statements have been made concerning the food of the electric eel. Schlesinger has recently speculated on the probable food of this group. His speculations are based on the similarity of species of the *Gymnotidæ* and the *Mormyridæ*.

Since large numbers of specimens of several species were available, a study of the contents of their stomachs was undertaken. The large number of specimens permits a detailed study of the food of *Gymnotus carapo*, *Sternopygus macrurus*, *Eigenmannia virescens* and *Eigenmannia macrops*. The data for the other species are rather incomplete. The stomach-contents were washed into Petri dishes with alcohol. All of the large pieces were picked out and identified. The residue was then taken up with a pipette and examined under the microscope on an ordinary glass-slide, on which four pieces of glass had been cemented to form an alley a little narrower than the field of the microscope. The results of the examinations are tabulated for each species. In several of the tables the terms, "Insect debris," "Vegetable debris," occur. No attempt was made to identify the vegetable matter. The "insect debris" is a mass of parts of insects which could not be identified with certainty. On the whole the stomachs were found either quite empty or containing a large mass of food, little, if at all, mangled. Only a few of the stomachs contained partly digested food. Examination of the intestines showed digestion to be quite complete, for chitinous parts of insects and fragments of the calcareous portions of macro-crustacea were the only undigested material found among the otherwise soft intestinal contents.

Gymnotus carapo Linnæus.

Snout short, heavy and blunt; conical teeth in both jaws; mouth large; size, not exceeding 500 mm.

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Annelida.	Malacostraca.	Fishes.	Vegetable Debris.
1	Holmia	430						1		
2	Aruataima	410						2		
3	Aruataima	320						1		
4	Nickaparoo	300						1		
5	Nickaparoo	250						1	1	
6	Trementina	250						1	1	
7	Aruataima	240		1				1		*
8	Nickaparoo	235		4		*				
9	Holmia	230		3				1	1	
10	R. das Velhas	225		1						
11	Aruataima	222		11			1	1		
12	Aruataima	200		3		*				
13	R. das Velhas	180		15	1					*
14	Nickaparoo	180		13		*		1		
15	Entre Rios	175		20		*				
16	Holmia	172		22						
17	Holmia	170		10		*				
18	Holmia	165		7		*				
19	Packeoo	160	3	7						
20	Packeoo	160	13							
21	Holmia	120		3						
22	Nickaparoo	100								
23	Tukeit	100	5	16						
24	Packeoo	90	6							
25	Entre Rios	90	9							
	Total		36	136	1		1	11	3	

It will be seen from the preceding table that a correlation exists between the kind of food taken and the size of the eel. The twenty-five specimens may be divided into three groups. The first of these groups includes all of the specimens between 240 mm. and 430 mm. in length. These fed almost entirely upon large crustacea and fishes, only a few insects having been eaten by three of the smaller ones. Of the eleven malacostraca one was an Isopod, the rest freshwater shrimps. Two of the three fishes found were small Characins; the third, which was found in the stomach of No. 4, was a *G. carapo* 90 mm. in length. The second group, those specimens between 100 and 240 mm. in length, contained little else than insect larvæ. The larvæ of Diptera and of Trichoptera of several species were especially abundant. Of the one hundred and thirty-six insect larvæ found eighty-one were Diptera, twenty-seven Trichoptera, six Odonata, and twenty-three uncertain. The Dipterous larvæ resemble the larvæ of *Simulium* in general shape and size. The Trichopterous larvæ, which had been swallowed with the case uncrushed, were forms whose cases were made of small particles of sand, some being straight, others cochlear in shape. Only fishes under 100 mm. in length had eaten Entomostraca. These had also taken small parts of insect larvæ. The single adult insect found was a medium sized cricket, the one worm a small Oligochæte.

Summarizing: The small specimens had fed upon Entomostraca and insect larvæ, those of medium size upon the larvæ of insects and large crustacea, the largest upon large crustacea and fishes. One individual was a cannibal. None of the food was from the air, the land, or the surface of the water; a large per cent of

it was free-swimming. It is probable therefore that most of the food is taken while it is moving.

ELECTROPHORUS ELECTRICUS (Linnæus).

Snout moderate and blunt; conical teeth in both jaws; mouth large; size up to seven feet.

No stomachs of this species were examined. From the references given below its food seems to consist for the most part of small fishes and freshwater shrimps. The data are for large eels only and in two or three instances show the kinds of food which is taken when in captivity, rather than the normal food as chosen by the free fish. The authority is stated and followed by the food mentioned.

Sachs, Zitteraal, p. 108: "especially freshwater crustacea, also small fish, small crayfish, many insects, and grasshoppers."

Flagg, Trans. Am. Philos. Soc., Vol. ii, p. 172: "Its common food is shrimps or any small fish."

Garden, Trans. Am. Philos. Soc., 1775, p. 110: "Small fish, also any animal food if it is cut so they can swallow it."

Faraday after Humboldt, Experimental Researches, 1753, p. 3: "Boiled meat and bread, small fish."

Sachs, *l. c.*, 110: "Nothing dead, except dead fish."

STERNOPYGUS MACRURUS (Bloch and Schneider).

Snout rather blunt; minute teeth in patches in both jaws; mouth moderately large; size, up to 500 mm.

Sternopygus macrurus (Bloch and Schneider).

The contents of twenty-nine stomachs of this species were examined. Three items are found distributed in the table much as in the table given for *G. carapo*, namely: fishes, malacostraca, and entomostraca. The first two were eaten only by the fish above 290 mm. in length, while the last named were only in the stomachs of specimens less than 100 mm. in length. The most noticeable difference between the food of *G. carapo* and *S. macrurus* is the amount of insects consumed by the latter. Adult insects form the major portion of the food, not only of the medium-sized individuals, but of the eels above 100 mm. long. Four hundred and three adult insects were counted, of which three hundred and twenty-one were aquatic Coleoptera (for the most part *Gyrinidæ*); seventy-five aquatic Hemiptera (Corisidæ and Notonectidæ); four terrestrial Coleoptera (Carabidæ); three terrestrial Hemiptera (Reduviidæ and Pentatomidæ). They are all surface-forms or land-forms which could easily reach the water. The eighty-two insect larvæ were identified as follows: fifty-three Diptera; one Odonate; twenty-one Trichoptera, and seven doubtful. Seventeen fishes (Characins), one Amphipod, three Isopods, and three freshwater shrimps with fourteen entomostraca made up the rest of the food. The main food of medium-sized specimens is adult insects. In two larger indi-

No.	Length.	Locality.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Malacostraca.	Fishes.	Vegetable Debris.
1	500	Georgetown			2			1	*
2	480	Georgetown		3	15		1		*
3	450	Potaro River		5	1		1		*
4	430	R. S. Francisco				*			*
5	430	Pirapora		8	1	*			
6	410	Penedo						14	
7	400	Amatuk					2	2	*
8	400	Georgetown			1				*
9	400	Georgetown			8				*
10	380	Georgetown			46				
11	370	Georgetown		1	8				*
12	350	Aruka			1	*			*
13	340	Penedo				*			*
14	340	Georgetown			47	*			*
15	300	Potaro River		3	5	*	1		
16	290	Potaro River		13			1		*
17	270	Georgetown			95				
18	250	Georgetown	1	3	57				*
19	220	Georgetown		2	12				*
20	200	Georgetown			34	*			*
21	180	Georgetown		10	6	*			*
22	180	Georgetown			25				
23	170	Georgetown			15				
24	170	Georgetown		7	6				
25	160	Georgetown		2	9				
26	160	Georgetown	1	6	5				
27	150	Georgetown			3				
28	95	Savanah		11	1	*			*
29	60	Amatuk	12	8					
Total			14	82	403		6	17	

Eigenmannia virescens (Valenciennes).

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Hydrachnidæ.	Annelida.	Isopoda.	Vegetable Debris.
1	Wismar	270		13				20		
2	Wismar	265	1	29						
3	Georgetown	260	54	6	1					
4	Georgetown	258	19	2			4	1		
5	Maripicru	250	4	40						
6	Maciel	250			7		1	4		
7	Uruguayana	250	228	10	1	*				
8	Georgetown	240	190	8			26			
9	Hubabu	240	10	3		*	1	3		
10	Wismar	230	70	12					2	*
11	Corumba	230		9	3				1	
12	Santerem	220		33		*	4	6		
13	Wismar	220		107						
14	Wismar	200	430	47		*				
15	Georgetown	200	361	8						*
16	Georgetown	200	71	9			17	1		
17	Georgetown	190	8	46			4			
18	Potaro	190	144	152						
19	Santerem	140	79			*				
20	Itapura	135	82		1					
21	Maciel	90	17	17						
22	Bebeduro	85		20						
23	Santa Rita	50	50	3						
	Total		1,817	574	13		57	35	3	

viduals these were supplemented by large crustacea and small fishes. As this fish is known to frequent the weeds of the small open streams and trenches, it is probable, judging from the nature of its food, that it does most of its feeding at or near the surface.

Eigenmannia virescens (Valenciennes).

Snout short and rather blunt; minute teeth in patches in both jaws; mouth small; not exceeding 300 mm. in length.

In the twenty-three stomachs examined the bulk of the food was of two kinds, regardless of the size of the fish, namely Entomostraca and the larvæ of insects. These two kinds of food exceeded all others not only in numbers but in bulk. The only kinds of food found in any amount were Hydrachnidæ and Annelida. All of the food is soft and small. The four classes of food are found distributed throughout the table, but there is a grouping with regard to the size of the fish. Over one-half of the eighteen hundred and seventeen Entomostraca were taken from specimens under 200 mm. long, and more than one-half of the insect larvæ from the specimens over 200 mm. The other kinds of food were also found in the stomachs of specimens over 200 mm. long. The young fish are restricted to entomostraca more than the adults. The insect larvæ were for the most part small Diptera, and the Annelida represented a small soft form resembling *Tubifex*.

(3) *Eigenmannia macrops* (Boulenger).

Snout short, truncated; teeth minute; in patches in both jaws; mouth quite small; size small, not exceeding 200 mm.

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Hydrachnidæ.
1	Rockstone	175	44	3		*	1
2	Tumatumari	172	17	30			
3	Tumatumari	170	9	122			
4	Tumatumari	165	40	109			
5	Rockstone	160	4	7			3
6	Rockstone	160	23	22			
7	Rockstone	155	42	72			
8	Rockstone	150	4	40		*	
9	Rockstone	148	1	2			3
10	Crab Falls	144	16	34	1		1
11	Rockstone	140	44				1
12	Rockstone	140	7			*	
13	Rockstone	135	2	3			1
14	Crab Falls	135	1	4		*	
15	Crab Falls	130	30	47		*	5
	Total		284	495	1		15

Only adult specimens of this species were examined, so no comparison of the food and the size of the fish could be made. The food of this small species seemed much the same as that of specimens of *E. virescens* of the same size. Entomostraca and insect larvæ formed the bulk of it.

(4) *Eigenmannia troscheli* (Kaup).

Snout short; minute teeth in patches in both jaws; size small, not exceeding 250 mm.

The stomach of but a single specimen 180 mm. long was examined. It came from San Joaquim and contained twenty-nine Copepoda, seventeen Cladocera, three dipterous larvæ and one Hydrachnid. This food is of the same type as that taken from the two preceeding species of this genus.

(5) *Hypopomus brevirostris* (Steindachner) and (6) *Hypopomus artedi* (Kaup).

These two species are so similar that they will be considered together. Snout short, somewhat pointed; teeth wanting; mouth small; caudal appendage moderate to long; size small.

Hypopomus artedi (Kaup).

Locality.	Length.	Entomostraca.	Insect Larvæ.	Annelida.	Vegetable Debris.
Lama Stop-off	170	3	.....	2	*
Rio Jauru	145	4	25	1	*
Uruguayana	140	.....	18		
Santerem	130	.....	14	3	*
Caceres	120	.....	23	.....	*
Total		7	80	6	

Hypopomus brevirostris Steindachner.

Locality.	Length.	Entomostraca.	Insect Larvæ.	Annelida.	Vegetable Debris.
Chipoo Creek	165	14	10		
Campo Grande	140	17			
Niekaparoo	118	9	12	4	*
Itaituba	100	.....	14	7	
Boa Ventura	75	20			
Total		60	36	11	

(7) *Steatogenys elegans* (Steindachner).

Head chubby; snout short and blunt; mouth small; a cylindrical filament in a groove on each side of the mental region; size small.

This species was of particular interest because of the peculiar mental filaments. The stomachs of the specimens examined contained a large number of small annelids. These worms are small mud-inhabiting Oligochæta. The contents of the three stomachs are tabulated here:

Length.	Locality.	Entomostraca.	Insect Larvæ.	Annelida.
140 mm.	Kumaka	3	1	43
130 mm.	Kumaka	9	4	18
120 mm.	Kumaka	2	.....	29
Total		14	5	90

(8) *Rhamphichthys rostratus* (Linnæus).

Snout produced, long, and tubular; mouth quite small, terminal and inferior; teeth wanting; size large, approaching six feet.

The stomachs of three adults of this remarkable species were examined. In addition to a large amount of mud they contained 612 annelids.

Locality.	Length.	Insect Larvæ.	Adult Insects.	Annelida.	Amphipoda.
Wismar	900	33	.....	148	1
Wismar	750	9	1	214	
Wismar	580	40	.....	250	
Total		82	1	612	1

The annelids were all small mud-inhabiting worms, resembling *Tubifex*. The eighty-two insect larvæ were identified as seventy-one Diptera (a form much like the "Blood Worm") and eleven uncertain. The single adult insect was a small *Gyrinid* and the Amphipod a tiny specimen in general shape similar to *Eucrangonyx*. The small mouth of this species (in even the largest specimen examined it barely admits a lead pencil), the large amount of mud in the stomach and the nature of the food indicate that this species probably feeds by sucking up quantities of mud with the animals inhabiting it.

Kaup[12] in 1856 wrote concerning the genus *Rhamphichthys* (which then included *Hypopomus* as well): "Judging from the narrowness of their toothless mouth, these fish must subsist on small insects."

(1) *Sternarchus albifrons* (Linnæus).

Snout heavy and blunt; teeth in both jaws minute, conical; mouth large; size moderate, not exceeding 500 mm.

The stomach of a specimen of this species 285 mm. long contained one small Characin, two freshwater shrimps, and one large insect larva (perhaps a Gomphid). From the stomach of a second smaller specimen, 105 mm. long, nineteen entomostraca and three large insect larvæ were taken.

(2) *Sternarchus brasiliensis* Reinhardt.

Similar to the *S. albifrons*, but slenderer. In the stomach of an individual of this species 290 mm. long from Pirapora two small freshwater shrimps and a quantity of vegetable debris were found.

(3) *Sternarchus hasemani* Ellis.

Mouth moderate; size small; otherwise much as *S. albifrons*.

Two stomachs of this species were examined. One taken from a specimen 160 mm. long contained twenty-seven entomostraca, two larvæ of insects and

[12] Kaup, Apod. Fish Brit. Mus., 1856.

one Hydrachnid. The other stomach came from a specimen 180 mm. long and held eighteen dipterous larvæ and one large Odonate larva. Both specimens were from Santarem.

(4) *Sternarchorhynchus oxyrhynchus* (Müller and Troschel).

Head produced into a long, decurved, tubular snout; mouth very small, terminal, and inferior; teeth minute in both jaws; size moderately large. The table lists the contents of the stomachs of three small specimens.

Locality.	Length.	Entomostraca.	Dipterous Larvæ.	Other Insect Larvæ.	Annelida.	Vegetable Debris.
Amatuk	240		7		9	*
Amatuk	180	1	10	1	6	
Amatuk	165		4		17	
Total		1	21	1	32	

(5) *Sternarchorhamphus mülleri* (Steindachner).

Head produced into a long, straight, tubular snout; mouth rather small and somewhat inferior; teeth minute in both jaws; size large, reaching 800 mm. in length. Two stomachs of this species were examined and the contents are stated in the following table:

Locality.	Length.	Entomostraca.	Dipterous Larvæ.	Other Insect Larvæ.	Annelida.	Vegetable Debris.
Pará	425	1	13	5	2	*
Pará	400		30		10	
Total		1	33	5	12	

The food of the last two species, *S. oxyrhynchus* and *S. mülleri*, consisted almost entirely of mud-inhabiting forms. The Annelida were small mud-worms and the dipterous larvæ were similar to the North American "Blood Worm." In addition to the food listed in the foregoing table and that given with the preceding species large amounts of mud were found in all stomachs of these species which were examined. There is thus a great similarity between the contents of the stomach of these two species and of *Rhamphichthys rostratus*. Not only were the same forms eaten by these three species, but they were evidently taken in the same manner. The anterior thirds of these three species are similar. All three have the head produced into a long tubular snout. The snout of *S. oxyrhynchus* is decurved so that the mouth is on a level with the outer edge of the anal fin. The snout of *Rhamphichthys rostratus* is straight but is joined to the rest of the head at an angle to the long axis of the body so that it is directed downward. This places the mouth on a level with the origin of the anal fin. The mouth is

inferior. The snout of *S. mülleri* is also straight and is only slightly out of line with the long axis of the body. It is, however, directed downward to some extent and the mouth is more or less inferior. All three species are thus adapted to feed upon the bottom fauna with the minimum of effort. It seems probable that they feed by sucking up quantities of mud and food after a suitable feeding-place has been found. Forms like these taken from the stomachs are usually found in large numbers, close together.

No stomachs of the long-snouted *Gymnorhamphichthys hypostomus* Ellis were examined.

General Considerations.

Two factors control the nature of the food taken by any fish, namely, (1) the structure, and (2) the size of the fish. In the *Gymnotidæ* the only structure that needs consideration is the mouth. The other structures which might influence the selection of food, such as shape, nature of fins, and the like, are all held in common by the several species of this small family. Considering size and mouth there are four types of *Gymnotidæ*, (1) large, large-mouthed specimens (adult only); (2) small, large-mouthed (young of large-mouthed); (3) large, small-mouthed eels; and (4) small, small-mouthed eels. The last three are ecologically the same, since they all have small mouths. Class two, however, differs in that the members of this group ultimately by growth attain to the first class. *G. carapo*, *E. electricus*, *S. macrurus*, *S. albifrons* and *S. brasiliensis* are the large-mouthed species of this family.

They are the only species examined which had eaten either fish or freshwater shrimps, or both. These two items, which are the most bulky food taken from Gymnotid stomachs, were found only in the largest specimens of the species belonging to the first class.

A comparison of the various tables shows that the young of all species partake of much the same food. They feed upon entomostraca, the larvæ of insects and small annelids. The second, third, and fourth classes are therefore alike as regards the food taken. There remains, however, the ability of the second class to change. Forbes has found that the food of all small North American fishes is much the same, being for the most part entomostraca and the larvæ of insects. For the predaceous fishes those which as adult feed largely upon other fishes he has also shown a regular cycle of foods from the young to the adult. Beginning with entomostraca and insect larvæ they pass to Annelida and adult insects, small Crustacea, large Crustacea, and finally to other fishes. Precisely this progression is shown in the first two tables (pp. 168 and 170). On the other hand, the non-predaceous members of this family, which are limited by small mouths, pass only from entomostraca to insect larvæ.

Schlesinger divides the species of this family into three groups. The first group contains *E. electricus* and *G. carapo*. He imagines that the food of these two species must be the same because of their general resemblance. This was

found to be correct. His second group contains all of the long-mouthed forms, *Sternarchorhynchus*, *Sternarchorhamphus* and *Rhamphichthys*. These he thinks must feed on insects. In this he was mistaken. The stomachs of these species which were examined contained mud-inhabiting forms. His third group includes the remaining *Gymnotidæ*. He regards the toothless forms of this group to be plankton-feeders, and cites *Sternarchogiton* and *Steatogenys* as examples. The first mentioned was not examined. Three stomachs of the latter contained the larvæ of insects and Annelida as well as entomostraca, with Annelida much preponderating. The forms with teeth he gives as feeding upon small water-insects and perhaps vegetable matter. *Sternopygus* was found to feed upon water-beetles in particular, but also upon fish and freshwater shrimps. *Eigenmannia* on the contrary took very few insects, but a great number of entomostraca and larvæ of insects.

Summary.

1. Entomostraca supplemented by the larvæ of insects form the main food of the young of all species examined.

2. Only the adult large-mouthed species fed upon freshwater shrimps and fishes.

3. The adult small-mouthed species feed upon entomostraca, insect larvæ, and adult insects.

4. The long tubular-mouthed species are bottom-feeders. Their food is mud-inhabiting forms, Annelida, and insect larvæ, sucked up with the surrounding mud.

Reproduction.

Nothing is known of the breeding habits of the *Gymnotidæ*. Several unsuccessful attempts have been made to obtain embryos or very small electric eels. This failure has tended to confirm the belief of the natives that the electric eel as well as the other *Gymnotidæ* brings forth living young. But no Gymnotids have ever been captured containing embryos, nor is the construction of the genital tracts such as would favor this view, except in one particular. In most species there is a more or less well developed papilla at the terminal opening of the sex ducts just below the head. Sachs (116 et seq., l. c.) was of the opinion that the electric eel lays eggs. He collected several females with ripe eggs in February and March. He thought the period of laying to be in the early part of the rainy season, that is, the last of December and the first of January. Miller (Bull. Am. Mus. Nat. Hist., Vol. XXIII, 1907) states that he took many females of *Gymnotus carapo* with eggs from the swamps and a sluggish stream near Los Amates, Guatemala, on Feb. 20, 1905. The largest of them was 200 mm. long. Among the specimens of *Eigenmannia virescens* and *Sternopygus macrurus* collected by Dr. C. H. Eigenmann in Georgetown are many females with eggs. Several females of *Eigenmannia* are very noticeably distended. Some of the specimens which I took from the same place on Sept. 26, 1910, contained eggs, but they did not seem as nearly ripe

as those collected by Dr. Eigenmann. In no case were the females at this time so full of eggs as to be distended.

Mutilations and Regeneration.

The specimens of *Gymnotidæ* in different collections show an unusual amount of mutilation and regeneration. This condition is undoubtedly in part due to their peculiar anatomy and shape. It may be recalled that they are all slender, elongate fishes, with the visceral anatomy occupying a relatively small portion of the fish just behind the head. The viscera, except the air-bladder, are so closely packed that the mass occupies a space a little longer than the length of the head. The compound air-bladder varies in size and shape in the several species. It lies just below the spinal column on the posterior portion of the body cavity and extends caudad to between the anterior third and the middle of the body. The position of the anus is also noteworthy. The alimentary canal after several turns bends down and runs forward along the floor of the body cavity and terminates below the head or below the base of the pectorals. Back of the body cavity the body tapers off gradually. The dorsal region bears no fins, hence the name, *Gymnotidæ*. Ventrals are also wanting. All species, however, have small fan-shaped pectorals and a very long anal fin. The anal begins in the pectoral region and extends caudad for the greater length of the fish. The number of rays in this fin varies greatly among the different species and also among individuals of the same species. In one species, at least, the number of anal rays may exceed five hundred (*Rhamphichthys rostratus*). The species of one subfamily, the *Sternarchinæ*, have a caudal fin. The tail of the other species tapers into a slender, cylindrical, caudal appendage.

Mutilation and the attendant regeneration are of general occurrence throughout this family. Many of the accounts of the *Gymnotidæ* note either in passing or even in detail, cases of regeneration in the caudal and anal regions. Nineteen of the twenty-seven species of this family are known to have regenerated lost portions. The present account consists of three parts: the first deals with regeneration in general in this group, and is based both on the collections examined and on the cases recorded by others; the second relates to special collections of three species; and the third gives an account of some experiments carried on during the Gimbel Expedition.

Part I. Regeneration in General.

The first table lists all of the species of the *Gymnotidæ* and indicates those known to have regenerated lost parts. Whenever specimens were at hand showing injury and regeneration, the word "specimens" follows, while cases not examined by myself are referred to the author mentioning them. Reference to several interesting regenerations recorded for species of which mutilated specimens were examined by myself is omitted from this table. It demonstrates the general occurrence of regeneration throughout the family, regeneration being recorded for

all but two of the sixteen genera. The eight species without recorded cases of regeneration are known by but few specimens.

Name of Species.	Caudal Fin.	Caudal Append-age.	Anal Region.	Author-ity.
1. **Gymnotinæ:**				
1. *Electrophorus electricus* (Linnæus)			*	Sachs
2. *Gymnotus carapo* (Linnæus)		*	*	Spms.
2. **Sternarchinæ:**				
1. *Sternopygus macrurus* (Bloch & Schneider)		*	*	Spms.
2. *Sternopygus obtusirostris* Steindachner		*	*	Spms.
3. *Eigenmannia macrops* (Boulenger)		*	*	Spms.
4. *Eigenmannia virescens* (Valenciennes)		*		Steind.
5. *Eigenmannia troscheli* (Kaup)		*		Steind.
6. *Steatogenes elegans* (Steindachner)		*	*	Spms.
7. *Hypopomus brevirostris* (Steindachner)		*	*	Spms.
8. *Hypopomus artedi* (Kaup)		*	*	Spms.
9. *Rhamphichthys rostratus* (Linnæus)		*	*	Spms.
10. *Gymnorhamphichthys hypostomus* Ellis		*	*	Spms.
3. **Sternopyginæ:**				
1. *Sternarchorhynchus oxyrhynchus* (Müller & Troschel)	*			Spms.
2. *Sternarchorhamphus müllcri* (Steindachner)	*			Spms.
3. *Sternarchorhamphus macrostomus* (Günther)				
4. *Sternarchus albifrons* (Linnæus)	*			Steind.
5. *Sternarchus brasiliensis* Reinhardt				
6. *Sternarchus bonaparti* Castelnau	*			Spms.
7. *Sternarchus leptorhynchus* Ellis	*			Spms.
8. *Sternarchus hasemani* Ellis	*			Spms.
9. *Sternarchella schotti* (Steindachner)	*			Spms.
10. *Sternarchella balænops* (Cope)				
11. *Sternarchogiton nattereri* (Steindachner)				
12. *Porotergus gymnotus* Ellis	*			Spms.
13. *Porotergus gimbeli* Ellis				
14. *Adontosternarchus sachsi* (Peters)	*		*	Spms.
15. *Orthosternarchus tamandua* (Boulenger)	*			Boulg.

Gymnotinæ, *Electrophorus electricus* (Linnæus). According to Sachs (*op. cit.*, 1881, p. 11), the long anal fin and confluent caudal of the electric eel were often found slightly injured and in various stages of regeneration. These injuries were usually V-shaped rents in the fins. The parts restored were fin-membranes and rays. The regenerations in some cases seemed fairly complete, none of the nine specimens in the present collections were found to be injured.

Gymnotus carapo Linnæus. This species is an almost cylindrical fish, rather pink with a greenish cast in life and crossed by blue-gray or greenish bands. The body tapers somewhat in the caudal region and ends in a small, cylindrical caudal appendage, which never exceeds the snout in length. The head is rather flat, and both of the strong jaws contain one or two rows of conical teeth. The adult of this species is largely predaceous. Only seven cases of regeneration were found among two hundred and forty individuals of *G. carapo* examined.

The collections of this species include specimens of all sizes from forty-eight localities. Four of the injured ones had lost only a few millimeters of caudal

appendage. The following table gives the data for these. All three of the localities from which they came are in British Guiana.

Gymnotus carapo.

No.	Locality.	Number of Specimens.	Length of Body.	Number Injured.
1	Holmia	34	80–435 mm.	2
2	Nickaparoo	32	80–340 mm.	1
3	Tukeit	30	51–310 mm.	1
	Total	96		4

The other three cases proved more interesting.

One specimen, body length estimated 125 mm., from the Rio Coite, Eastern Brazil, had lost the entire caudal appendage and about twenty millimeters of the caudal portion of the body. It had been lost by an irregular injury which ran at right angles to the back. The regeneration had been most rapid in the region of the backbone. The new tissue at this point being six millimeters long and bearing a new caudal appendage nearly two millimeters in length. There had been scarcely any repair to the extreme ventral edge of the injury in the region of the anal fin. The entire piece of regeneration tissue was thus roughly triangular. It bore along its ventral margin several very tiny fin-rays, not over half a millimeter long, and its maximum thickness was nearly two millimeters, only about one-half that of the uninjured body, just in front of it. The dorsal portion of the new tail was scaled over most of its basal half. The regenerated portion was uniformly pale yellow in color and without markings. Fig. 19 is an outline drawing of this tail.

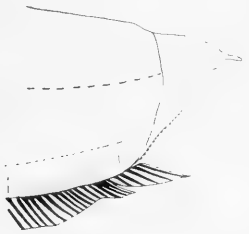


Fig. 19. Regenerated Tail. *Gymnotus carapo* (Linnæus), Rio Coite.

Another individual three hundred millimeters long, from the Amazon at Santarem, Brazil, had received nearly the same kind of injury, differing, however, in that the regeneration was much farther advanced. (See Fig. 20.) Nearly eighty millimeters of the body, and the entire caudal appendage, had been lost by a rather straight injury across the body. Of this sixty-five millimeters had been regenerated. The new tail bears a caudal appendage eight millimeters long and a small well developed fin. The latter is completely, although irregularly, joined to the unin-

jured anal. The entire piece was normally scaled and marked with the typical bands of pale yellow and dark blue (compare with Fig. 22, the normal tail). It differed chiefly in being a little smaller than the uninjured part of the body, which gave the fish a constricted appearance along the line of injury.

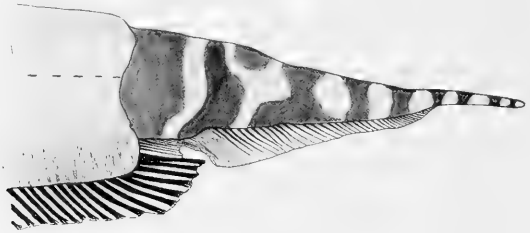


Fig. 20. Regenerated Tail. *Gymnotus carapo* (Linnæus), Santarem, Brazil.

The third case was quite different. This fish, a specimen one hundred and thirty millimeters long, from Aqua Quente, Paraguay, had received an injury parallel to the lateral line. The caudal appendage and caudal portion of the body were split for a distance of thirty-five millimeters. Both pieces had rounded themselves out so that there were two well-formed caudal appendages, each longer than the normal. The ventral tail has an anal fin regularly attached except for a slight fold (see Fig. 21).

Fig. 21. Split Tail. *Gymnotus carapo* (Linnæus), Aqua Quente, Paraguay.

Fig. 22. Normal Tail. *Gymnotus carapo* (Linnæus), Holmia, British Guiana.

Taken collectively these regenerations show *G. carapo* capable of rather complete regeneration of injuries in the caudal region. Caudal appendage, muscle scales, color markings, and anal fin were all restored. It, of course, could not be determined absolutely whether these injuries had been received when the fishes were much smaller and the regenerated parts, after some fraction of the part removed had been restored, had grown with the rest of the fish, or whether the regenerations were the results of recent injuries, and really represent the amount of tissue lost. The appearances all favor the view that the injuries were recent. The

scars are clear and well defined, and the new tissue quite distinct from the old, conditions that would probably not obtain were the injuries old ones.

The small number of individuals of this species showing any mutilation could be explained in either of two ways. *First*, it is possible that injuries of greater severity than the slight mutilation of the caudal appendage were fatal, and consequently no specimens collected showed these; or *secondly*, the species *G. carapo* is not frequently injured. The first explanation evidently does not obtain, for, two specimens previously mentioned (see Figs. 19 and 20) had each not only lost the entire caudal appendage, but a considerable portion of the body as well, and more than merely surviving these injuries, had restored by regeneration much of the part lost. Concluding that *G. carapò* is only occasionally injured, the causes for this immunity are to be sought, and the color-pattern and the predaceous habit of the species present themselves as probable reasons for their exemption from injury.

In life this fish is strikingly marked with numerous bands of greenish blue, which cross the body at right angles. An isolated individual is thus rather conspicuous, yet these same bands may afford a certain protection when this species lurks among the vertical stems of the calladium, the "Mucka Mucka" and other aquatic plants, forming its normal habitat in the small streams which it frequents. It was observed to be a very rapid, vigorous swimmer, and the contents of the stomachs examined, as well as the shape of the head and jaws, show this fish to be predaceous, at least as an adult. Both factors probably contribute to the immunity of this species. Plate XX, fig. 4 is an outline drawing in which the seven injuries discussed in connection with this species are indicated by outlines of the injuries.

Sternopyginæ.—The species of the *Sternopyginæ* are distinctly compressed and more or less elongate. The caudal appendage is slender and well developed, being almost a third as long as the entire body in some species. Two of the genera, *Eigenmannia* and *Sternopygus*, have patches of very small teeth in each jaw, while the others are toothless. All the species of the subfamily feed largely upon plankton, insects, and worms. One of the first records of regeneration in this subfamily is by Kaup, 1856, who prefaces his discussion of the genus *Rhamphichthys* with the following: "One perceives sometimes at the point of the damaged tail a projecting cuticular process destitute of vertebræ which resembles the reproduced tail of a lizard. Judging from the narrowness of the toothless mouth these fish must subsist on small insects and be themselves destroyed or injured by predaceous fish whence it happens that the point of the tail is often defective."

From the following table it is plain that regeneration is common among these species. The injuries were of two sorts: (1) part of the caudal appendage sometimes with more or less of the caudal region of the body had been removed; (2) V-shaped, or semicircular, pieces of the anal fin and its muscles had been taken out of the ventral region, often well cephalad. The particular cases are considered in the second part. The regeneration in many cases was quite complete, muscle, fin-rays, scales, pigment, and caudal appendage having been restored.

The general data for this subfamily are given in the table here given:

Species of Sternopyginæ.	Specimens Examined.	Specimens Injured.	Per Cent.	Number of Localities.
1. *Sternopygus macrurus*	214	20	10	27
2. *Sternopygus obtusirostris*	None			
3. *Eigenmannia macrops*	56	7	12	3
4. *Eigenmannia virescens*	482	72	15	63
5. *Eigenmannia troscheli*	3	0	0	1
6. *Steatogenes elegans*	19	2	11	3
7. *Hypopomus brevirostris*	56	4	8	19
8. *Hypopomus artedi*	90	7	8	16
9. *Rhamphichthys rostratus*	8	2	25	4
10. *Gymnorhamphichthys hypostomus*	11	1	9	7

Sternarchinæ.—The presence of a small caudal fin is the main point of difference between the *Sternarchinæ* and the other three subfamilies. The fishes of this group are quite compressed. In the cephalic and pectoral regions the body is more or less suddenly tapered into a peduncle which bears the caudal fin. All the species, with the exception of *Adontosternarchus sachsi* (Peters), have teeth. Few specimens of this subfamily, in comparison with the *Sternopyginæ*, were examined, yet the general occurrence of regeneration throughout the group is evident from the following table. The several species will be considered separately.

Species of Sternarchinæ.	Specimens Examined.	Specimens Injured.	Per Cent.	Number of Localities.
1. *Sternarchorhynchus oxyrhynchus*	9	1	10	4
2. *Sternarchorhamphus mülleri*	5	3	60	2
3. *Sternarchorhamphus macrostomus*	None			
4. *Sternarchus albifrons*	9	0	0	4
5. *Sternarchus brasiliensis*	2	0	0	1
6. *Sternarchus bonaparti*	2	1	50	2
7. *Sternarchus leptorhynchus*	3	0	0	1
8. *Sternarchus hasemani*	13	13	100	1
9. *Sternarchella schotti*	5	5	100	1
10. *Sternarchella balænops*	None			
11. *Sternarchogiton nattereri*	None			
12. *Porotergus gymnotus*	4	1	25	2
13. *Porotergus gimbeli*	4	0	0	1
14. *Adontosternarchus sachsi*	57	5	9	2
15. *Orthosternarchus tamandua*	None			

The single individuals of *Sternarchorhynchus oxyrhynchus* (Müller and Troschel), and *Porotergus gymnotus* Ellis, and the five of *Adontosternarchus sachsi* (Peters) noted in the above table as regenerating were each repairing small injuries to the anal fin, rays and fin-membrane having been lost. None of these regenerations were completed.

Two specimens of *Sternarchorhamphus mülleri* (Steindachner), from Pará, Brazil, each about four hundred and thirty millimeters long, had lost the entire caudal peduncle and caudal fin, the line of injury running across the body through the end of the anal fin. Comparison with an uninjured specimen of the same

size showed the part removed to have been about sixty-five millimeters long and ten by six millimeters deep at its base. In repairing these injuries neither had regenerated a caudal peduncle. Instead, from the line of injury both had regenerated a broad fan-shaped fin, nine millimeters long on fish "A" (Fig. 23) and

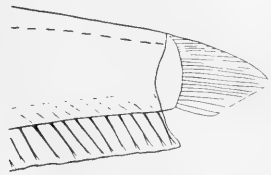


FIG. 23. Regenerated Tail of *Sternarchorhamphus mülleri* (Steindachner). Fish "A."

twelve millimeters on fish "B" (Fig. 24). Both regenerated fins had the shape of

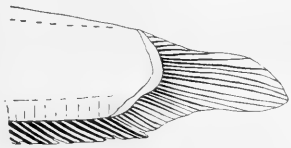


FIG. 24. Regenerated Tail of *Sternarchorhamphus mülleri* (Steindachner). Fish "B."

the normal caudal fin, from which they differed in three particulars, (1) both were much larger than the normal caudal; (2) each contained more rays than the normal caudal which has only ten rays, while the regenerated fin of specimen "A," nine millimeters long, contained twenty, and the fin of "B," twelve millimeters long, contained twenty-six rays; (3) they were situated at least fifty millimeters nearer the head than the normal fin, arising from the body directly and not from the slim caudal peduncle. The fin twelve millimeters long differed in still another respect; it was confluent ventrally with the anal fin. Figures 23 and 24 show the regenerated fins "A" and "B" respectively, and Figure 25 a normal caudal of this

FIG. 25. Normal Tail and One Fourth of Caudal Peduncle. *Sternarchorhamphus mülleri* (Steindachner).

species. The third specimen had lost only the caudal fin and the extreme tip of the caudal peduncle. From the old tissue a small bud of new tissue projected. As this was quite small and showed no structure, it is probable that this fish had been injured only a short time before it was captured.

No specimens of *Sternarchus albifrons* Linnæus, *Sternarchus leptorhynchus* Ellis, or *Porotergus gimbeli* Ellis, were found with regenerations, and, the last named two species being new, no mutilations have been noticed by others. On

the other hand Steindachner, who has examined many specimens of *Sternarchus albifrons*, observes that the caudal region of most of the individuals had been mutilated and the caudal fin regenerated. He says: "Seit der Publication meiner Abhandlung über die Gymnotidæ des K.K. Hof-Naturaliencabinetes zu Wien im Jahre 1868 habe ich mehrfach Gelegenheit gehabt Exemplare von *Sternarchus albifrons* sp. Linné zu untersuchen, darunter viele aus dem See Manacapuru, von Teffé, Obidos (im Museum zu Cambridge, Massach., Thayer-Expedition). Bei den meisten derselben war das Schwanzende verstümmelt und die caudale regenerirt." (Flussfische Süd Amer., III, 1881, p. 13.) This species which reaches the length of five hundred millimeters, or more, is entirely black save for two bright pink bands around the tail and a band of the same color along the top of the head. Is it that these strikingly colored bands attract other fish and account for the frequent injury of the caudal region?

A specimen of *Sternarchus bonaparti* Castelnau, from Santarem, Brazil, had a regenerated caudal very similar to those regenerated by the two individuals of *Sternarchorhamphus mülleri*. This fish, estimated to be about one hundred and forty millimeters long, representing an inconspicuous brown species, had lost about thirty millimeters of the caudal portion of the body, as well as the entire caudal fin. From near the backbone there had been regenerated a symmetrical, rounded caudal fin, eight and a half millimeters long, and a well-scaled, seemingly normal caudal peduncle some four millimeters in length. (This caudal peduncle is much shorter than the normal one.) In the angle between the new caudal peduncle and the old anal fin there is a small piece of regenerated anal fin bearing six new anal rays. The new caudal fin is quite normal in shape although distinctly larger than a normal caudal, and perhaps a little rounder. It contains twenty-three rays as compared with twenty in the normal caudal. (See Figure 26.)

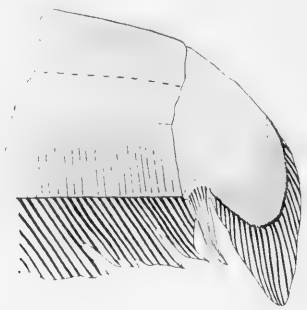


Fig. 26. Regenerated Tail. *Sternarchus bonaparti* Castelnau, Santarem, Brazil.

Of all the specimens of *Sternarchus hasemani* Ellis and *Sternarchella schotti* (Steindachner) examined, thirteen of the former and five of the latter had lost the entire caudal fin together with more or less of the caudal portion of the body.

These fishes are of a dull gray color in alcohol and of the same general shape as the other members of this subfamily. From the injured surfaces all were regenerating caudal fins after the fashion just mentioned in the case of *mülleri* and *bonaparti*. In no case was the new caudal confluent with the old anal fin, and in the more advanced regenerations there was a small caudal peduncle. Figure 27 shows a series

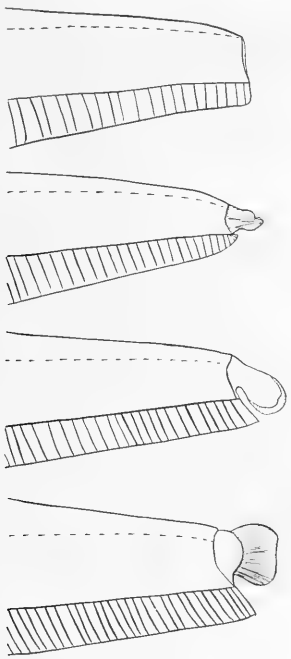


FIG. 27. Regenerated Tails of *Sternarchus hasemani* Ellis, Santarem.

of the regenerated fins of *hasemani*. Steindachner notes an interesting specimen of *Sternarchella* (*Sternarchus*) *schotti* which has regenerated a second caudal fin above the true caudal. His figure is copied in Figure 28.

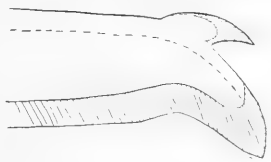


FIG. 28. Double Tail. *Sternarchella schotti* (Steind.). After Steindachner.

No specimens of *Sternarchella balænops* (Cope), *Sternarchogiton nattereri* (Steindachner) and *Orthosternarchus tamandua* (Boulenger) were examined, and no recorded regeneration for the first two species was found. However in his original description of *O. tamandua*, Boulenger speaks of his unique type as having a regenerated caudal confluent with the anal and figures it thus (*op. cit.*, 1898, p. 427, pl. XLII). A second specimen of this same species, recorded and figured by von Ihering (*op. cit.*, 1907, p. 277, pl. VIII, fig. 1), had the same type of a regenerated caudal.

In conclusion, eight of the fifteen species of *Sternarchinæ* are known to possess the ability to regenerate muscle, fin, rays, and scales. Several of these species regenerate new caudal fins from various levels more cephalad than that at which the caudal fin normally occurs, entirely without, or with only a very small caudal peduncle. It is probable that the other species of this group would show the same type of regeneration, if enough specimens were examined, since they are so closely related to the species in which these regenerations are known to occur.

Part II. Quantitative Data.

This section deals with several large collections of each of three species; in each case all of the specimens caught at a given time and place were preserved. Most of these collections were made by Dr. C. H. Eigenmann, in British Guiana in 1908, and the others by the writer in the same country in 1910. The three species considered are *Eigenmannia virescens*, *Eigenmannia macrops* and *Sternopygus macrurus*. In life they all closely resemble each other, not only in color but in size and shape. They are quite compressed and somewhat elongate. The body

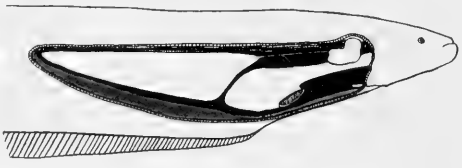


Fig. 29. Section showing location of air-bladder in *Gymnotus carapo* Linnæus.

tapers rather suddenly in the caudal region, which ends in a long, cylindrical caudal appendage, at least one-fourth as long as the entire body. The caudal appendage contains a continuation of the vertebral column, enclosed in a well-scaled sheath of skin. These fishes are so translucent that their blood gives them a distinctly red color. The epidermis is bright yellow, and beneath it are dark blue chromatophores, very abundant in *S. macrurus*, less so in *E. virescens*, and almost wanting in *E. macrops*.

In consequence of these peculiarities these species are capable of changing color to some extent. In proportion to the amount of blue pigment present they

may change through orange, purple, and green. In general they are red or orange-red, with a golden green cast dorsally. The yellow pigment dissolves in alcohol and the entire fish becomes opaque. Alcoholic specimens of *Eigenmannia* are straw-yellow, and of *Sternopygus* stone-grey (because of the greater number of blue chromatophores). Figures 29–32 give outline drawings of *G. Carapo*, *S. macrurus*, *E. virescens*, and *H. brevirostris*, showing the location of the viscera.

From these figures it may be seen that the viscera proper occupy about the same space in all of three species, but the air-bladder of *S. macrurus* is much longer, being conical in shape and extending some distance beyond the rest of the viscera.

For the interpretation of the data, the fish may be divided into three regions:

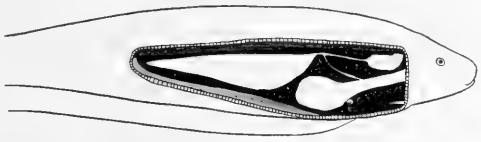


FIG. 30. Air Bladder of *Sternopygus macrurus* (Bloch and Schneider.) Side-view.

(1) all behind the middle which may be termed the "caudal half"; (2) that portion of the body in front of this line and above the lateral line which may be designated as the "dorsal quarter"; (3) that portion below the lateral line and in front of the caudal half which may be called the "ventral quarter." The detailed data of the eleven special collections of these three species is given in the following table.

Col. No.	Species.	Locality.	Length.	Number of Specimens.	Number of Regenerations.	Per Cent. of Regenerations.	Injury in		
							Caudal Half.	Dorsal Quarter.	Ventral Quarter.
1	*E. virescens*.....	Georgetown.....	105–300 mm.	155	24	15	18	0	6
2	*E. virescens*.....	Georgetown.....	100–300 mm.	50	10	20	8	0	4
3	*E. virescens*.....	Georgetown.....	160–320 mm.	35	6	17	4	0	2
4	*E. virescens*.....	Wismar.....	150–290 mm.	30	5	16	5	0	0
	Total.....			270	45	17	35	0	12
1	*E. macrops*.....	Rockstone.....	165–200 mm.	32	4	12	4	0	0
2		Tumatumari.....	165–180 mm.	12	2	17	1	0	1
3		Crab Falls.....	125–150 mm.	12	1	8	1	0	0
	Total.....			56	7	12	6	0	1
1	*S. macrurus*.....	Georgetown.....	155–500 mm.	104	8	8	6	0	2
2	*S. macrurus*.....	Georgetown.....	200–400 mm.	18	3	17	3	0	1
3	*S. macrurus*.....	Wismar.....	118–212 mm.	10	2	20	2	0	0
4	*S. macrurus*.....	Hububa Creek.....	190–300 mm.	17	3	17	3	0	2
	Total.....			149	16	10	14	0	5

The number of individuals found regenerating injuries of some sort is sufficient

to show that these species are subject to frequent injury. The percentage of regenerating specimens may be a little high, as it is possible that the injured ones were more easily captured, and consequently occur in the collections in greater numbers than they do among equal numbers of the same species in a normal environment. Against this, it may be said, however, that in one locality, that in which collections No. 1 of *E. virescens* and No. 1 of *S. macrurus* were made, an entire trench was drained, and all of the fishes, both normal and injured, were secured. In making the other collections, it was also the object to take the entire fish-fauna at the point selected. Granting, however, that the percentages themselves are higher than normal, they nevertheless indicate that a very appreciable percentage of all the individuals are injured. This conclusion is substantiated by a review of the general data in the table on page 000, in which the percentages of mutilated individuals of these three species are 10, 12, and 15 respectively.

The location and severity of all of these injuries are shown in Plate XX, figs. 1–4. These figures, as previously mentioned, are outline drawings of an average sized fish of each species, on which the line of each of the several injuries found in the collections of the particular species is indicated.

If the line of injury crosses the body of the fish, the loss of the entire portion of the body behind the line is indicated. It is to be understood that these plates do not represent any one fish, but the entire series of injuries found among the specimens of a single species superimposed and drawn to scale on the outline of one fish.

Considered in connection with the foregoing table Plate XX, figs. 1–4, shows one region, the dorsal quarter, to be uninjured. The majority of the injuries are in the caudal half, only about one-third of them occuring in the ventral quarter. The absence of any injury to the dorsal quarter is striking, and is made still more so by the following table, which locates all the injuries of all the specimens of these three species examined:

Species.	Regenerating Specimens.	Dorsal Quarter.	Ventral Quarter.	Caudal Half.
E. virescens	72	0	20	52
E. macrops	7	0	1	6
S. macrurus	20	0	5	15
Total	99	0	26	73

The ventral quarter and the caudal half share all of the injuries in a ratio of about 1 to 3. From a consideration of the gross anatomy and some experiments and observations made upon living specimens of these fishes in British Guiana, it was concluded that this distribution of injuries is the result of the joint action of two factors: (1) the liability of the several regions to injury; (2) the relative mortality resulting from injuries to the various parts of the body.

The habits of these species explain the first factor. The several regions of

the body are not equally exposed to injury. These fishes frequent the weeds of the trenches and small streams, for the most part feeding upon insects and small

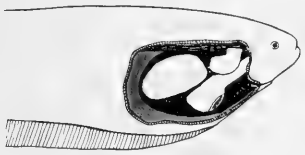


FIG. 31. Air-Bladders of *Eigenmannia virescens* (Val.). Side-view.

crustacea. They are easily frightened, and, being very swift swimmers, seek safety in flight. This habit naturally exposes the caudal region more than any other to the attack of the pursuing enemy. Because of the tapering shape and the straight dorsal profile, the sloping ventral quarter is also more or less exposed to attack from the rear.

FIG. 32. Air Bladders of *Hypopomus brevirostris* (Steindachner).

That injury to some regions of the fish would be more apt to be fatal is easily seen from the anatomy of these fishes. The anterior third of the body of the two species of *Eigenmannia* contains all of the viscera, in addition to the most important parts of the circulatory and nervous systems. *S. macrurus* does not differ materially from the two species just described, except in the size and shape of the air-bladder, previously mentioned. Its posterior air-bladder is conical and terminates about the length of the head caudad of the viscera proper. It is interesting to note in this connection that no individuals of *Sternopygus* showed injuries extending entirely across the body as far cephalad as several of those which *E. virescens* was regenerating. (See figures 30 and 32.)

With the distribution of injuries just discussed in mind, a number of experiments were made in order to ascertain the effect of various injuries and their relative severity.

PART III. EXPERIMENTS.

Forty-three specimens of *S. macrurus*, having an average length of two hundred and fifty millimeters, were collected from a large trench near the Botanic Garden, Georgetown, at about 8 A. M., Sept. 27, 1910. As these fishes were seined, they were put into buckets of the trench-water from which they had been taken and were operated upon within ten or fifteen minutes afterwards. All injuries were made with a razor, and the fishes, immediately after being operated upon, were

placed in a screened portion of a second smaller trench. As this was fed from the main trench, the fishes were returned to a normal environment. As the screened trench was only about eighteen inches wide and two feet deep their actions were

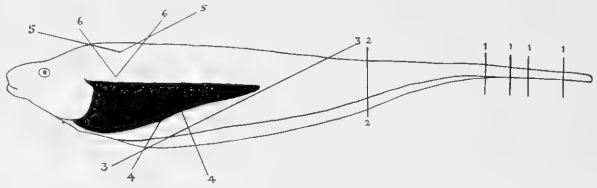


FIG. 33. Injuries used in experiment. *Sternopygus macrurus* (Bloch and Schneider).

easily observed. Figure 34 shows the several injuries discussed under these experiments. Each bears the number of the series.

Series 1. Injury to the Caudal Appendage.

Various amounts of the caudal appendage were removed from five fishes and the entire caudal appendage from three others. These, when returned to the water, swam about much the same as uninjured specimens. The loss of the caudal appendage seemed in no way to disturb their activity. When the appendage was cut off only a tiny drop of blood came to the surface of the wound. All were alive and active when observed twenty-four hours later.

Series 2. Injury to Caudal Appendage and Caudal Region.

Five more specimens were injured by the removal of the entire caudal appendage and from ten to twenty millimeters of the caudal region of the body. These, when placed in the water again, behaved much as normal fishes though they seemed less inclined to swim about at first. The removal of a larger portion of the caudal region was followed by the loss of a little blood, that is, the entire surface of the wound was covered with blood immediately after the cut was made. This blood came almost entirely from the caudal artery and spread out over the cut surface, but the bleeding stopped when the specimen was placed in water. All of these fishes were alive and active the next morning.

Series 3. Diagonal Injuries.

Five other individuals were injured by a diagonal cut which removed all of the caudal region, just missing both the viscera and air-bladder. These did not swim when returned to the water, but sank to the bottom, maintaining, however, the normal swimming position. When disturbed they swam feebly with the pectorals and the remaining portion of the anal fin, the major part of which had been removed by this injury. It is well at this point to recall that the *Gymnotidæ*

swim almost entirely with the long anal fin, the pectorals being used largely to guide the fish. All of this series were dead when visited the following morning.

Series 4. Injury in Ventral Quarter.

From the anal fin and anal muscles of ten specimens V-shaped pieces about 20 mm. wide at the base were cut, so that the point of the "V" pierced the body cavity for some five millimeters. These when dropped into the water made some rather feeble efforts to right themselves.

Seven of them died during the two hours they were observed and the other three were found dead the next morning.

Series 5. Surface Injury, Dorsal Quarter.

Wedge-shaped pieces about 20 mm. long and 5 mm. deep were cut from the middle of the back in the region above the pectorals from five specimens. The tissue thus removed included only skin, scales and dorsal muscle. These injuries bled considerably more than those of Series 2, the entire surface of the wound being covered with blood shortly after the cut was made, and blood continued to ooze from the wounds for about five minutes after each fish was returned to the water. These injuries were apparently of little consequence to the fishes, for they swam about as actively and in the same fashion as their uninjured associates. On the following morning all were found alive and active. In each case the wound had begun to heal.

Series 6. Deep Injury, Dorsal Quarter.

From the same region as that operated upon in Series 5, wedge-shaped pieces about twenty millimeters long, and deep enough to remove a portion of the vertebral column, were cut from each of ten fishes. These injuries were such as to sever the vertebral column, the spinal cord and the dorsal blood vessel, the wound thus produced bleeding considerably. The injured fish when returned to the water made disconcerted efforts to swim but soon settled to the bottom. Here they maintained a half normal position or lay completely on one side. Blood continued to ooze from their wounds for about half an hour after the operation and when they were left at the end of an hour and a half most of them seemed almost dead. None of this series were alive next morning.

In the above experiments the injuries which produced death during the first twenty-four hours after the operation were those inflicted in Series 3 (the removal of all of the body caudad of the viscera and air-bladder), Series 4 (the opening of the body cavity and air-bladder), and Series 6 (the severing of the dorsal artery, the spinal cord and the vertebral column in the suprapectoral region). Naturally, specimens regenerating such injuries were not found among the collections.

The injuries of the other three series, Series 1 (loss of the entire caudal appendage), Series 2 (removal of the entire caudal appendage plus a small portion of

the caudal region of the body), and Series 5 (surface injury to the dorsal region), did not prove fatal during the first twenty-four hours. On the contrary, the fishes of these series either were not visibly inconvenienced by the injuries, or, as far as could be observed, were completely recovered from the shock of the operation by the end of the first day. Comparing these series with the collections: the majority of mutilated specimens regenerating injuries were of the type of Series 1 or 2. Not a single individual showing an injury similar to that inflicted in Series 5 was taken. The absence of specimens with an injury of the same type as that inflicted in Series 5, namely, a non-fatal injury in the dorsal quarter, as has already been discussed, may be due to the fact that the dorsal quarter is less liable to injury than the caudal half.

Nature of Regenerations.—Regenerations were found of various degrees of completeness, in some case almost the entire part removed appeared to have been restored. Caudal appendage, anal fin, muscle tissue, skin, and scales were all regenerated. Three cases, one for each species, will suffice to show the nature of these regenerations.

A specimen of *Eigenmannia macrops* from Rockstone, estimated length one hundred and sixty-five millimeters by comparison with uninjured specimens of the same species, had lost the entire caudal appendage, about sixty-five millimeters in length, and some thirty-five millimeters of the caudal portion of the body. The regenerated piece was eighty millimeters in length, fifty millimeters being caudal appendage, and thirty millimeters body proper. The ventral edge of the thirty millimeters of body-tissue bore a well formed anal fin of normal width. It was perfectly fused with the old anal at the line of injury. The regenerated tail was much narrower both dorso-ventrally and laterally, giving the fish a pinched or constricted appearance at the line of injury. Plate XXI, fig. 1, shows a normal uninjured specimen of this species, and Fig. 2 of the same Plate represents the specimen described in the preceding lines.

A specimen of *Eigenmannia virescens* of one hundred and eighty-five millimeters in length, from Wismar, is chosen to illustrate this species. In this specimen the regeneration is especially complete. The regenerated part is quite normal in size, length, color, and markings. It differs from the uninjured portion of the fish in but two particulars: (1) it was a little thinner; (2) it did not fit quite perfectly on the ventral edge where it joined the old anal fin. The part regenerated was sixty-eight millimeters long, of which thirty-eight millimeters was caudal appendage and thirty millimeters body proper. This seemed by comparison with other normal specimens to be about the amount that had been removed. The breadth at the base was two and one-half millimeters, as compared with the three and one-half millimeters of uninjured tissue in a normal specimen, and the depth six millimeters; that of the old tissue being eight millimeters. (See Plate XXI, fig. 3.)

One of the largest specimens of *Sternopygus macrurus*, from Georgetown Trenches, five hundred millimeters long, showed three distinct injuries: (1) on the

end of the caudal appendage thirty-seven millimeters had been completely restored as far as could be determined; (2) an irregular, semicircular piece fifty-seven millimeters long and twenty-two millimeters deep had been removed from the anal fin and anal muscles quite well caudad on the anal fin. Here a strip twelve millimeters wide, bearing a narrow fringe of fin fused at both ends with the old anal, had been regenerated; (3) a piece twenty millimeters long and thirty millimeters deep was gone from the anal region about one hundred millimeters back of the head. In its place was a regenerated mass twenty-two millimeters wide with a rather complete fin on its ventral edge, this fin being fused with the old anal on both ends. This fish showed no abnormalities to account for being thus mutilated. It answered in every particular the specific measurements of the species. Plate XXI, fig. 4 gives an outline drawing of this fish showing the regenerations first mentioned.

Source of Injury.—The source of these injuries was supposed to be predaceous fishes. As many small alligators and snakes are found in the same habitat these may be responsible for part of them. The wounding of one Gymnotid was observed. A specimen of the "hooree," *Hoplias malabaricus*, was seen to bite off the caudal portion of an *Eigenmannia virescens*. It had been placed in a small trench with several of the latter. The hoorees are abundant in all of the streams from which either *Eigenmannia* or *Sternopygus* were collected in British Guiana.

General Discussion.

The power of regeneration in the *Gymnotidæ*, as long as the injury is not fatal, is quite general. All of the species of which more than a very few specimens were examined showed some regenerated parts. As long as the mutilated specimens amount to no large fraction of the whole number, they may be considered as chance injuries. Out of a large number of individuals of any species of animal some may be expected to have been injured in the natural course of events On the other hand, when the number of injured in the collection of a given species amounts to a considerable per cent, some other factor than chance alone has probably been operative. Tabulating the total number examined in each subfamily with the number injured, we have:

Subfamily.	Number of Species.	Specimens Examined.	Specimens Injured.	Per Cent. Injured.
1. *Gymnotinæ*.....	2	250	7	3
2. *Sternopyginæ*.....	10	939	115	12
3. *Sternarchinæ*.....	15	113	29	26
Total.....	27	1302	151	

This table and all of the special data show the members of the first subfamily to be subject to only chance injury, and those of the other two, to frequent injury. The immunity from frequent injury of *E. electricus*, one of the species of the first subfamily, is undoubtedly due to its remarkable electric power. The immunity

of *G. carapo*, the second species of the *Gymnotinæ*, as has already been intimated, may be the result of its color-markings and active, predaceous life. The other two subfamilies, the *Sternopyginæ* and *Sternarchinæ*, show a relatively high percentage of injured individuals. This seems to be due to two causes: (1) the exposure of a large amount of tail to injury; (2) the survival of the injuries received in the region of the tail.

The longer the caudal portion exposed the greater the chance of its being attacked and injured by other fishes. Size in itself, other things being equal, may be quite a factor in determining the liability to injury. This statement is borne out by an analysis of the injured specimens of *Sternopygus macrurus*. A larger percentage of the large fishes have been injured than of the small ones.

Sternopygus macrurus (Bloch and Schneider).

Size.	Number of Specimens.	Number Injured.	Per Cent. Uninjured.
155–250 mm.	50	7	14
250–350 mm.	100	24	24
350–500 mm.	5	3	60
Total.....	155	34	

All the specimens mentioned in this table were taken at the same time in one catch from the Botanic Garden, Georgetown. Of course the element of time in addition to that of size enters into the comparisons in this table. The larger examples, being the older, have been exposed to injury for a longer period than the smaller.

The long caudal portion, which contains no viscera or vital organs, may be mutilated without killing the fish. Specimens having been mutilated in this region are therefore in evidence. Species of a shorter type with the viscera occupying relatively much more of the body, if injured, would be more liable to be fatally affected, consequently fewer mutilated specimens would be found in a large collection. The presence of so many mutilated specimens among the collections of *Gymnotidæ* does not necessarily mean that the *Gymnotidæ* are more frequently injured than other species of the same habit subjected to the same conditions, but it does show the injuries to be less frequently fatal. The frequent injury to the caudal portion seems due to the elongated tail. Since the *Gymnotidæ* survive these injuries because of the elongate tail and the extreme cephalad position of the viscera the question arises whether they are not "protectively shaped."

Regeneration is probably of little importance to the first two species, *E. electricus* and *G. carapo*, as compared with its value to the *Sternopyginæ* and *Sternarchinæ*, for in these two subfamilies it tends to restore the protective shape. The power of regeneration seems about equally developed in both species subject to frequent injury and those not often injured. The same parts are regenerated by both groups and with about an equal degree of completeness.

Summary.

1. The power to regenerate lost portions of the caudal half and the anal region is quite general throughout the family *Gymnotidæ*. Nineteen of the twenty-seven species are known to possess this power of regeneration.

2. The part regenerated is quite like the part lost, scales, fin, fin-rays, muscles, and pigment being restored.

3. Two species at least, *G. carapo* and *E. virescens*, regenerate the parts removed very completely.

4. Several species of the *Sternarchinæ* regenerate a complete caudal fin, which may be larger and may contain more rays than the normal caudal, at whatever point the part has been removed. The caudal fin is regenerated without the restoration of more than a small portion, if any, of the caudal peduncle.

5. Experiments show injury to the caudal half to be of little consequence.

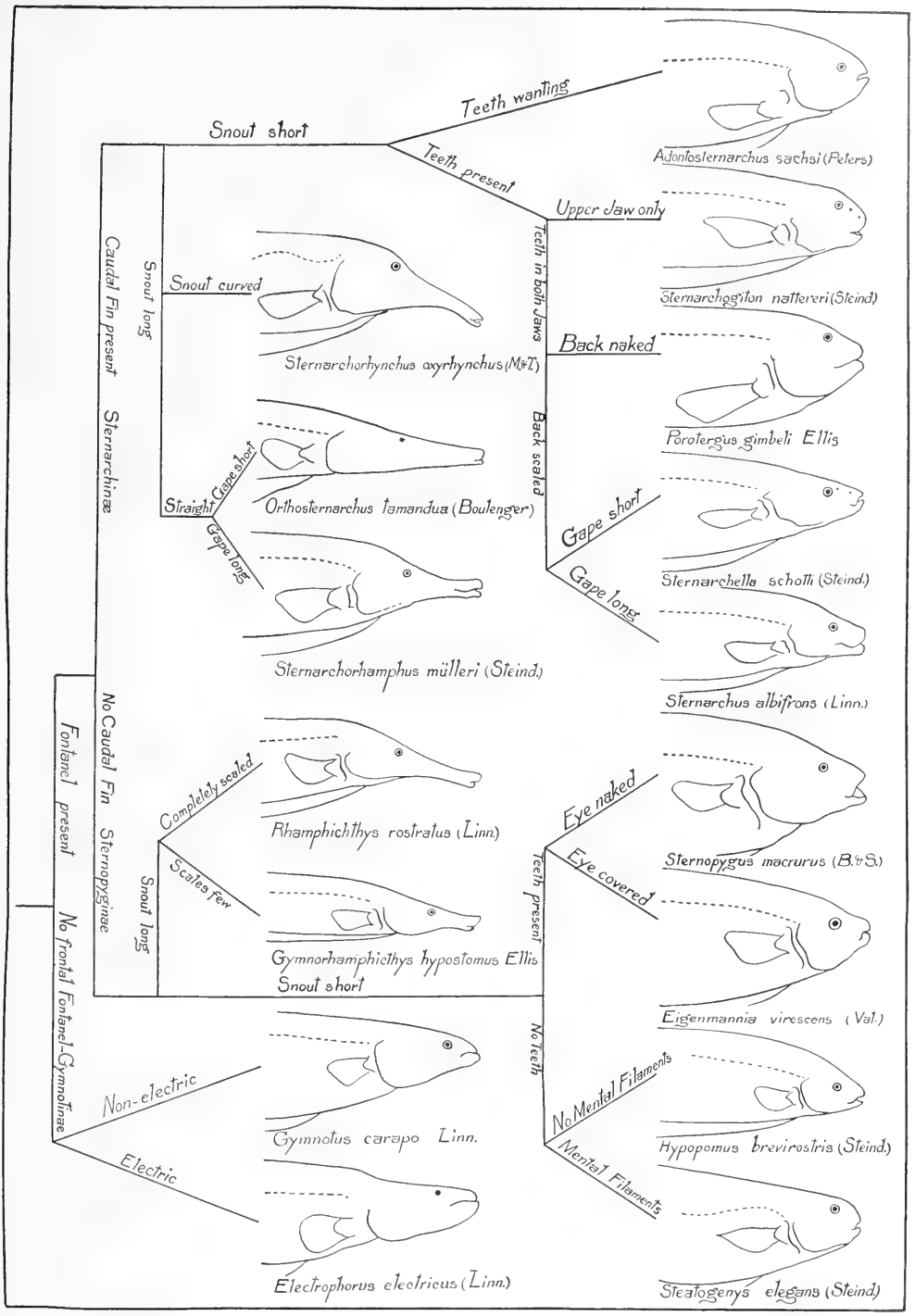
6. The majority of the injuries found were in the caudal region. This localization of injury was noted particularly in the *Sternopyginæ*, in which the caudal region bore about three-fourths of the injuries.

7. The elongated tail and the extreme cephalad position of the viscera seem to be protective adaptations.

NOTE BY C. H. EIGENMANN.

In a paper which appeared after the present contribution was offered for publication, Regan (The Classification of the Teleostean Fishes of the Order Ostariophysi.-Cyprinoidea. Ann & Mag. Nat. Hist. (8), Vol. VIII, July, 1911, pp. 13–32) recognizes four families and two subfamilies of the "Gymnotiformes" as follows:

1. Rhamphichthyidæ (*Rhamphichthys*).
2. Sternarchidæ.
   Sternarchinæ (*Sternarchus, Sternarchogiton, Sternarchorhamphus, Sternarchorhynchus*).
   Sternopyginæ (*Sternopygus, Steatogenys, Eigenmannia, Hypopomus*).
3. Gymnotidæ (*Gymnotus*).
4. Electrophoridæ (*Electrophorus*).

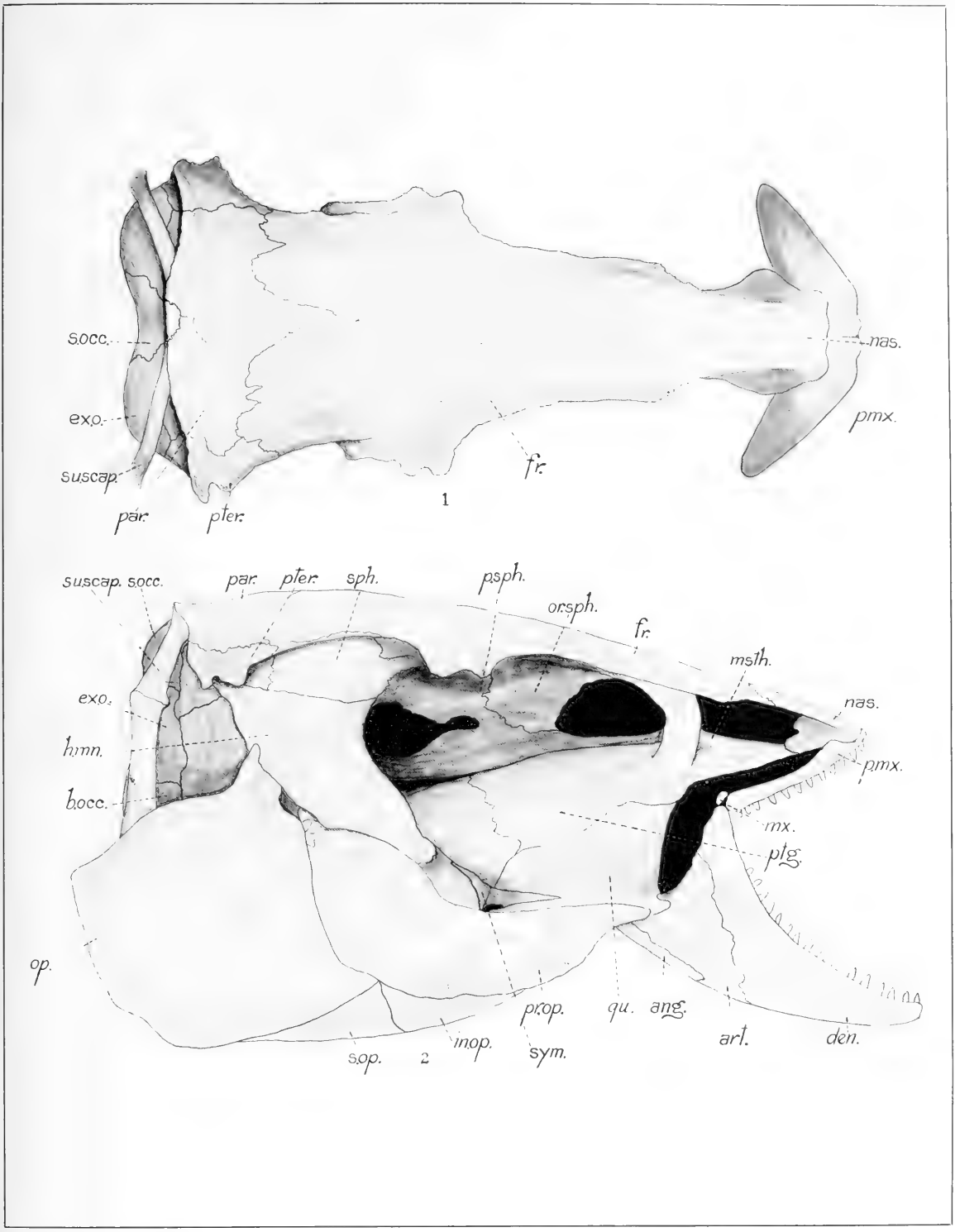


GYMNOTID EELS OF SOUTH AMERICA. GENERIC RELATIONSHIPS, PARALLELISMS, AND CONVERGENCES.

EXPLANATION OF PLATE XVI.

Skull of Gymnotus carapo Linnæus.

Fig. 1, dorsal view; Fig. 2, lateral view. *ang.*, angulare; *art.*, articulare; *b. occ.*, basi-occipital; *den.*, dentary; *ex. o.*, exoccipital; *fr.*, frontal; *h. mn.*, hyomandibular; *in. op.*, interoperculum; *msth.*, mesethmoid; *mx.*, maxillary; *nas.*, nasal; *op.*, operculum; *or. sph.*, orbitosphenoid; *par.*, parietal; *p. mx.*, premaxillary; *pr. op.*, preoperculum; *p. sph.*, parasphenoid; *pter.*, pterotic; *ptg.*, pterygoid; *qu.*, quadrate; *s. occ.*, supra-occipital; *s. op.*, suboperculum; *sph.*, sphenotic; *su. scap.*, suprascapular; *sym.*, symplectic.

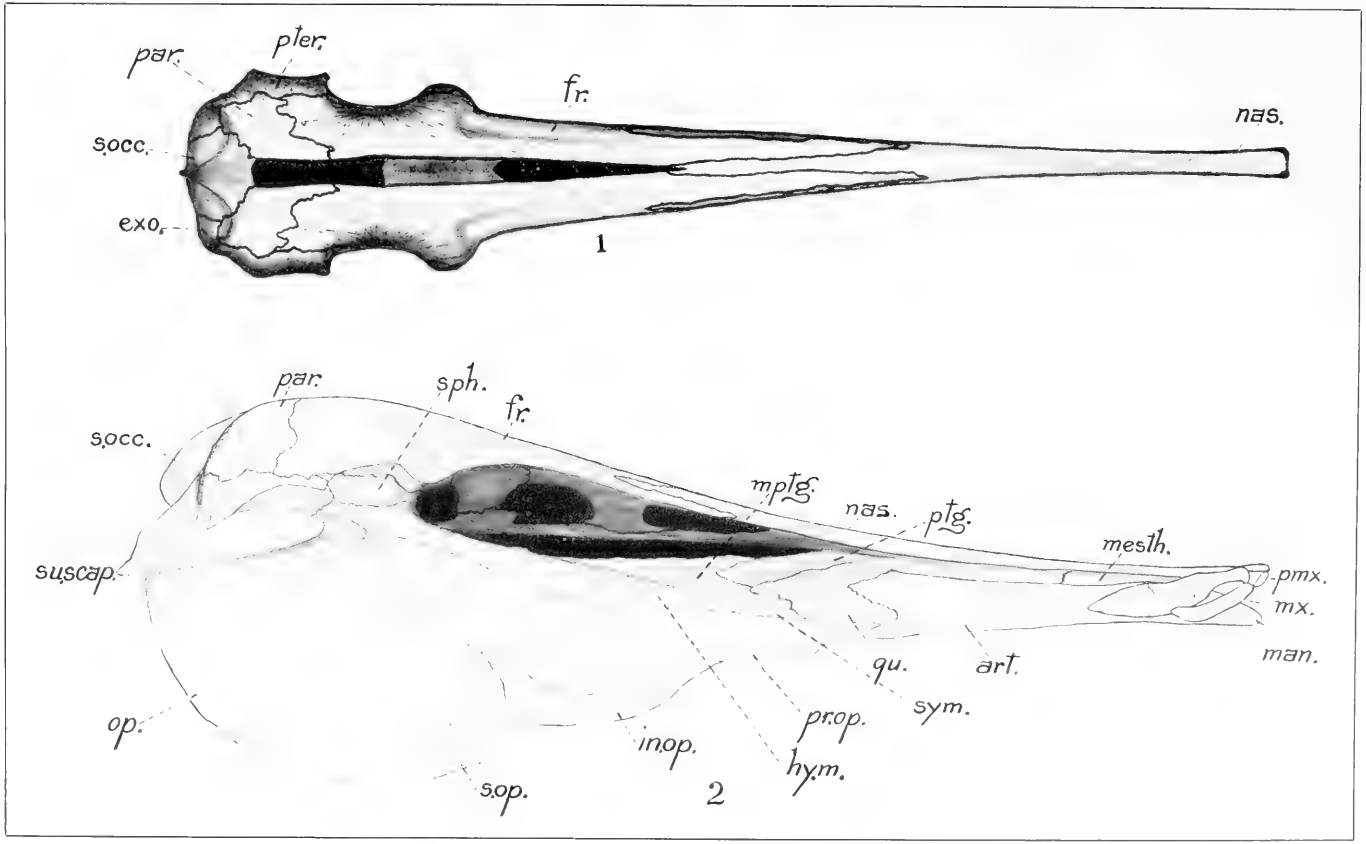


SKULL OF *Gymnotus carapo* LINNÆUS. FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XVII.

SKULL OF RHAMPHICHTHYS ROSTRATUS (Linnæus).

Fig. 1, dorsal view; Fig. 2, lateral view. *art.*, articulare; *exo.*, exoccipital; *fr.*, frontal; *hy. m.*, hyomandibular; *in. op.*, interoperculum; *man.*, mandible; *mesth.*, mesethmoid; *mptg.*, metapterygoid; *mx.*, maxillary; *nas.*, nasal; *op.*, operculum; *par.*, parietal; *p. mx.*, premaxillary; *pr. op.*, preoperculum; *pter.*, pterotic; *ptg.*, pterygoid; *qu.*, quadrate; *s. occ.*, supraoccipital; *s. op.*, suboperculum; *sph.*, sphenotic; *su. scap.*, suprascapular; *sym.*, symplectic.

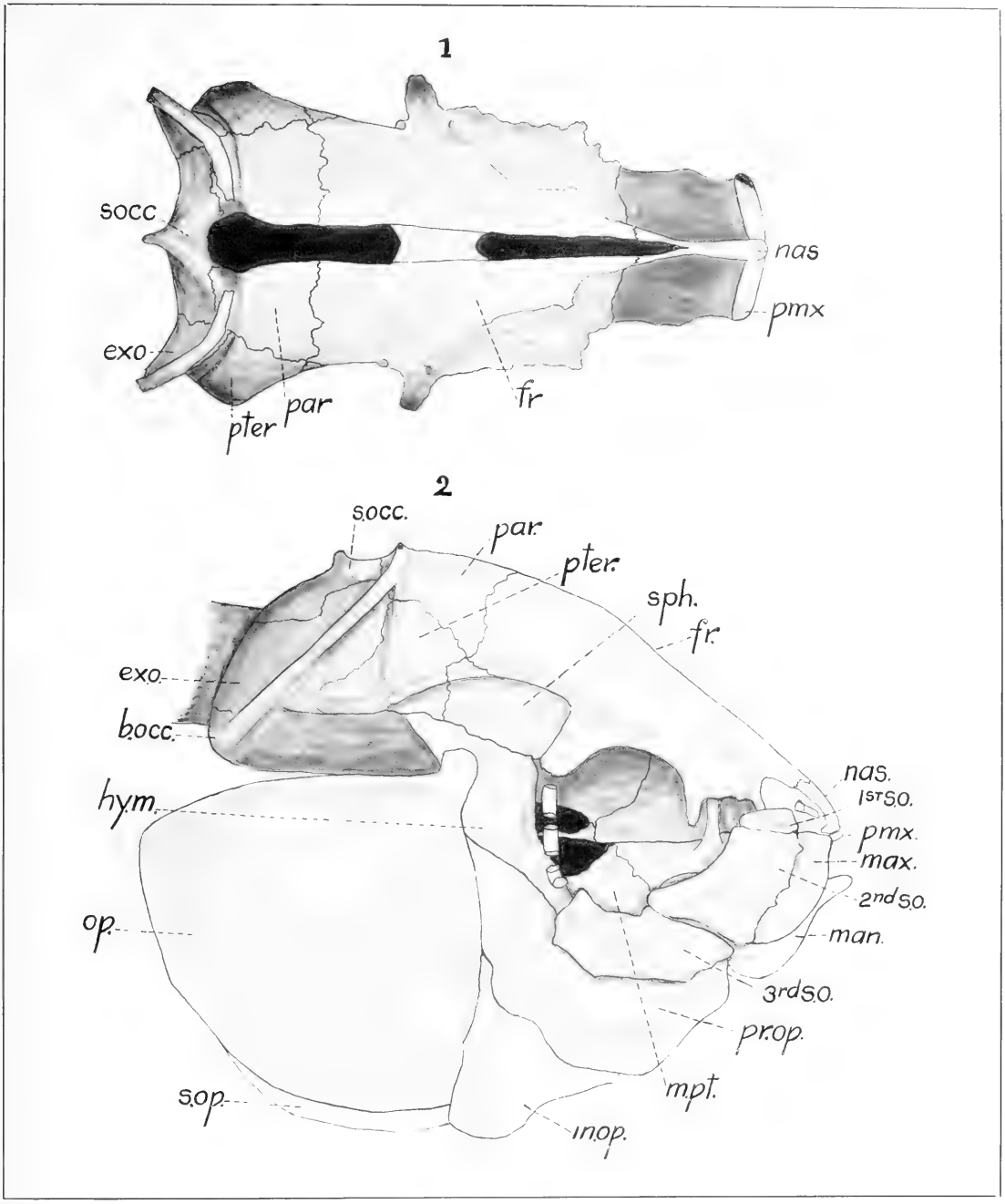


SKULL OF *Rhamphichthys rostratus* (LINNÆUS). FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XVIII.

SKULL OF EIGENMANNIA VIRESCENS (Valenciennes).

Fig. 1, dorsal view; Fig. 2, lateral view. *par.*, parietal; *pter.*, pterotic; *fr.*, frontal; *nas.*, nasal; *pmx.*, premaxillary; *exo.*, exoccipital; *spc.*, sphenotic; *b. occ.*, basioccipital; *1st. s. o.*, first suborbital; *2d s. o.*, second suborbital; *3rd s. o.*, third suborbital; *max.*, maxillary; *man.*, mandible; *pr. op.*, preoperculum; *in. op.*, interoperculum; *s. op.*, suboperculum; *op.*, operculum; *m. pt.*, metapterygoid; *hy. m.*, hyomandibular.



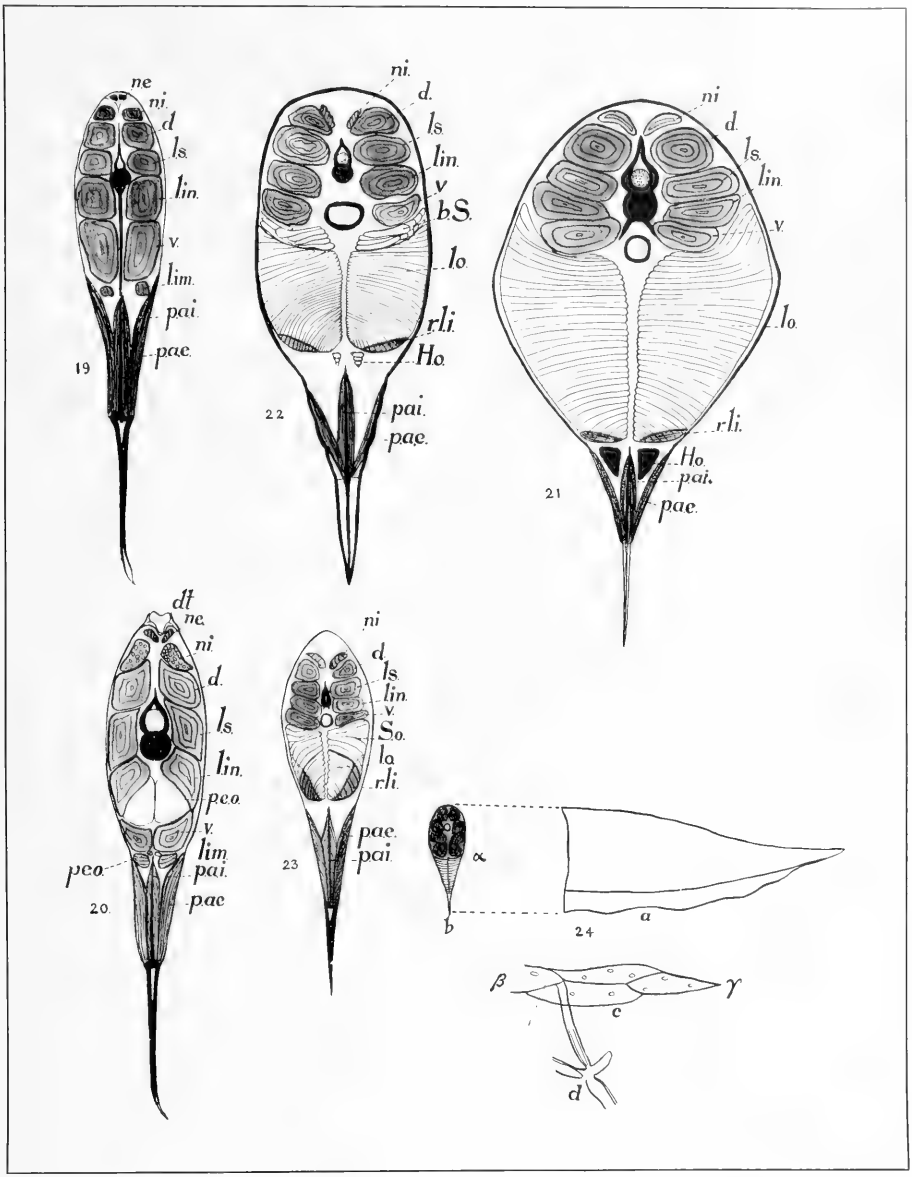
SKULL OF *Eigenmannia virescens* (VAL.). FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XIX.

FIG. 19. Cross-section of *Eigenmannia virescens* (Valenciennes).
FIG. 20. Cross-section of *Sternarchus albifrons* (Linnæus).
FIG. 21. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 22. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 22. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 23. Cross-section of *Electrophorus electricus* (Linnæus) near end.
FIG. 24. Pseudo-electric tissue of *Eigenmannia virescens* (Valenciennes) after Sachs. *a.* end of tail; *b.* cross-section through same; h. point corresponding to that occupied by the electric organ of *Electrophorus electricus* (Linnæus); gv. axis of distribution of structural units, which are indicated by *c.*; *d.* nerve-fibers; (after Sachs "Untersuchungen am Zitteraal" p. 69).

NOTATION OF FIGS. 19–23.

b. S., bundles of Sachs: *d.*, dorsalis; *d. t.*, dorsal thong; *H. o.*, Hunter's organ; *l. in.*, lateralis inferior; *l. im.*, lateralis imus; *l. o.*, large electric organ; *l. s.*, lateralis superior; *n. e.*, notalis externalis; *n. i.*, notalis internalis; *p. e. a.*, pinnalis analis externalis; *p. a. i.*, pinnalis analis internalis; *p. e. o.*, pseudo-electric organ; *r. l. i.*, remnant of lateralis imus; *S. o.*, organ of Sachs; *v.*, ventralis.



ANATOMICAL DETAILS OF STRUCTURE OF GYMNOTIDS.

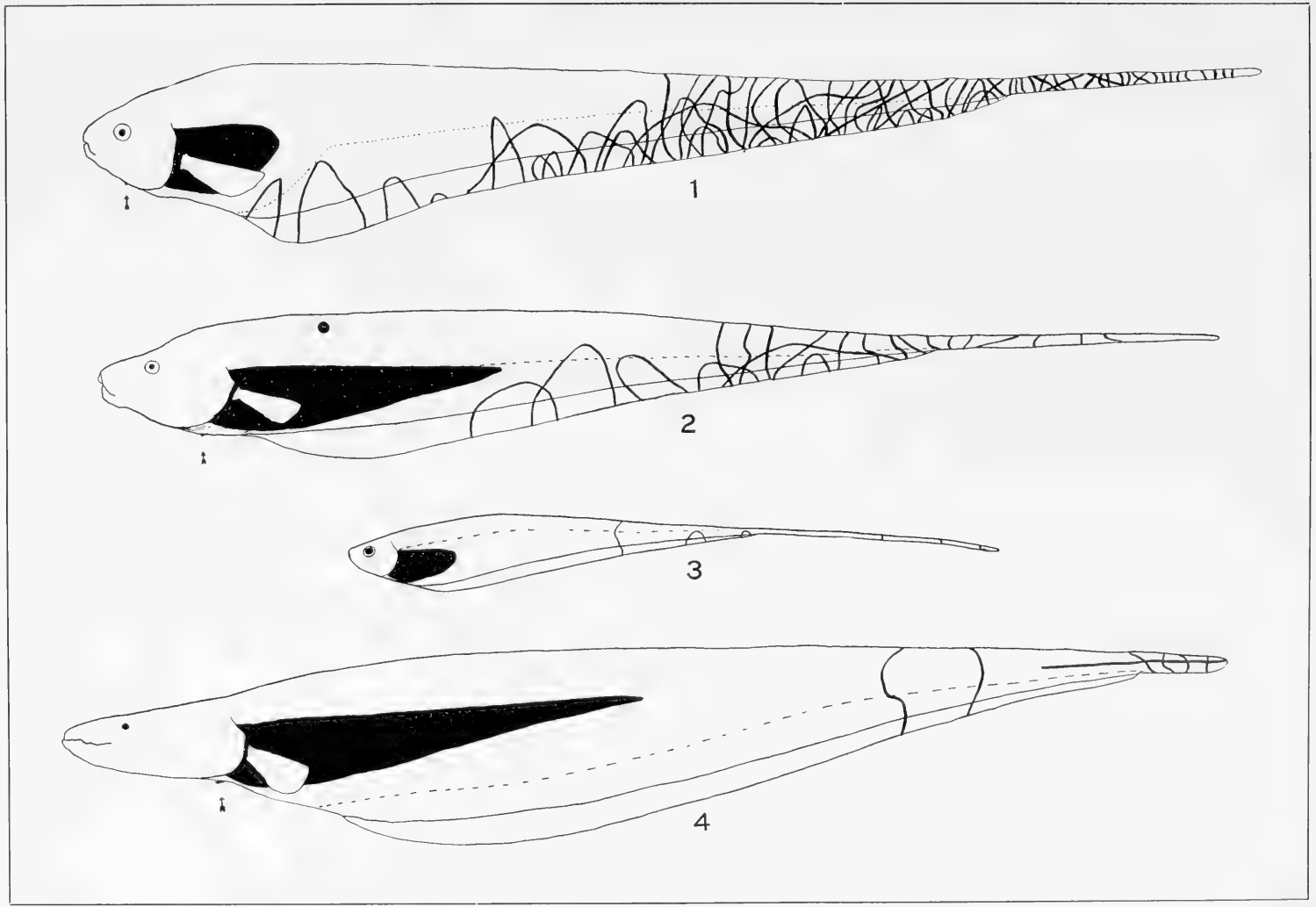


FIG. 1. OUTLINE OF *Eigenmannia virescens* (VAL.) SHOWING ALL INJURIES FOUND. FIG. 2. OUTLINE OF *Sternopygus macrurus* (BL. & SCHNEID.) SHOWING ALL INJURIES FOUND. FIG. 3. OUTLINE OF *Eigenmannia macrops* (BLGR.) SHOWING ALL INJURIES FOUND. FIG. 4. OUTLINE OF *Gymnotus carapo* (LINN.) SHOWING ALL INJURIES FOUND.

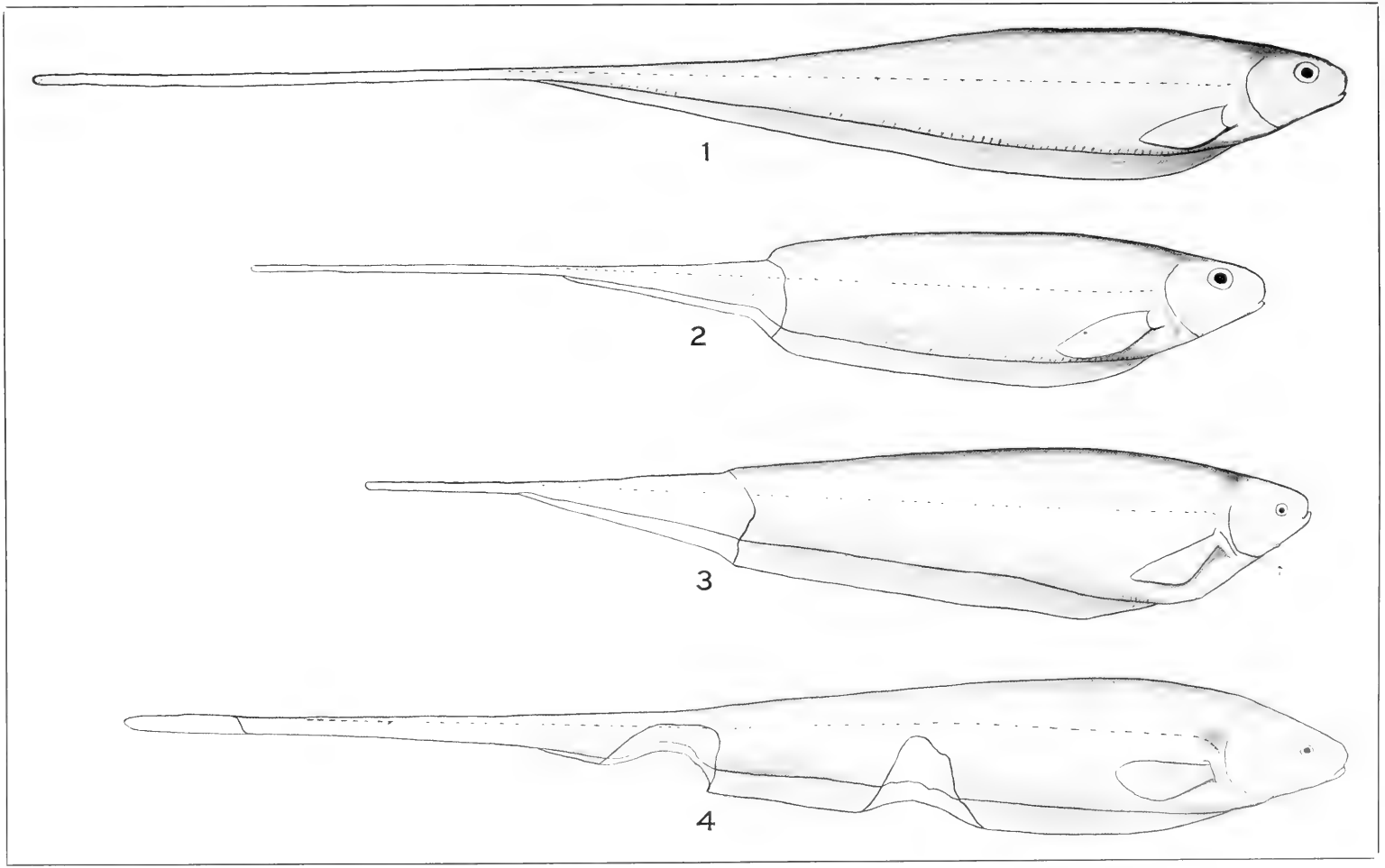


FIG. 1. OUTLINE OF *Eigenmannia macrops* (BLGR.) NORMAL. FIG. 2. MAXIMUM REGENERATION FOUND IN *E. macrops* (I. U. Cat. No. 12601). FIG. 3. MAXIMUM REGENERATION FOUND IN *Eigenmannia virescens* (VAL.), (I. U. Cat. No. 12604). FIG. 4. THREE INJURIES ON A 500 MM. *Sternopygus macrurus* (BL. & SCHNEID.), (I. U. Cat. No. 12592).

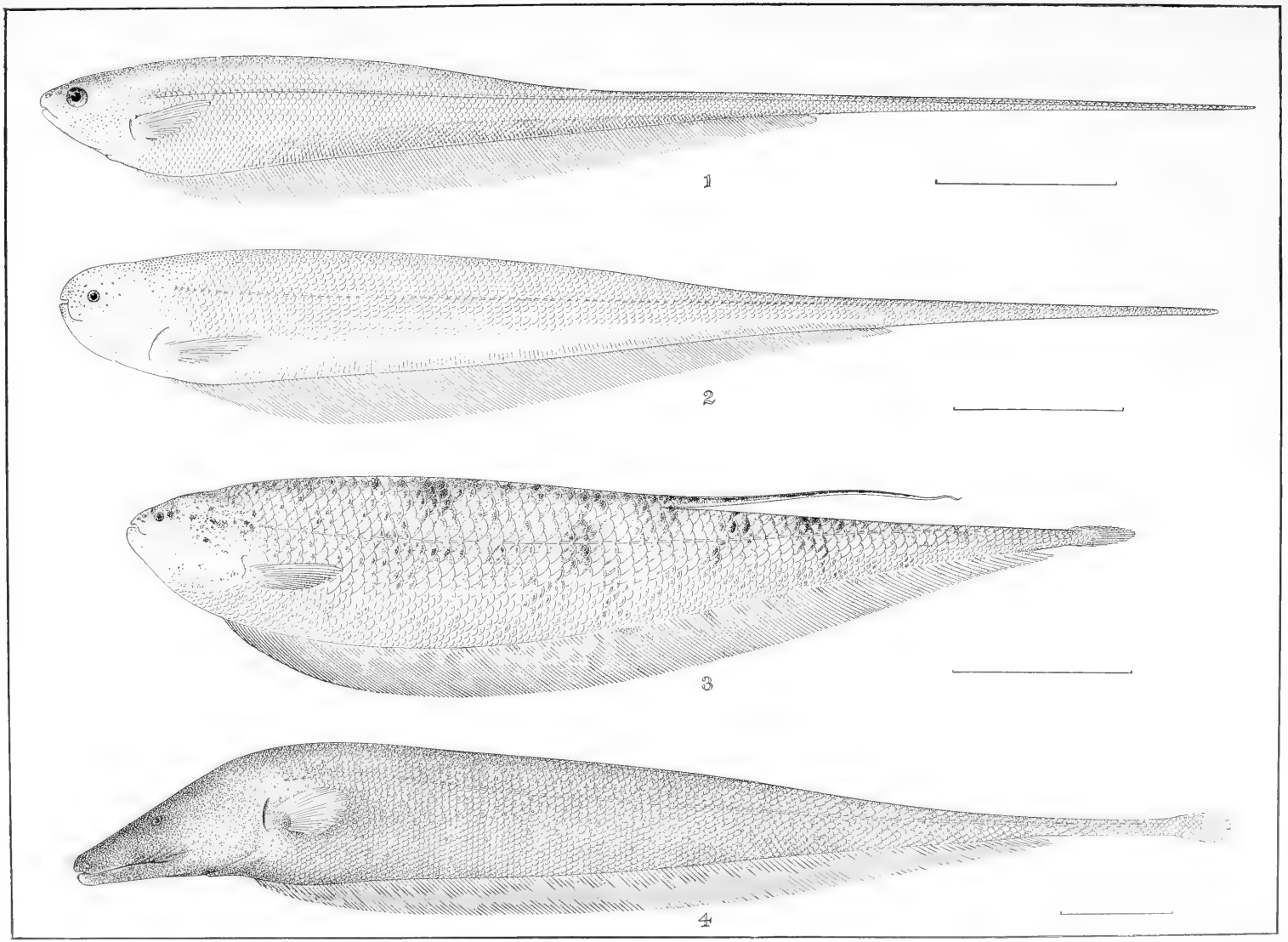


FIG. 1. *Eigenmannia macrops* (BOULENGER) 170 mm., C. M. Cat. No. 1805. FIG. 2. *E. troscheli* (KAUP) 175 mm., C. M. Cat. No. 3164. FIG. 3. *Adenosternarchus sachsi* (PETERS) 140 mm., C. M. Cat. No. 3199. FIG. 4. *Sternarchus leptorhynchus* ELLIS (TYPE) 260 mm., C. M. Cat. No. 1763.

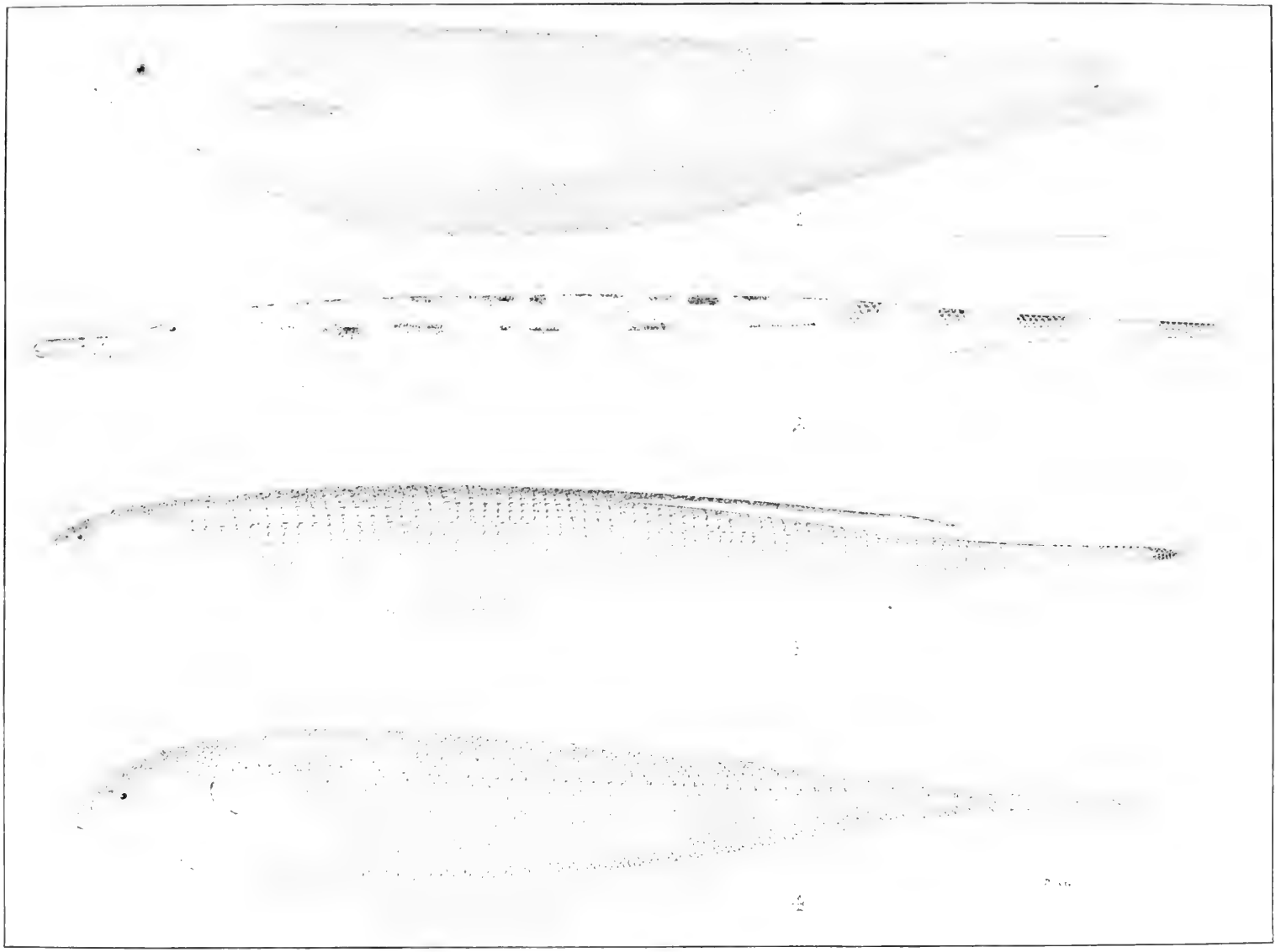


Fig. 1. *Sternarchus hasemani* Ellis (Type) 170 mm. to Base of Caudal. C. M. Cat. No. 3191. (Caudal and Part of Peduncle Regenerated). Fig. 2. *Gymnorhamphichthys hypostomus* Ellis (Type) 215 mm., C. M. Cat. No. 3182. Fig. 3. *Porotergus gimbeli* Ellis (Type) 200 mm., C. M. Cat. No. 3197. Fig. 4. *Porotergus gymnotus* Ellis (Type) 70 mm., C. M. Cat. No. 1759.

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