

PROCEEDINGS
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AN INTERESTING SPECIES OF FISH FROM THE HIGH
ANDES OF CENTRAL ECUADOR.*

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By permission of Hon. George M. Bowers, Commissioner of Fish and Fisheries.

Through the kindness of Dr. S. Austin Davis, surgeon of the Guayaquil and Quito Railway Company, the Bureau of Fisheries has recently come into possession of a number of excellent specimens of a very rare and little known species of fish from the high Andes of central Ecuador.

According to the classification of Eigenmann and Eigenmann,† these specimens belong in the Siluroid family Argidæ, and are beyond doubt the *Pimelodus cyclopus* of Humboldt or *Cyclopius cyclopus* of later authors. But in a recent monograph of the fishes of the family Loricariidæ,‡ by Mr. C. Tate Regan, that author regards the specimens identified by Eigenmann and Eigenmann as *Cyclopius cyclopus* as belonging to a different and undescribed species which he names *Arges eigenmanni*.

* Read before the Biological Society of Washington, January 23, 1904.

† A Revision of the South American Nematognathi or Catfishes, Occasional Papers Cal. Ac. Sci., I, 1890, 347-351.

‡ A Monograph of the Fishes of the Family Loricariidæ, Trans. Zool. Soc. London, XVII, Part III, Oct., 1904, 191 to 326, Plates XV-XXI. Rec'd Oct. 13 and read Nov. 17, 1903. Since the receipt of Mr. Regan's monograph this paper has been rewritten.

Recognizing Regan's classification, our specimens would represent his species. However, for reasons appearing further on in this paper, we are convinced that *Cyclopium cyclopium* is the valid name for them.

Our collection contains specimens representing both the eastern and western slopes of the Andes, but from very closely neighboring localities. These specimens exhibit considerable variation among themselves and show that previous descriptions have been not wholly accurate. The discrepancies indicate that certain changes in the present arrangement of the genera and species are necessary and suggest the possibility that future investigations may necessitate still further modifications in our views of the whole family.

In the present paper we present at some length the data which these specimens furnish and indicate the conclusions to which they point in the thought that this will prove of use to others who may have occasion to study these fishes.

CLASSIFICATION AND SYNONYMY.

The classification adopted by Eigenmann and Eigenmann is based upon the descriptions by previous authors and a few specimens of *Cyclopium cyclopium* in the Museum of Comparative Zoology at Cambridge, which we also have been privileged to re-examine, through the kindness of Prof. Samuel Garman. Eigenmann and Eigenmann include three genera in the Argidæ, which they separate as follows :

- a.* Adipose fin a long, low fold of skin which gradually merges into the dorsal profile anteriorly and posteriorly; lower lip very broad. *Arges.*
- aa.* Adipose fin short, with a spine placed near the tail. *Cyclopium.*
- aaa.* Adipose and ventral fins wanting. *Astroblepus.*

Under the genus *Arges*, they place *Arges sabalo* of all previous writers; *Brontes prenadilla* Cuvier & Valenciennes; *Arges prenadilla*, Steindachner; *Arges brachycephalus* Günther; *Arges longifilis* Steindachner; and *Arges peruanus* Steindachner.

In the genus *Cyclopium* are the one form which has borne the various names, *Pimelodus cyclopium* Humboldt; *Stygogenes cyclopium*, Günther; *Cyclopium cyclopium*, Putnam; *Cyclopium humboldtii* Swainson; *Stygogenes humboldtii*, Günther; and the additional species, *Stygogenes guentheri* Boulenger..

The third genus contains but one species, *Astroblepus grixalvii* Humboldt.

The genus *Arges* was erected by Cuvier and Valenciennes* to include those species having bifid teeth and a "long, low adipose fin." It was distinguished from *Brontes* by the latter's having no adipose fin. The first included *Arges sabalo* and *Arges cyclopum*; the second *Brontes prenadilla* which Valenciennes says is of identical structure in every way with *Arges cyclopum* except that it has no adipose fin. He further says regarding the latter :

They have shown to me that the fish of M. Boussingault indicates the place that should be assigned to *Astroblepus*. It is, if the term be allowable, an apodal *prenadilla*; and the *Pimelodus cyclopum* is very probably of the same genus as the *sabalo*.

Steindachner has re-examined the types of *Arges sabalo* and one of the two type specimens of *Brontes prenadilla*. Regarding the latter he says :†

Valenciennes's assertion that an adipose fin before the caudal is lacking, is erroneous, and the figure in l'Histoire Naturelle in plate 444 is one of the numerous errors in this work.

He further states that Günther's *Arges brachycephalus* is identical with *Arges prenadilla* Cuvier & Valenciennes.

These two positive assertions, of Valenciennes and Steindachner, respectively, become significant from an examination of our specimens. When first received these examples revealed no trace of an adipose fin excepting what was soon discovered to be a short spine, sometimes naked but in most cases concealed under the skin, evidenced only by a slight elevation, which was at first regarded as a "short adipose fin"; but in alcohol there gradually appeared on the back a low, thick, fleshy fold which increased in resemblance to a thick adipose fin with their continuance in the preservative, and, in the smaller individuals, became thin and very much like an adipose fin in appearance.

Regarding the adipose fin in *Arges sabalo*, Steindachner says (l. c., p. 18) :

A more or less puffed, rather deep fold of skin begins on the back behind the dorsal, at a distance equal to the whole or rather more than half the length of the base of the fin, and unites with the upper caudal

* Hist. Nat. Poiss., XV.

† Flussfische Sudam., IV, 21.

ray, the short upper rays of this fin being completely surrounded by it. A puffed fold of skin surrounds the lower short rays of the caudal.

Referring to *Arges longifilis* (l. c., p. 20), he says :

The fold of skin on the back is in some more, in others less, fleshy, and of equal height and length with *A. sabalo* ;

and regarding some very small examples, 4.5 to 5.5 cm. long, he further remarks :

The fold of skin on the back is very distinct throughout its length, and very thin.

Concerning *Arges prenadilla*, he says, on this point :

A plainly visible seamlike fold of skin on the back begins over and a little in front of the anal and extends to the caudal, uniting with the upper ray of the fin.

In another place he states :

In my opinion Günther's species of *Arges brachycephalus* is identical with *Arges prenadilla*,

and he goes on to say regarding three examples (male and female) which he believes to be the same species, from Peru, measuring 4.5, 5 and 9 cm. :

The two little specimens are especially noteworthy in that they show not the slightest trace of the adipose fold, but as to depression and form of head they correspond almost exactly with 7 cm. specimens of *Arges sabalo* previously mentioned.

However, Steindachner's figures of *Arges sabalo* and *Arges longifilis* show a decidedly high and thin adipose fin which, from his description, must be inaccurately represented. Regarding his *Arges peruanus*, Steindachner says (l. c., p. 21) :

The adipose fin resembles a long thickish fold in the skin, of slight elevation, gradually losing itself before reaching the caudal ;

but his figure shows even no trace of such a fold.

These descriptions show conclusively that what has been so regarded is not a true adipose fin, which conclusion our specimens substantiate. It is evident that the presence of the supposed adipose fin on the different species, is simply due to the action of the preservative and that there is no true adipose ; and the smaller the individual and the longer its stay in the preservative, the more like an adipose fin the fold may become.

Since the publication of Eigenmann's South American Nematognathi, Boulenger writes : *

Leaving aside the two or three species in which a spine is present between the rayed dorsal fin and the caudal, whether exposed and supporting the small adipose fin or partly imbedded in the skin, and for which the name *Stygogenes* Günther may be retained, I find upon examination of the material in the British Museum, and after perusal of Dr. Steindachner's descriptions, that as many as six species of the genus *Arges* are entitled to distinction.

He further says :

A. longifilis, *sabalo*, *taczanowskii*, and *peruanus* inhabit the Andes of Peru, *A. prenadilla* and *whymperi* the Andes of Ecuador. I had originally confounded the two latter species, when Mr. Whymper submitted to me his specimens for identification some years since, but renewed examination has convinced me that there are at least three kinds of "Prenadillas" in Ecuador, instead of one as believed by Putman.

He then retains *Stygogenes* Günther instead of *Cyclopium* Swainson for the form with the spine on the caudal peduncle, and *Arges* for the one with no spine and more or less of an "adipose fin." Our specimens belong to the first named group. *Arges whymperi* is doubtless an individual variation of *Cyclopium cyclopum* as indicated by our specimens, since they show that the presence or absence of a spine is not even a specific difference. *A. whymperi* has no adipose fin and no spine. *A. taczanowskii* possesses a low fleshy fold which is supposed by the authors to be an adipose fin, and has no spine, and represents the *sabalo* group of Peru.

In 1898 Boulenger described a species from Ecuador, † under the name *Arges festæ*, which appears to be valid. In the same paper he redescribes *A. prenadilla*, regarding which he wrote that the examples confirmed the identity, recognized by Steindachner, of *Brontes prenadilla* C. & V. and *Arges brachycephalus* Günther.

Regan (l. c.) has recently made radical changes in the classification of this Siluroid group and described a number of new species. He objects to the family name Argidæ of Gill and

* Description of two new species of the Siluroid Genus *Arges*, Proc. Zool. Soc. London 1890, 450 to 452, and plate.

† Poissons de l'équateur Boll. du Mus. Zool. ed Anat. Comp. R. Univ. Torino, XIII, No. 329, 1898, Pl. XXI, Fig. 7.

includes the group in a subfamily Argiinae in the family Loricariidæ.

The following list enumerates the characters which, according to Regan, distinguish the subfamily Argiinae from the other subfamilies of the Loricariidæ, and which, as suggested by Dr. Gill, and according to our own view, are sufficient to establish a well marked family :

Teeth in jaws in more than one series ; no pseudobranchiæ ; body naked, no bony plates or scutes ; rudimentary ray of ventral present, represented by a small internal round plate ; stronger ribs ; neural and hæmal spines somewhat less expanded ; pterygoid small, instead of large and not connected with the prefrontal ; clavicle and coracoids running somewhat forward to their symphyses instead of the lower portions lying transversely between the bases of the pectorals.

In this subfamily, as he regards it, Regan recognizes only one genus, *Arges*, substituting Cuvier & Valenciennes's name for Swainson's *Cyclopium* for the following reason which he gives in a footnote on page 307 (l. c.) :

Swainson established the genus in these words: "The third genus is that by which we distinguish the *Pimelodus cyclopum* of Humboldt (*Cyclopium humboldtii* Sw.)." His generic name being derived from the genitive plural of *Cyclops*, is as inadmissible as would be that of *Silurorum*.

While most American zoologists regard as very objectionable the use in generic nomenclature of the genitive plural form of a substantive, they do not hesitate to accept such words when once used, retaining the original spelling. Any other practice tends away from stability of nomenclature. But whatever view one may hold regarding this matter, Mr. Regan's contention does not hold in the case under consideration. *Cyclopium* is not the genitive plural of *Cyclops*, as he imagines, but the neuter form of the adjective *cyclopius*.

The only character that separates the genera *Arges* and *Cyclopium* is the presence of a spine in the location of the "adipose fin" of the latter. That this spine may have been easily overlooked in other specimens, since it is so often concealed under the skin in ours, is evident. By an examination of specimens of the species of *Arges*, it is possible that a spine may be found. This character is therefore of doubtful value.

Regarding *Astroblepus*, it remains to be said that, for the same

reason, the absence of an adipose fin in that genus is of no importance and the only distinctive character is the very improbable absence of ventral fins.

Regarding this genus Regan remarks that it is allied to *Arges*, differing only in the absence of ventral fins; that it is possible that this feature is abnormal or accidental and that the genus may be founded on a specimen of *Arges brachycephalus* or an allied species.

Astroblepus grivalvii is known only from the very imperfect description and monstrous figure of Humboldt; and it probably never will be found so long as one of this group without ventral fins is looked for. It is not improbable that *Cyclopium guentheri*, occurring in the same river basin in which the *Astroblepus* was found common enough to be used as food by the inhabitants is identical with it. Humboldt says regarding it:

The *Pescado negro*, which is largely eaten at Popayan, is not found in that part of the Cauca River which is nearest the city. The physical cause of this phenomenon is quite remarkable. A river impregnated with sulphuric acid descends from the volcano of Purace to which the inhabitants give the name of Vinegar River. It is known by the beautiful cascade which it makes at the foot of the volcano. From the point where the waters of the Vinegar River mingle with those of the Cauca River, as far as four miles farther down, the latter is without fish, although in its upper part the fish are quite abundant. Small quantities of the acid, which were taken for our chemical analyses, are often considerable enough to injure the organization of fishes.

Regan recognizes nineteen species of *Arges*, to eight of which he gives new names. Of the eight supposed new species four are founded on forms which had been regarded as known species. *Arges boulengeri* is based on *Stygogenes humboldtii* of Boulenger, but not of Swainson. *Arges eigenmanni* is the *Cyclopium cyclosum* of Putnam, and Eigenmann and Eigenmann (not *P. cyclosum* Humboldt). *Arges cyclosum* is redescribed from four specimens from some unknown locality. *Arges vaillanti* is based on a single specimen sent from the Paris Museum as *Brontes prenadilla*. *Arges fissidens* is founded on a part of Boulenger's *Arges whymperi* (two specimens).

There is a key to the species the main divisions of which are based on the character of the adipose fin. The other divisions are based on extent of ventrals and pectorals, character of teeth, position of ventral, etc. Among our specimens there are indi-

viduals which fall respectively into several of his main categories, excepting that of a well developed adipose fin without trace of spine. In other words, judging by the principal divisions alone, we have *A. clycopum*, *eigenmanni*, *prenadilla* and *fissidens*. They do not agree, however, in some other points, which, if given consideration, prevent us from identifying our specimens with any of his species. There is no doubt of the specific identity of our specimens. The differences are mostly due to age, size and sex. The adipose fin, as we have shown before, is of doubtful value, and of no value whatever in the species to which we have just called attention. The development of the spine may be of value in larger specimens but in one of two small specimens we have there is a long spine connected posteriorly with the caudal peduncle and in the other there is in addition to the spine a long, moderately developed adipose fin. Most of the other spines are small, just visible, imbedded in the skin and appearing only as tubercles or not at all apparent.

In the males, as already remarked, the ventrals are inserted farther forward than in the females; therefore, comparison of extent of pectorals with ventrals or ventrals with proximity to vent is of no value. In fact, there is such a range of variation in these characters, regarded by Regan as showing specific differences, that there arises a serious distrust of the value of any of them for that purpose. Regan had the advantage of material representing more species and localities than we have, but in view of the foregoing fact the suggestion offers itself that unless there are other grounds for separation, the five alleged Peruvian species may be, if not all one, certainly not more than two species at greatest.

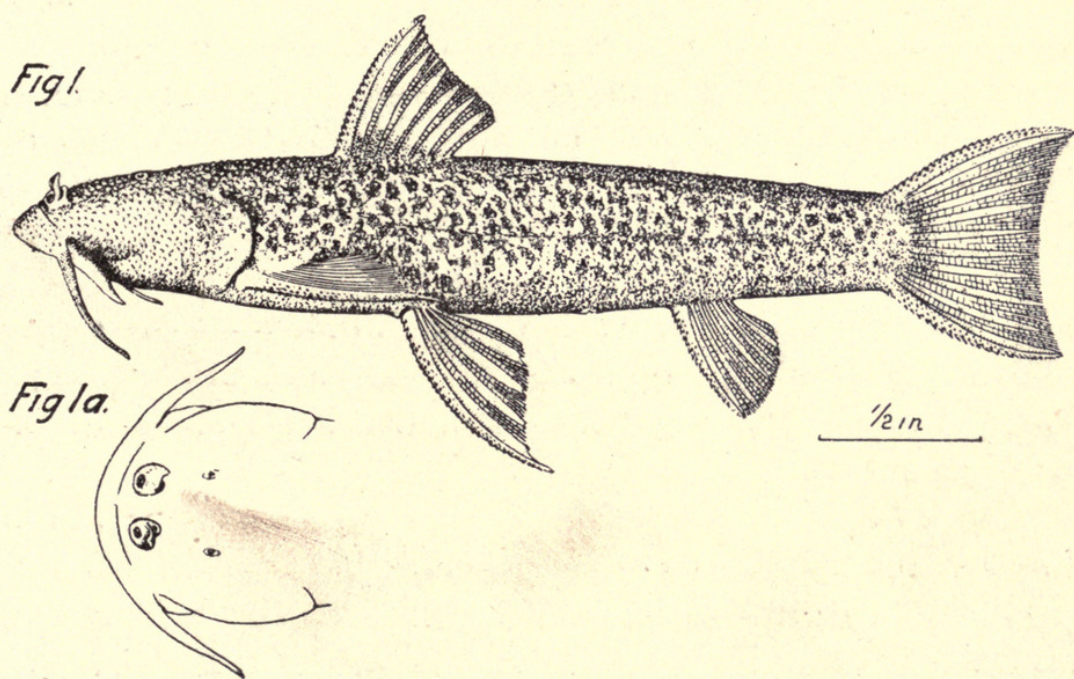
Regan's figures of the various species show more dissimilarities than do his descriptions, but even the figures, taken in conjunction with the variations in our specimens, indicate that *homodon* and *guentheri* are possibly the two sexes of the same species. Among the Ecuador species, one of the Atlantic slope forms, *A. festæ*, is clearly a distinct species, as shown by the elongate nasal barbel.

There seems hardly ground for identifying Madame Ida Pfeiffer's specimens as *A. cyclopum* and establishing a new species on individuals that agree more closely with the original description and plate than the others do. *Arges whymperi* and

fissidens have but little left by which to distinguish them and the same may be said of *sabalo*, *taczanowskii*, *vaillanti* and *prenadilla*.

Since the male examples of our specimens agree with all that has been said of *Arges prenadilla*, and the females equally as well with *Cyclopium cyclopium*, we are forced to unite these two forms in the genus and species *Cyclopium cyclopium*, which will include *A. eigenmanni* and perhaps *whymperi* of Regan. There is nothing in the laws of nature, so far as we know, to prevent the existence of a number of genera and species of this group of fishes; but the indications derivable from the literature and material at hand are that the number may be still further reduced as a result of more extended investigations, and there may be but one genus, *Astroblepus*, to include all the nominal species.

The following description of *Cyclopium cyclopium* is based on two individuals, female and male, each about 3.12 inches in length, in the collection sent us by Dr. Davis:

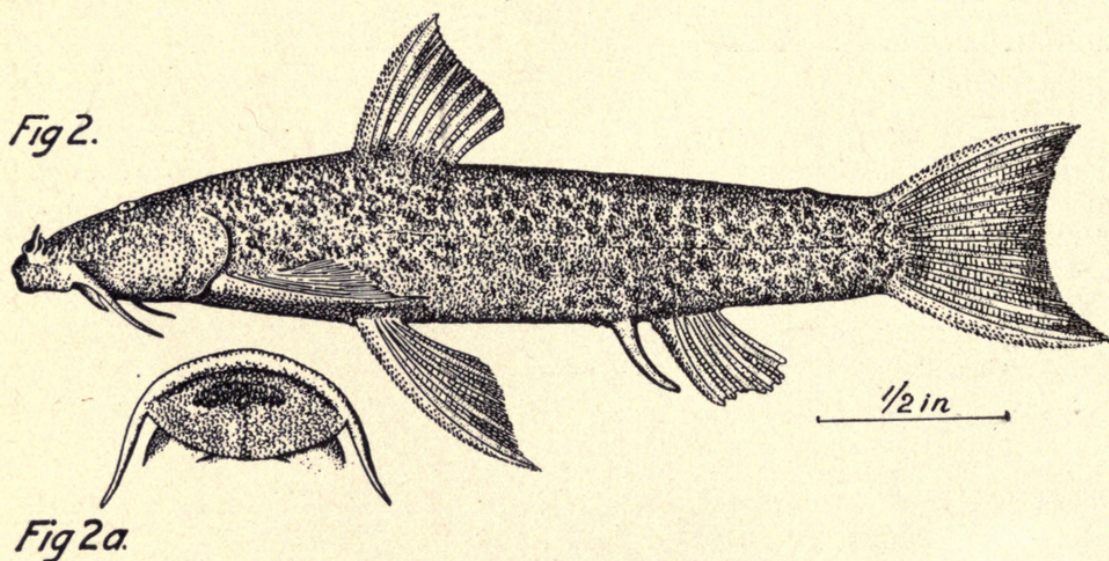


FIGS. 1 and 1a.—*Cyclopium cyclopium*, female.

Female.—Head 4.18 in length to base of caudal; D. 7; A. 7; P. 10; V. 5; C. 13. Body rather robust, somewhat depressed anteriorly and compressed posteriorly; a thick fleshy fold or ridge (after months in alcohol), somewhat arched, extending from a short distance back of dorsal to base of upper ray of caudal, with a small rough, nearly concealed, spine posteriorly; skin rather loose and wrinkled, full of fine mucous pores posteriorly to dorsal, coarser in front; first dorsal, outer pectoral and

ventral and upper and lower caudal rays slightly produced; ventral somewhat rounded; first or outer rays of all fins spinuliferous; longest ray of pectoral just reaching base of outer ray of ventral; insertion of ventral about under middle of dorsal; ventral reaching slightly beyond vent but not to anal; head rather broad and depressed; gill-openings reaching below base of pectoral, membranes broadly attached to isthmus; gills 4, no slit or pore behind the last; cheeks tumid; eyes minute, vertical, covered by the common outer skin and situated about midway between nostrils and upper angle of opercle; interorbital space about equaling distance from posterior edge of nostril to eye; barbel reaching somewhat beyond cheek; nasal openings separated by an irregular triangular flap; mouth opening inferior; upper lip thick, plicate and papulose; lower lip expanded, papulose, with median suture connected by the skin, posterior margin rounded, slightly notched; teeth in several rows in each jaw; upper teeth simple, somewhat curved, conical, some of them somewhat expanded at end, teeth of inner rows all bifid; lower jaw bones separate, connected only by the membrane; teeth all bifid, situated only at the expanded inner ends of the bones.

Color, olive-gray, thickly clouded with darker; fins all barred with dark gray.



FIGS. 2 and 2a.—*Cyclopium cyclopum*, male.

Male.—Head 4.28 in length to base of caudal; D. 7; A. 6; P. 10; V. 5 C. 13. Body rather slender, differing remarkably in appearance from the female; more depressed anteriorly and more compressed posteriorly; posterior dorsal fold not so noticeable, barely evident; spine hardly distinguishable through the skin; pores on anterior part of body coarser than in the female; outer ventral and lower caudal ray, somewhat more produced; the first rays of all fins spinuliferous; pectoral reaching beyond base of ventral; ventral inserted under or slightly in advance of front of dorsal, not reaching vent; head much flatter and somewhat broader than in female. Color, similar to female but much darker. Sexes otherwise readily distinguishable by the long papilla just posterior to the vent in the male, probably serving as an intromittent organ; this organ somewhat

distant from the front of anal but apparently representing the 7th ray which is always present in the females and absent from the fin proper in the males. These females contain ovaries with rather large but still immature ova.

There are several young individuals in our collection. The smallest of these is a trifle more than 1 inch in total length and has the dorsal fold conspicuous and thin and the posterior dorsal spine not concealed but comparatively long and spinuliferous. The color now is plain light brown.

TABLE OF PROPORTIONAL MEASUREMENTS OF SPECIMENS OF
Cyclopium cyclopum.

LOCALITY.	PALMIRA PASS.						ALAUSI RIVER.	
	1	2	3	4	5	6	7	8
Number of specimen								
Sex	♀	♀	♀	♀	♀	♂	♀	♂
Total length in inches	3.20	2.56	2.72	2.40	2.60	3.20	3.32	2.92
Head in length without tail	4.18	4.31	4.14	3.70	4.00	4.28	3.88	3.86
Depth " " " "	5.58	5.20	5.04	5.00	4.90	7.61	5.00	5.27
Width of head in length of head	1.08	1.11	1.07	1.22	1.17	1.08	1.05	1.03
Maxillary barbel in head	2.46	2.41	2.00	2.73	2.00	2.00	1.89	1.85
Interorbital width in head	3.55	3.62	3.50	3.85	3.85	4.00	4.00	3.75
Distance from D. to C. in length without tail	2.03	2.08	2.14	2.00	2.03	1.67	2.18	2.07
Distance from mouth to D. in length without tail	2.68	2.71	2.52	2.50	2.76	2.58	2.59	2.41
Longest dorsal ray in head	1.52	1.45	1.55	1.58	1.50	1.52	1.38	1.42
Longest anal " " "	1.77	1.70	1.75	1.80	1.68	2.00	1.80	1.87
Longest pectoral " " "	1.18	1.20	1.07	1.12	1.22	1.23	1.13	1.07
Longest ventral " " " *	a	a	a	c	a	b	b	c

* a. slightly longer; b. slightly shorter; c. same length.

The fin formulas are as follows: D. 7 (9 in No. 4); A. 6 in ♂, 7 in ♀; P. 10; V. 5; C. 13 (11 in No. 8 and 12 in No. 9).

SIZE AND DISTRIBUTION.

In the Riverside Natural History, page 114, it is stated that—

The five or six known species of Argidæ reach a length of 2 or 3 inches only, and inhabit the ponds and springs of the upper Andes on the Peruvian or Pacific slope, where they take the place occupied by the Lorica-riidæ on the Atlantic side.

In this statement there are two errors. First, regarding the size; the type of *Arges sabalo* was about 21 cm. or about 8.25 inches long, and Steindachner mentions examples 11 to 32 cm. long (about 4.4 to nearly 13 inches); and *Astroblepus grixalvi*,

Humboldt says reaches a length of 14 inches. According to Steindachner, *Arges longifilis* ranges from 9.5 to 18 cm. (about 3.8 to 7.2 inches). The other species of *Arges* and of *Cyclopium* are small. Regarding the restriction of the species to the Pacific slope of Peru, it may be said that most of the recorded localities in which the different species of *Arges* and *Cyclopium* have been obtained, are in the Atlantic drainage. Regan places all of the species of the genus *Arges* excepting *cyclopum*, *whymperi*, *eigenmanni*, *chotæ*, and *simonsii* in the Atlantic drainage, the exceptions occurring only in the west coast streams of Peru and Ecuador. Orton's specimens, which Putnam identified as *C. cyclopum* and which Regan says are the same as his *Arges eigenmanni* are from both drainages in Ecuador. *Stygogenes humboldti* Günther is from the Amazon basin in Ecuador. *Brontes prenadilla* Cuvier & Valenciennes is from the east slope of Cotopaxi. Our specimens are from both slopes of the Andes of Ecuador.

Of the nineteen nominal species recognized by Regan, four are exclusively of the west coast drainage, two at least are common to both slopes, and the remainder restricted to the Atlantic drainage.

HABITS.

For the following interesting account of the habits of these fishes we are indebted to Dr. Davis:

The specimens from Alausi River were found in a bight made by deviating the channel for purposes of railway construction. The stream at the point mentioned has a fall of about 200 feet to the mile, and an elevation above the sea of 9,400 feet. The water of the Alausi River reaches the Pacific Ocean via the Guayas River.

The specimens from Palmira Pass or Desert were taken from small brooks flowing through deep channels cut in the volcanic deposits of which the desert is largely composed, and were found in some instances at the very sources of some of the rivulets, where the water seeps, spring-like, from under the vertical walls of volcanic dust. These streams finally reach the Atlantic through the Amazon River. The elevation of these waters is about 10,500 feet and a strip of desert about 2 miles wide, and perhaps 200 feet vertically, is all that intervenes between the headwaters of streams on the Atlantic slope and the Alausi which does not come from the desert but flows past its southern approach and to the Pacific.

The fish usually remain quietly on the creek bottom, sometimes in sight but preferably under stones, aquatic plants or overhanging banks. They are quiet unless disturbed, when they are active in getting out of

sight. In captivity, as when under observation in a wash basin they make use, after a while of their organ of locomotion, by climbing up the side of the dish, out of the water, and shoving themselves along on the shelf or the floor. They appear not to suffer as other fishes do when out of water, as I have found them on the floor some hours after having left the water, judging from lack of moist traces of their progress, quite active and shoving themselves along by the aid of their sucker-mouth and the organ of locomotion. This is a bony plate under the skin of the belly, freely movable for $\frac{1}{2}$ inch to $\frac{3}{4}$ inch to which are attached 2 pairs of cord-like muscles, one pair passing forward to near the junction of head and one pair ending just forward of the anal orifice. On each side of this plate is attached a ventral fin moving with the plate and having its chief bone finely tuberculated, the minute points of which tubercles, being directed backward, aid in locomotion by engaging the surface over which the fish travels.

The fish appears to be able to move over the ground or other surface in 2 ways, one when the mouth is fixed and the body brought forward by being arched, when the mouth is loosed and the head advanced; the second as when the roughened fin-bones act as a fixed point, the body being shoved forward by a jerky motion by the contraction of the posterior pair of muscles, when the fins are then hauled forward by the anterior pair of muscles to repeat the act.

The food of this fish may be known by an examination of the stomach contents and is determined naturally by the sort of supply furnished by the locality of capture. Those from the quiet water of the bight of the Alausi contained grains of sand, portions of aquatic plants, about a dozen different forms of diatoms, and bunches of hooklets, smooth and toothed, the origin of which I do not know.

The stomachs of the fish from the desert are stuffed with insect larvæ of various sorts, the same being very plentiful in those streams. I found no diatoms in these specimens.

In connection with the foregoing sketch by Dr. Davis, of his observations in Ecuador, the following account by Humboldt of the same region and fish may be of interest. Cuvier and Valenciennes quote freely from it and add effusively to Humboldt's description of the very remarkable phenomenon, the absurdity of which must be apparent to every one.

It is probably a fact that the fish have appeared on the plains below the volcanoes after an eruption, but it is, of course, unnecessary to explain that they probably were washed there by the freshets of the mountain streams caused by the volcanic or seismic disturbances. Humboldt says :

The volcanoes of the province of Quito eject pumice, basalt and porphyritic scorïæ, and great quantities of carburetted water, and clay mud, which spread to a distance of 8 or 10 miles. Yet the volcanoes of the district of

Quito present from time to time another phenomenon less alarming but not less astonishing to the naturalist. The great eruptions are periodical and quite rare. Cotopaxi, Tungurahua and Sangay (sometimes not for 20 or 30 years,—but in the intervals) vomit up enormous quantities of clayey masses and, wonderful to state, an immeasurable quantity of fishes. It is regretted that one of these volcanic floods did not occur while I tarried in the Andes of Quito, but the eructation of fishes is a phenomenon so common and so generally known by all the inhabitants of this country that there can not be the slightest doubt concerning its authenticity. There are in this region many well-informed persons and even those of scientific attainments from whom I was able to procure exact information about these fishes. While searching the annals of many small towns in the neighborhood of Cotopaxi, I have sometimes found records of fishes cast out by volcanoes. Upon the lands of the Marquis of Selvalegre, Cotopaxi ejected so great a quantity that their putrefaction spread a fetid odor far and wide.

In 1691 the nearly extinct volcano of Imbaburu vomited thousands into the environments of Ibara. The pestilential fevers which occurred about this time were attributed to the miasmas which the fishes, heaped upon the ground and exposed to the sun, exhaled. In recent times Imbaburu has continued to throw out fishes. In the eruption of June 19, 1698, the volcano of Caqueirazo threw out from its summit thousands of these animals enveloped in clay or mud.

Cotopaxi and Tungurahua cast forth fishes, sometimes through the crater at the summit, sometimes through lateral fissures, but always at an elevation of 15,000 or 15,600 feet above the surface of the sea. Now the plains there about being nearly 7,800 feet in altitude, it may be seen that these animals emerge from a point that is 7,800 feet higher than the plains upon which they are thrown. Some Indians have assured me that the fish vomited by the volcanoes were sometimes still living on descending the length of the side of the mountain, but this fact does not seem to me to be sufficiently substantiated. It is certain, however, that among the thousand of dead fishes that in a few hours can be seen descending from Cotopaxi with great quantities of cold and fresh water, there are but few that have been so affected as to cause one to believe that they had been exposed to the action of a strong heat. That fact becomes still more astonishing when one considers the soft skin of these animals and the thick steam that the volcano breathes out at the same time. It has seemed to me to be a subject of very great interest for descriptive natural history to correctly prove the nature of these animals. Every inhabitant agrees that they are identical with those that have been found in the streams at the foot of these volcanoes and which have been called *prenadillas*. It is even the only species of fish that has been discovered above 8,400 feet in the waters of the district of Quito. This small fish lives in waters which have a temperature of 10 degrees Centigrade, while other species of the same genus live in the rivers of the plains, of which the water is 27 degrees.

According to the enormous quantity of *pimelodes* which are vomited from time to time from the volcanoes of the province of Quito,

one would not dare to doubt that the country contains some great subterranean lakes which conceal these fishes, because the specimens that live in the small rivers around about are very few in number. A part of these rivers ought to communicate with these subterranean cavities, and it is very probable that the first pimelodes which have populated these caverns have remounted there against the current. In the province of Quito the subterranean roaring which accompanies the quaking of the ground, the masses of rocks which one would expect to cave in from the arched roof upon which he walks, the immense quantity of water which emerges from the ground in the thinnest portions; then the volcanic explosions and a number of other phenomena show that the entire ground of this plateau is undermined. But, if it is easy to conceive that the vast subterranean basins are filled with water and that they can nourish fishes, it is less easy to explain how these animals are aspirated through the volcanoes, elevated to 7,800 feet and vomited, sometimes through the craters and again by means of openings in the sides. Would it be possible to suppose that the pimelodes live in the subterranean basins at the same height at which they are seen emerging? How can their origin be conceived in a position so extraordinary, in the side of a cone so often heated, and perhaps in part produced through the volcanic fire? What can be the method by which they are cast out with the form not disfigured, which would be expected, by these volcanoes, the highest and most active in the world, causing from time to time convulsive movements, during which the release of heat appears less considerable than one would expect it to be. The tremblings of the ground do not always accompany these phenomena. Perhaps in the different caverns that occur in the interior of a volcano the air is from time to time condensed, and that it is this condensed air which aids to raise the water and fishes; perhaps they emerge from a concavity removed from those that give out the volcanic fire; perhaps, finally, the clayey masses in which these animals are enveloped protect them from the action of an extreme heat.



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