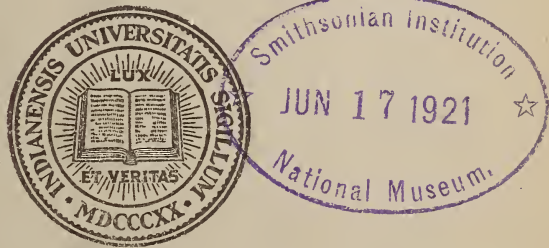


INDIANA UNIVERSITY STUDIES



Study No. 47

- A. THE FRESH-WATER FISHES OF PANAMA EAST OF LONGITUDE 80° W.
- B. THE MAGDALENA BASIN AND THE HORIZONTAL AND VERTICAL DISTRIBUTION OF ITS FISHES.

By CARL H. EIGENMANN

The INDIANA UNIVERSITY STUDIES are intended to furnish a means for publishing some of the contributions to knowledge made by instructors and advanced students of the University. The STUDIES are continuously numbered; each number is paged independently.

Entered as second-class matter, June 14, 1918, at the post-office at Bloomington, Ind., under the act of August 24, 1912. The INDIANA UNIVERSITY STUDIES are published four times a year, in March, June, September, and December, by Indiana University, from the University Office, Bloomington, Ind.



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The present study continues the discussion of the distribution of the fresh-water fishes of western South America begun in *Study No. 45* and continued in *Study No. 46*. Other articles on the same subject are: "The Fish Fauna of the Cordillera of Bogota" (*Journal Washington Academy of Sciences* X, pp. 460-468, October 4, 1920); "The Origin and Distribution of the Genera of the Fishes of South America west of the Maracaibo, Orinoco, Amazon, and Titicaca Basins". *Proc. Am. Philos. Soc.*, LX, 1921).

The detailed account of the specimens of this region, fully illustrated, forming *Contribution from the Zoölogical Laboratory of Indiana University No. 172*, is in the hands of the Carnegie Museum of Pittsburgh which has contracted to publish it.

The Fresh-Water Fishes of Panama¹ East of Longitude 80° W.

By CARL H. EIGENMANN

THE eightieth meridian passes thru the mouth of the Chagres river. East of it lie the entire eastern and southern Panama with the Chagres basin and Panama Canal, the Chepo basin, and the Tuyra basin. The Chagres is the only large river flowing toward the Atlantic; between the Chagres and Colombia the streams flowing toward the Atlantic are small. Nothing is known of the fish contents of those east of the Rio Cascajal at Porto Bello. In the region of the Chagres the continental divide is close to the Pacific ocean. Between the Chagres and Colombia the continental divide lies within a few miles of the Atlantic. The rivers coming from the mountains flowing nearly direct to the sea are short and very probably turbulent.

On the Pacific side there are numerous rivers longer than those on the Caribbean side, and inasmuch as there is considerable tide on the Pacific side, several of the rivers are navigable, the Tuyra being navigable half-way across the continent.¹ The rivers which have been examined for fishes are: first, the smaller rivers near the canal, the Chame, the Chorrera, the Grande, and the Juan Diaz; second, the Bayano or Chepo emptying about 25 miles east of Panama City; and third, the Tuyra emptying about 80 miles southeast of Panama City. Of these the Tuyra is by far the largest, draining with its tributaries a territory 120 miles north and south. Its basin lies just north of the Darien mountains, south of which the continental divide is again switched to near the Pacific ocean.

The natural interest in the faunas on the two sides of the Isthmus of Panama was greatly magnified when the Panama Canal was projected.

¹Miscellaneous information on Panama was published by the War Department in *Notes on Panama*, by Captain N. C. Hale, Washington, D.C., 1903. The *Report of the Isthmian Canal Commission 1899-1901*, Washington, 1904, contains excellent maps of the entire region.

The fresh-water fishes on the two slopes of the present state of Panama were incidentally considered in various articles, or books dealing largely with other things. Those published before 1864-66 were reviewed in detail in Günther's volume, "An Account of the Fishes of the States of Central America, Based on Collections made by Captain J. M. Dow, F. Godman, Esq., and O. Salvin, Esq." (*Trans. Zoöl. Soc. London*, VI, pp. 378-494, plates 63-87). While Günther dealt largely with marine fishes, he considered the fishes of the Bayano, Chagres, and the rivers, not specifically named, between 7° and 9° N., and 77° and 83° W., in which collections were made by Wagner.

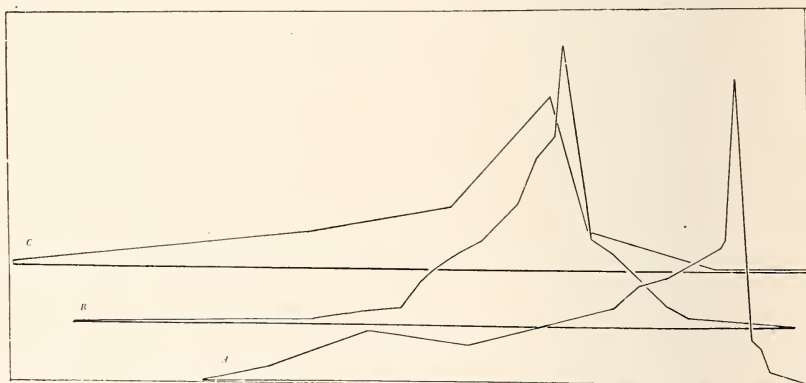


FIG. 1. Sections from tide water on the Pacific side to the Atlantic ends of surveyed ship canals. Adapted from Selfridge, *Reports of Explorations and Surveys to ascertain the Practicability of a Ship-Canal between the Atlantic and Pacific Oceans by Way of the Isthmus of Darien*. Washington, 1874, Plate I.

A. Between tide water in the Rio Lara, a tributary of the Rio Savana and Caledonia Bay.

B. Between the mouth of the Rio Bayano, a tributary of the Chepo and the Gulf of San Blas.

C. Between tide (Pinogana) in the Rio Tuyra basin and the Rio Atrato near Rio Sucio via the Rio Caarica.

Regan (*Biologia Centrali Americana*, "Pisces", pp. v-xxxii and 1-203, Maps 1 and 2, Plates 1-26) considered all of the fresh-water fishes of the area, incorporating the results of the various studies between Günther's general account and his own excellent volume. Three special studies were made of the fresh-water fishes before the canal united the two slopes. The first two were limited largely to a consideration of the fishes that had been recorded by previous authors before the canal had materially

changed natural conditions. The first one of these is Vaillant's "Contribution a l'Etude Ichthyologique du Chagres" (*Bull. Mus. d'Hist. Naturelle*. 1897, No. 6, pp. 220-223).

The second by myself (*Science*, N.S. XXII, pp. 18-20, July 7, 1905), besides listing the fishes recorded from the two slopes made a plea for a thoro study before the canal should be completed and unite the two faunas. The known facts concerning the fishes were very far from complete. I said in part:

I have just finished a consideration of the geographical distribution of the fresh-water fishes of tropical America and Patagonia as applied to the Archhelenis-Archiplata theory of von Ihering. The details will appear in one of the volumes of the Hatcher reports of Princeton University.² The evidence there collected indicates that the Pacific slope fauna of tropical America has been derived from the Atlantic slope fauna. It is quite within the range of possibilities that the Atlantic slope fauna ascended the Chagres and succeeded in crossing the low divide and descended the Pacific rivers. The Chagres route has a rival farther south. In Colombia the Cordilleras form four separate chains. The eastern, east of the Rio Magdalena, the central, between the Magdalena and its tributary, the Cauca, the western, west of the Cauca, and finally, a coast range. Between the western Cordillera and the coast Cordillera is a trough whose highest point is but 300 feet above sea level.

In the west Cordilleras to the east of this trough arise two rivers, both of which flow into the longitudinal valley, where one, the Atrato, flows to the north into the Caribbean, the other, the San Juan to the south, and then through a break in the coast Cordilleras to the west to the Pacific Ocean. The height of land separating the two systems scarcely reaches a height of 100 m. This waterway is one of the strategic points in the geographical distribution of South American fishes and it is more than to be regretted that there is not a single record of a fresh-water fish from either of these rivers!

We are a little more fortunate about our knowledge of the fishes of the two sides of Panama, but are far from an exhaustive knowledge on the subject.

It would certainly be a disgrace not to make an exhaustive study of the fresh-water faunas of the two slopes before there is a chance of the artificial mingling of the two faunas. It ought to be urged upon congress to make provision for the biological survey of the canal zone if the president or the bureau of fisheries does not already possess authority to provide for it. The work should be undertaken at once.

For the biological survey of the Atrato-San Juan route we must depend upon private enterprise, and it is to be hoped that the means for so interesting and profitable work will not be lacking when the volunteers for the work are so numerous and willing.³

²"The Fresh-Water Fishes of Patagonia and an Examination of the Archiplata-Archhelenis Theory". *Reports of the Princeton University Expeditions to Patagonia*, III, 1909, pp. 225-374. Plates XXX-XXXVII. Maps.

³This work was later done by myself and Mr. Charles Wilson. The results have appeared in these *Studies*, No. 46.

As a result of this article and much propaganda, the Smithsonian Institution and the Field Museum undertook a joint survey of the fish fauna of Panama. The survey was not begun until the work on the canal had made many changes in the natural habitat of the fishes, but Meek and Hildebrand's "The fishes of the fresh-waters of Panama" published in *Field Museum Natural History Zoölogical Series*, X, 1916, pp. 217-374, must remain the last word on the distribution of the fresh-water fishes of the canal region before the canal united the waters of the two slopes. They spent two seasons, January to May, inclusive, 1911, and from January to March, inclusive, 1912, in the field and covered the territory from the eightieth meridian to Colombia. I covered rivers from the boundary of Panama south. I have made free use of Meek and Hildebrand's results in the series of articles of which the present paper forms one.

The problem of the origin of the fauna of Panama resolves itself into the questions of the origin of the Pacific slope fauna, particularly that of the Tuyra, and the question of the origin of the fauna of the Chagres.

We may consider first the origin of the Tuyra fauna and then that of the Chagres.

The Atrato-Tuyra Problem. The Atrato plain east of the Tuyra river is very low and extends close to the divide between the Atrato and Tuyra which, at its lowest point, is but about 400 feet high. On the Pacific side the slope is longer, but also for the most part low. About half the distance between the mouth of the Atrato and the Crest is influenced by the tide.

On the easterly side of the Gulf of Panama [but on the Pacific coast] lies the Gulf of San Miguel, which is an excellent harbor, carrying tide water halfway across the isthmus. The Savana River enters this gulf from the north, and the Tuyra River from the southeast, while the Chucunaque, heading near the Chepo and flowing southeasterly, is a tributary of the Tuyra. *Report of the Isthmian Canal Commission*, 1899-1901 p. 50.

The lowest point in the divide between the Tuyra and the Atrato given in the Canal Commission's map of this region is 800 feet. The International Railroad Survey gives the pass of Cajon as 400 feet and this is the height given by Selfridge. While this pass or divide is less than 100 feet higher than the Isthmian pass between Atrato and San Juan, the nature of the territory is evidently quite different. The gradient from the Atrato to the San Juan is very gradual.

Concerning the Tuyra-Atrato region Selfridge⁴ says in part, pp. 65-66:

On the Atlantic side the alluvial plain of the Atrato extends close up to the spurs jutting out from the divide, and there is found an amount of level ground that nowhere exists on the other side. This appearance that impressed me so strongly on my first reconnaissance to Paya, coupled with the favorable report of the Pacific slope from previous explorers, gave me strong hopes that our explorations in this part of the Isthmus would be crowned with success.

On the Pacific side our survey from the mouth of the Paya to the Cué as well as up that river, indicated plainly that this whole region is a broken country, traversed by deep ravines and hills of moderate height.

From Chipigana to Santa Maria the country is a flat plain, with a rise in this distance of about 10 feet. From Santa Maria to Pinogona, as also to the mouth of the Cupe within a half mile of the river, it is generally level, with here and there elevations of from 25 to 100 feet. The mouth of the Cupe is 48 feet above the sea.

Above the Cupe the whole characteristics of the country change. A line within half a mile of the river, and often closer, is obliged to cross several ranges of hills, known among the natives as the Paloma, the Tres Veces de Parva, the Paca, and the Loma de Diablo, which vary in height from 250 to 400 feet. Various reconnaissances were made to see if these hills could be turned, but they resulted in only finding still higher ground as one receded from the river. The mouth of the Paya is 144 feet above sea-level, and the Cué 179 feet.

The height of the divide at the point crossed by the survey is 710, and through that of the so-called Caearica Pass is 410 feet.

On the Atlantic side of the divide the descent is much more abrupt, a fall of 200 feet being met with within a mile of the summit.

The fishes of the Tuyra were made known by Meek and Hildebrand in two papers in *Field Museum Natural History Publications, Zoölogical Series, X*, one issued in 1914, the other in 1918.

Only one paper earlier than these considers the fauna of the Tuyra⁵.

The Atrato-Tuyra faunæ problem is comparatively simple. Fifty species of fishes have been taken in the Tuyra. One hundred and four species are known from the two rivers, of which 19 or over 18 per cent are found in both rivers. Thirty-eight per cent of the Tuyra fishes are found in the Atrato.

⁴Selfridge, in his *Reports of Explorations and Surveys to ascertain the Practicability of a Ship-Canal between the Atlantic and Pacific Oceans by the way of the Isthmus of Darien*, Washington, 1874, gives an account of the region between the Atrato and the Pacific ocean via the Tuyra.

⁵Boulenger, G. A., "Poissons de l'Amerique Centrale. Viaggio del Dott. Enrico Festa nel Darien e regione vicine." *Bollettino, Mus. Zool. Anat. comp. della Univ. di Torino*. XIV, No. 346, April 29, 1899. This paper deals largely with marine fishes in the estuaries along the Pacific side of Darien.

The genera of 20 more Tuyra fishes are represented in Colombia. Concerning the origin of most of the 19 species there cannot be any doubt; they are abundant in the Atrato-Magdalena, and find their farthest north in the Tuyra or at least in the southern half of Panama. They moved from the Atrato to the Tuyra.

Such undoubtedly are *Phanagoniates macrolepis*, *Ageneiosus caucanus*, *Loricaria variegata*, *Curimatus magdalenaë*, *Astyanax fasciatus*, *Ctenolucinus beani*, *Hoplias malabaricus* and *Hypopomus brevirostris*.

It is possible that some species have more recently gone from the Tuyra to the Atrato, but originally all of them went in the other direction. There is no direct evidence that any specifically Pacific slope forms have come over to the Atrato. The tide of migration has all flowed westward. The strictly west-slope things like *Awaous transmontanus* and *Philypnus maculatus* have not come across into the Atrato. A number of species whose ancestors came from the Atrato have become more or less modified in the Tuyra. *Trachycorystes amblops* is a modified *fisheri*, *Pimelodus punctatus* a modified *clarias*.

The species common to the Atrato-Tuyra (18 per cent) as compared with the number of species common to the Atrato and San Juan (30 per cent) may be taken as an inverse measure of the difficulties in crossing from the Atrato to the Tuyra and from the Atrato to the San Juan.

The 11 species of the Tuyra not found in the Atrato or not represented by a species of the same genus are:

1. *Lasiancistrus planiceps*, 2. *Leptancistrus canensis*, 3. *Astroblepus longifilis*, 4. *Apareiodon dariensis*, 5. *Compsura gorgonæ*, 6. *Pseudocheirodon affinis*, 7. *Hemibrycon dariensis*, 8. *Sternarchus rostratus*, 9. *Mollienisia caucana*, 10. *Philypnus maculatus*, 11. *Awaous transmontanus*.

Of these the genera of numbers 1, 3, 4, 7, 8, 9, 10, and 11 are found in the Magdalena or the San Juan and will most probably be found in the Atrato between the two. *Leptancistrus* is derived from *Lasiancistrus*, *Compsura* and *Pseudocheirodon* from *Cheirodon*, both found in Colombia. The genera of numbers 1 to 8 find their farthest north in Panama.

Every consideration shows the close affinity of the Tuyra fauna to that of the Atrato, from which it has in large part been derived.

The Chagres Problems. The completion of the Panama Canal has greatly modified the Chagres basin and merged it with

that of the Rio Grande on the Pacific side. It is, therefore, a matter of satisfaction that Meek and Hildebrand made a thoro examination of this region before the canal was completed.

Forty-four species of fresh-water fishes were taken from the Chagres before the canal was cut. Of these, 3 species are peculiar to the Chagres. They are members of widely distributed genera. *Creagrutus notropoides* of the Chagres is scarcely, if at all, distinct from *C. affinis*; *Brycon chagrensis* differs but little from *B. striatulus* of the Pacific side; *Nectroplus panamensis* is the southernmost one of three species of this genus. The species of the Chagres are distributed among the following ten families:

	Number of Species	Number of Genera
1. Siluridæ (Pimelodinæ).....	2	2
2. Loricariidæ (Plecostominæ).....	3	3
(Loricariinæ).....	1	1
3. Characidæ (Cheirodontinæ).....	2	2
(Tetragonopterinæ).....	4	4
(Bryconinæ).....	2	1
(Glandulocaudinæ).....	1	1
(Characinæ).....	1	1
(Piabucinæ).....	1	1
(Erythrinæ).....	1	1
4. Gymnotidæ.....	1	1
5. Poeciliidæ.....	8	5
6. Mugilidæ.....	3	2
7. Atherinidæ.....	1	1
8. Centropomidæ.....	1	1
9. Cichlidæ.....	4	4
10. Gobiidæ.....	9	8

It will be noted that the Chagres contained no representatives of such Palearctic families as the minnows, suckers, Ameiurine cat fishes, sunfishes, perches and darters, salmon or trout, sturgeons, etc. These families find their farthest south very largely north of Guatemala.

The 10 families belong to several distinct ecological groups. The Gobiidæ, Atherinidæ, Mugilidæ, Centropomidæ, and Poeciliidæ are families with both fresh-water and marine species. The fresh-water genera of these families are largely confined to Central America, the Gobiidæ finding their optimum about Panama

The Pœciliidæ and fresh-water Mugilidæ are more distinctly Central American types than the Gobiidæ, and the Chagres certainly got some of its genera of these families from the north, either by sea or by land. None of the genera of these families find their farthest north in the Chagres and only a few of the genera of the Pœciliidæ extend farther south than Panama. Their ancestors most probably came from the north.

Remain then the Siluridæ, Loricariidæ, Gymnotidæ and Cichlidæ.

Of the Siluridæ, *Rhamdia wagneri* and *Pimelodella chagresi* represent the farthest north of genera everywhere on the Atlantic slope from Buenos Aires north and on the Pacific slope at least from Guayaquil north. The ancestors of these species undoubtedly came from the south. The Chagres species are common at least as far south as the Magdalena.

The Loricariidæ flourish everywhere in South America north of Guayaquil and Buenos Aires and the ancestors of all four of the Chagres species came from the south and found their farthest north in the Chagres. Only one member of the family, *Ancistrus aspidolepis*, has gotten as far as northern Panama.

Of the Characidæ, the Cheirodontinæ⁶, Piabucininæ, and Erythrininæ find their farthest north in the Chagres. The Glandulocaudinæ reach Costa Rica; the Bryconinæ and Characinæ reach Guatemala. Only the Tetragonopterinæ attain the United States. The Chagres undoubtedly got the ancestors of all of its Characins from the south.

The Cichlidæ have undergone an elaborate evolution in Central America and Mexico as well as in South America, and there is evidence that the Cichlid fauna of the Chagres came in part from the north and in part from the south. The genera *Geophagus* and *Aequidens* universally distributed between Buenos Aires and Colombia find their farthest north in the Chagres, and the ancestors of *Geophagus crassilabris* and *Aequidens coeruleopunctatus* came from the south. The genus *Neetroplus*, on the other hand, is a Central American product. One species inhabits Nicaragua, one Costa Rica, and the third the Chagres. The genus reaches its farthest south in the Chagres, and the ancestors of *Neetroplus panamensis* may very well have come from the north. The same is true of *Cichlasoma maculicauda*, which finds its farthest south in the Chagres.

⁶With one exception?

Viewing the composition of the Chagres fauna from a little different angle, we find that there are 38 genera of fishes in the Chagres and that 28 of these are also found in the Atrato or Magdalena. Two genera, *Compsura* and *Pseudocheirodon*, found in all the Panama rivers have closely related genera in the Atrato and Magdalena from which their ancestors no doubt came. Six of the 28 genera—*Gambusia*, *Priapichthys*, *Mollienisia*, *Poeciliopsis*, *Joturus*, and *Neetroplus*—came from the north, altho the first 3 now extend into the Atrato-Magdalena. *Memidia* is a marine genus with species in the fresh waters in numerous places and came from the ocean. Four are lowland or brackish-water genera of the Gobiidæ, which are found largely in Panama.

As far as the genera give any indication, the Chagres fauna is composed of about 70 per cent derivatives from the south, about 16 per cent derivatives from the north. The rest of the fauna is composed of derivatives from the ocean.

Eighteen, or about 40 per cent of the Chagres species were found in the small streams opposite the Chagres emptying into the Pacific. Forty-three per cent are also found in the Chepo basin, 27 per cent in the Tuyra, and 18 per cent in the Atrato.⁷ The drop in percentage from the Chepo to the Tuyra is due to the fact that some northern species stop at the Chepo and do not extend into the Tuyra (*Gambusia episcopi*, *Mollienisia sphenops*, *Joturus pichardi*) and to the fact that some Chagres-Chepo species are replaced by other species of the same genera in the Tuyra (*Piabucina panamensis* by *festæ*, *Hoplias microlepis* by *mala-baricus*, *Priapichthys tridentiger* by the variety *cana*).

The Chagres is the meeting-place of three streams of migration, the largest from the south, a smaller one from the north, and another from the ocean.

The Chagres fauna having come largely from the south, a supplementary question is, Did it arrive by land or by sea?

The Chagres drains into the Caribbean Sea. The nearest large rivers to the south draining into the Caribbean are the Magdalena and the Atrato. The Magdalena basin is much the larger of the two and contains a much more varied fauna than the Atrato. The bulk of the Atrato fauna came from the Magdalena.

If the region between Buenaventura and the canal should be depressed by 400 feet, the Atrato and San Juan valleys would be converted into a channel, and so would the Canal Zone. Large

⁷Most of the 18 per cent are included in the 27 per cent of the Tuyra and 43 per cent of the Chepo.

parts of the Tuyra and Mamoni basins would be submerged. This condition may have obtained during the lifetime of some of the present species and it may be argued that the migration from the Magdalena to the Atrato and Chagres has been very recent. Its beginning may, however, have antedated the last submergence, the species having been preserved in the higher tributaries of the rivers. Leaving this speculation aside and assuming that the present distribution has developed during the present configuration of the country, did the Chagres fauna arrive by land or by sea or by both routes? The answer to this question ought to give us an index to the general question of the migration of fresh-water faunas over land and sea.

The Atrato pours a large amount of fresh water into the Gulf of Darien, which ought to facilitate the migration of fresh-water fishes between this gulf and the Chagres. But a comparison of the faunas of the Atrato, Tuyra, Chepo, and Chagres shows that only *Hypheobrycon panamensis* got into the Chagres that, as far as we know now, did not also get into the Tuyra and Chepo.

Many species crossed the divide between the Atrato and the Tuyra. As stated above, of the 50 species in the Tuyra, 19 are still found in the Atrato, and the genera of 20 more are represented in Colombia. Some species coming from the Atrato got no farther than the Tuyra, but 11 of the 19 species that presumably went from the Atrato to the Tuyra got into the Rio Chepo. Sixteen more of the Chepo's 37 species probably came from the Tuyra.

Of the 10 species in the Chepo not found in the Tuyra, *Hoplias microlepis* reappears in Guayaquil, 6 find their farthest south in the Chepo, the other 3 belong to the Pacific slope Gobiidæ, some of which are found far south of the Tuyra and will probably be found in it.

Five of the 19 species that presumably went from the Atrato to the Tuyra and Chepo arrived unchanged in the Chagres; *Rhamdia wagneri*, *Pimelodella chagresi*, *Chætostomus fischeri*, *Piabucina panamensis*, and *Hypopomus brevirostris*. Several more of the Tuyra species not directly from Atrato are unchanged in the Chagres.

A number of species of the Tuyra, Chepo, or the Pacific slope opposite the Chagres have closely related species in the Chagres. Such pairs are *Ancistrus spinosus* and *chagresi*; *Ræboides occidentalis* and *guatemalensis*; *Brycon striatulus* and *chagrensis*; *Brycon argenteus* and *petrosus*; *Creagrutus affinis* and *notropoides*; *Dormitator latifrons* and *maculatus*; *Eleotris picta* and *pisonis*;

Awaous transandeanus and *taiasica*. Four other species from the Atrato, Tuyra, and Chepo reach the Pacific slope west of the Chagres, but as far as is known did not reach the Chagres. They are *Curimatus magdalenæ*, *Astyanax fasciatus*, *Ctenolucinus beani*, and *Thoracocharax maculatus*.

A glance at the detailed list given below will show that a number of species find their farthest north in the Chepo basin. Others have not succeeded in passing north of the Tuyra, as if their line of migration had been stopped at one or another of these rivers.

It is a remarkable fact that while 12 of the 23 species of strictly fresh-water families, the Characidae, Siluridae, Loricariidae, Gymnotidae, and Cichlidae have crossed the divide at Panama, only *Sicydium salvini* of the 15 species of the marine and lowland Gobiidae is identical on the two sides. It would seem that the marine or lowland forms have been separated long enough to become specifically distinct on the two sides and that the intrusion and intermigration of the strictly fresh-water species has been more recent. The isthmus may have been a barrier to the intermigration of marine forms long before it became suitable for colonization by fresh-water species which have not been long enough in the area to become altogether distinct on the two sides. It is also quite probable that a certain amount of intermigration from river to river is still taking place.

There is a very great probability that all of the immigrants of the Chagres from the south except the Atlantic slope *Eleotridinae* (Gobiidae) followed the route Atrato, Tuyra, Chepo (Grande?), Chagres, altho this involved two crossings of the continental divide. Only the partly marine *Eleotridinae* came by way of the ocean, and possibly *Hyphessobrycon panamensis*.

It appears that the ocean served to a very small extent as a highway for the migration of fresh-water fishes, even for such a short distance as that between the Atrato and Chagres.⁸ It is a separate question whether the ocean with its high tides and the long tidal areas of the Tuyra and Chepo facilitated the migration from the Tuyra to the Chepo and Rio Grande.

⁸This conclusion is re-enforced by the fact that aside from members of the Gobiidae the only fresh-water fish that got from the Tuyra to the San Juan or the reverse without getting into the intermediate Atrato is *Astyanax ruberrimus*, which also went as far south as the Rio Patia.

The Distribution of the Fresh-water Fishes between the Canal Zone and the Atrato

	Costa Rica	Chagres	Pacific slope ⁹	Chepo	Tuyra	Atrato ¹⁰	Remarks
<i>Rhamdia wagneri</i> (Günther).....	—						
<i>Pimelodus clarias</i> Bl.....							
<i>Pimelodus clarias punctatus</i> (M. and H.).....							
<i>Pimelodella chagresi</i>							
<i>Trachycorystes amblops</i> (M. and H.).....							fisheri in Atrato
<i>Agonostomus caucanus</i>							
<i>Plecostomus plecostomus panamensis</i> E.....							Genus in Magdalen
<i>Chaetostomus fischeri</i> St.....		11					centrolepis in Atrato
<i>Ancistrus spinosus</i> H.....							
<i>Ancistrus chagresi</i> E. and E.....			12				Genus in the Magdalena
<i>Lasiancistrus planiceps</i> (M. and H.).....							
<i>Lepioancistrus caucensis</i> (M. and H.).....							
<i>Loricaria uracantha</i> (K. and S.).....			13				
<i>Loricaria filamentosa latifura</i> E. and V.....							
<i>Loricaria variegata</i> St.....							
<i>Loricaria capetensis</i> M. and H.....							
<i>Loricaria fimbriata</i> E. and V.....							
<i>Sturisoma panamensis</i> (E. and E.).....							

<i>Sturisoma citreus</i> M. and H.								Genus in Magdalena = longifilis? in Magdalena basin
<i>Hoplosternum punctatum</i> H.								
<i>Astrolepis pirrense</i> (M. and H.)								
<i>Pygidium striatum</i> (M. and H.)								
<i>Curimatus magdalenæ</i> St.								
<i>Apareitodon darwensis</i> (M. and H.)								
<i>Phanagoniates macrolepis</i> (M. and H.)								
<i>Compsura gorgonæ</i> (E. and G.)								
<i>Pseudochirodon affinis</i> (H.)								
<i>Gephyrocharax vircaudata</i> (M. and H.)								Genus in Atrato
<i>Gephyrocharax intermedius</i> (H.)								
<i>Astyanax fasciatus</i> (C.)								
<i>Astyanax ruberrimus</i> E.								
<i>Bryconamericus emperador</i> E. and V.								Genus in Atrato
<i>Bryconamericus cascabelensis</i> H.								
<i>Hemibrycon darwensis</i> H.								Genus in Magdalena
<i>Hyphessobrycon panamensis</i> Durbin								
<i>Thoracocharax maculatus</i> (St.)								
<i>Cresagrutus notropoides</i> M. and H.								
<i>Cresagrutus affinis</i> St.								
<i>Rebooides guatemalensis</i> (Günther)								Genus in Atrato
<i>Rebooides occidentalis</i> H.								
<i>Brycon striatulus</i> (Kner)								Genus in Atrato
<i>Brycon chagrensis</i> (Kner)								
<i>Brycon petrosus</i> M. and H.								

¹This column includes the territory from north of the Chepo to the Rio Chame north of the Canal Zone.

²This column contains only those of the Atrato species which are also found in the Tuira.

³Very rare on the Atlantic side.

⁴On the Pacific side in the Chorrera only.

⁵Günther records this from the Pacific side.

<i>Poeciliopsis isthmensis</i> Regan.....	—	14	—	—	Panama only to Mexico and Cartagena to the Cauca
<i>Mollinia sphenops</i> (C. and V.).....	—	—	—	—	Gulf of Darien to Mexico
<i>Mollinia caucana</i> (St.).....	—	14	—	—	to R. Cauca and San Juan Toro Point
<i>Mollinia cuneata</i> (Garman) not seen	—	—	—	—	West Indies and Lower California
<i>Mollinia formosa</i> (Girard) not seen	—	—	—	—	Guatemala
<i>Rivulus elegans</i> St.....	—	—	—	—	Cuba, Costa Rica, etc.
<i>Rivulus brunneus</i> M. and H.....	—	—	—	—	
<i>Mugil inellii</i> G.....	—	—	—	—	
<i>Agonostomus monticola</i> Baneroff.....	—	—	—	—	
<i>Agonostomus macracanthus</i> Regan.....	—	—	—	—	
<i>Joturus pichardi</i> Poey.....	—	—	—	—	
<i>Menidia chagresi</i> M. and H.....	—	—	—	—	
<i>Centropomus parallelus</i> Poey.....	—	—	—	—	
<i>Centropomus ensiferus</i> P.....	—	—	—	—	
<i>Aequidens coeruleopunctatus</i> (K. and St.).....	—	—	—	—	Genus in Atrato Genus in Atrato To Guatemala
<i>Geophagus crassilabris</i> St.....	—	—	—	—	
<i>Cichlasoma maculicauda</i> Regan.....	—	—	—	—	New Granada, west slope Panama
<i>Cichlasoma tuyenense</i> M. and H.....	—	—	—	—	
<i>Cichlasoma sieboldii</i> (K. and St.) not seen	—	—	—	—	
<i>Cichlasoma calobrense</i> M. and H.....	—	—	—	—	
<i>Cichlasoma umbriferum</i> M. and H.....	—	—	—	—	
<i>Neotroplus panamensis</i> M. and H.....	—	—	—	—	
<i>Philypnus dormitor</i> Lacépède.....	—	—	—	—	
<i>Philypnus maculatus</i> (G.).....	—	—	—	—	Genus in Magdalena
<i>Dormitator maculatus</i> Bloch.....	—	—	—	—	
<i>Dormitator latifrons</i>	—	—	—	—	

⁹⁹This column includes the territory from north of the Chepo to the Rio Chame north of the Canal Zone.

¹⁰⁰This column contains only those of the Atrato species which are also found in the Tuira.

¹⁰¹On Atlantic side but not in Chagres.

The Distribution of the Fresh-water Fishes between the Canal Zone and the Atrato—Continued

	Costa Rica	Chagres	Pacific slope ⁹	Chepo	Tuyra	Atrato ¹⁰	Remarks
<i>Eleotris pieta</i> (K. and St.).....							
<i>Eleotris pisonis</i> (Gmelin).....							
<i>Eleotris isthmensis</i> H.....							
<i>Guavina guavina</i> (C. and V.).....							
<i>Leptophilypus fluviatilis</i> H.....							
<i>Microeleotris panamensis</i> H.....							
<i>Microeleotris mindii</i> H.....							
<i>Hemieleotris latifasciatus</i> (M. and H.).....							
<i>Awaous taiasea</i> (Licht.).....							
<i>Awaous transandeanus</i> (Günther).....							
<i>Sicydium salvini</i> Grant.....							
							In Magdalena

⁹This column includes the territory from north of the Chepo to the Rio Chame north of the Canal Zone.¹⁰This column contains only those of the Atrato species which are also found in the Tuyra.

The Origin of the Central American Fishes. There is some evidence that Central America got at least some of the ancestors of its South American types by another than the Panama route.

Gymnotus and Symbranchus, abundant in South America to Guiana and Colombia, are also found in Guatemala but have not been found in Costa Rica or Panama. The great development of Cichlids in Mexico and Central America may indicate that this family got into Central America before the present bridge of Panama came above the ocean.

A comparison of the first three columns will show how very few of the fishes of southern Panama extend into Costa Rica.

The Magdalena Basin and the Horizontal and Vertical Distribution of Its Fishes

By CARL H. EIGENMANN

THE Magdalena basin lies in western Colombia and drains the entire area of Colombia between the Cordillera of Bogota, also called Oriental, and the Cordillera Occidental except a small corner south of Popayan. Its western boundary consists of the oldest (Occidental) Cordillera which extends from Cartagena the entire length of the continent to Cape Horn. Nowhere in Colombia does it reach the height attained by it south of Colombia. Its eastern boundary consists of the much higher eastern crests of the Cordillera of Bogota. The Cordillera Central separates the Magdalena valley proper from the Cauca valley. The Cordillera Central is older than the Cordillera of Bogota, hence the Cauca flowing between the oldest chains in Colombia must be the oldest part of the Magdalena basin.

The Magdalena basin is surrounded by high mountain barriers except in the northwest where low areas separate it from the basins of the Sinu and of the Atrato beyond. It is the reservoir from which the Atrato and thru the Atrato the San Juan to the south, and the Tuyra, Chepo, and Chagres to the west and north, got part of the ancestors of their present fresh-water fish fauna. Where did the Magdalena get its fishes?

Physical Features of the Magdalena Basin. The Magdalena basin may conveniently be divided into five sections: (1) the Andean torrents flowing from the heights to the valleys; (2) the Upper Cauca; (3) the Upper Magdalena; (4) the Lower Magdalena; and (5) the Cesar.

The Cauca and the Magdalena rise near the second degree of North latitude. They unite near 9° 30' North latitude and empty near 11° north into the Caribbean Sea.

Veatch (*Quito to Bogota*, 1917) says of the Cauca:

The three great physiographic provinces between the Cordillera del Choco (Occidental) and the Cordillera del Quindio (Central) are thus:

First—The inter-mountain plains of the present Departments of Cauca and Valle del Cauca which occupy the first 250 miles of the depression.

Second—The region of hills and valleys which lie between the two chains along the Cauca River in the Departments of Caldas and Antioquia. The Cauca River, after traversing a portion of the southern plains, flows in this second division of the inter-mountain depression through a series of gorges.

Third—The river-plain of the lower Cauca, in north-central Antioquia and southern Bolivar, which, bounded by the gradually disappearing spurs of the mountains, soon amalgamates with the great low plain of the Magdalena River.

The southern plains (part first, above) area of this inter-mountain depression is divided into three parts: the Plain of the Patia, the Plain of Popayan, and the Plain of Cali. The Plain of the Patia occupies the southern quarter of this area, the Plain of Popayan the next quarter and the Plain of Cali the northern half. The last is thus about 125 miles long and 15 miles wide.

Of these, the plain of Popayan, with a mean elevation of about 6,000 feet, is the highest, and contains the divide between the waters of the Atlantic and the Pacific. However, there is no marked hill mass between the two drainage basins, such as we had inferred from published maps and accounts, and one of the surprises of the journey was to find that in the Plain of Popayan we had crossed from the tributaries of the Rio Patia, which flows into the Pacific thru a great gorge in the Western Andes at the very southern end of the Plain of the Patia, to the tributaries of the Rio Cauca, which flows into the Atlantic by way of the hill country of Antioquia, without having appreciated that we had passed across the hydrographic divide between the two oceans. One would naturally expect in the Andes of South America that the divide between two great river systems, tributary to different oceans, would be a marked mountain crest, and it is perhaps this wholly natural preconception which has led to the showing on a number of maps of such a mountain range across this plain between the head-waters of the two streams and has caused rather misleading statements in many geographic descriptions.

We found the divide to occur here in a rolling plain where the low elevation between the two river systems is of less topographic importance than the elevations between certain tributaries of either river. Looking across the plain from either of the mountain slopes, it would be impossible to say with certainty, in many cases, which little tributary belongs to the Cauca and which to the Patia. The line of this inter-oceanic divide crosses the plain of Popayan in an east-west direction. On the west it mounts to the summit of the Western Andes and then turning abruptly northward, follows it very closely on the western side of the plains area; while to the east it climbs the other chain, and turning abruptly south, follows the summit of the mountains on the east side of the Popayan and Patia Plains.

There is in this general plains-region the suggestion of a remnant of a cross-range, but it does not lie between the Cauca and Patia drainages, but near the northern end of the Plain of Popayan, and a number of miles north of the head-waters of the northward flowing Cauca. It is somewhat near the boundary between the Plains of Cali and Popayan, but the separation of these into distinct units rests on a marked difference in elevation rather than on this feature. Perhaps at one time in the geologic past this remnant of a

cross-range was an important feature in the drainage systems of this region, and while it is certainly not so to-day, its presence adds but another feature to the physiographic history of the Cauca River, which will some day be unravelled.

The Plains of Cali and Patia lie some 3,000 feet below the Plain of Popayan, and the latter is therefore deeply trenched towards its northern and southern borders by the streams which cross it on their way to these lower levels. The Plain of Cali has suffered very little erosion. It is slightly concave, sloping up to the mountains on either side, and between its southern end, thirty miles south of Cali, and its northern limit, near Cartago, it has a slope of about four feet per mile, and may be regarded as a plain between 3,000 and 3,500 feet above sea-level. The Cauca River flows through the Cali Plain from end to end, and the levelness of the land, together with the gentle rainfall and the healthy warm character of the region, have all combined to cause it to be regarded as one of the garden spots of Colombia.

North of Cartago the Cauca flows thru the knot formed by the union of the Western and Central Cordilleras. In 110 miles, between Cartago and Boca de Nechi it drops from an elevation of 3,000 to 500 feet and forms, with the lower Magdalena, No. 4 of the above regions.

The Magdalena descends rapidly from its sources to Neiva, which has an elevation of 1,442 feet. From Neiva near 3° North it descends more gradually to Girardot, at 1,056 feet, and Beltran or Ambalema, 774 feet near 5° North. Between Beltran, Honda, and La Dorado there are rapids where the river cuts its way out from a trough in the Cordilleras of Bogota to the plain between the Central Cordilleras and the Cordilleras of Bogota. This lower Magdalena (below 600 feet) with the Cauca below Boca de Nechi forms No. 4 in the present classification. No. 5, the Rio Cesar, rises in the southeastern part of the Sierra Nevada de Santa Marta, flows a little west of south and empties into the Magdalena at El Banco. It is the only stream in Colombia with a southward flow that finally enters the Atlantic.

The Fishes of the Magdalena Basin. In the lower Magdalena (No. 4), collections have been made in the Cienega near the mouth of the Magdalena, at Caceres on the Cauca, and at Bodega Central for Steindachner and at Soplaviento, Calamar, and at various places to Honda during my reconnaissance of Colombia. It is from this part of the river that Humboldt probably got his notes of the fishes mentioned in *Recueil d'Observation de Zoologie et Anatomie*. Nothing is known from the Rio Cesar. In the Upper Magdalena the only collection was made at Girardot. In the Upper Cauca I collected in the Plains of

Cali in tributaries of the Cauca, at Boquilla, Piedra Moler, Cartago, Paila, Cali, and in the Cauca itself at the port of Cálí.

From the torrential mountain tributaries, collections were made at St. Agustin for the British Museum; in a line from Honda to Bogota, on the Plains of Bogota, in a line from Bogota thru Santander¹, all during and for my Reconnaissance of Colombia; in the Santa Marta Mountains by the party of the University of Michigan; at Ibagué and Toche, by myself; at Popayan by Humboldt; and in Antioquia by parties of the American Museum of Natural History.

Our knowledge of the fauna is still deficient for all of these regions, more particularly the upper Magdalena, the rapids of the Cauca, the torrential streams of the Western and Central Cordilleras. Nothing is known concerning the fauna of the Cesar.

In a system as large as the Magdalena there are many units of environment each of which has its own complement of species. Not all of them unique, to be sure, but nevertheless containing a per cent of uniques. The sum of the faunas of many such units is very probably greater than the number of species found in a smaller river system. The number of species in a given stream is proportional to the size of the system to which it belongs.

The Magdalena fauna is more like that of the Orinoco than the Guayas fauna of Ecuador is like that of the Magdalena. The resemblance is five times greater if the number of identical species is taken as a criterion.

There are one hundred and fifty-odd species belonging to seventy-odd genera of fresh-water and brackish-water fishes known to occur in the Magdalena basin.

Of these the common eel and the tarpon were contributed by North America thru the Caribbean Sea. The tarpon found in the Caribbean Sea and Gulf of Mexico enters many of the rivers discharging into them.

The common eel of North America descends the ocean to spawn. The young enter the rivers. So far but one small specimen collected by the Expedition from the University of Michigan has been found in the Magdalena or as far as that goes from any of the rivers of South America. It was a stray.

Gambusia, Mollienisia, Agonostomus, and four genera of the Eleotridinæ, possibly also Rivulus, were contributed by Central America.

¹The fishes in this area were considered in "The Fish Fauna of the Cordillera of Bogota." *Journ. Washington Acad. Sci.*, X, pp. 460-468, 1920.

Several genera pertain to the Andes and may be autochthonous or may have come from the south. *Astroblepus* is a high Andean genus forming the family *Astroblepidæ* found in Venezuela, Colombia, Ecuador, and Peru, possibly also parts of Bolivia. Several species are found in the Magdalena basin. The genera *Lasianceistrus*, *Pseudanceistrus*, and *Chætostomus* of the *Loricariidæ* or mailed catfishes have nearly the same distribution as *Astroblepus* but do not reach such great altitudes. One species of each genus is found in the Magdalena basin. The genus *Pygidium* is a swift-water mountain genus distributed from southern Panama to Guiana and south to Rio Grande do Sul and Patagonia wherever high altitudes or swift water form a suitable environment for it. Several species are found in different parts of the Andes within the Magdalena basin.

Fifty-odd genera in the Magdalena basin, 76 per cent, are also found east of the easternmost Cordilleras.

The rest are either peculiar to the Magdalena basin or to the Magdalena-Atrato-Chagres-San Juan. These are in detail:

Xyliphius confined to the upper Magdalena is an offshoot of *Bunocephalus*, a genus widely distributed from the Atrato to Paraguay but not yet caught in the Magdalena. *Cetopsorhamdia* and *Nannorhamdia* are catfishes derived from *Pimelodella*—like *Pimelodina*, which are found abundantly in our area as well as east of the Andes.

Eremophilus, confined to the plain of Bogota, is an offshoot from *Pygidium*. It is a *Pygidium* without ventrals.

Grundulus, also confined to the plain of Bogota, is a member of the *Cheirodantina* abundantly distributed in western Colombia as well as all thru the east.

Genycharax of the Cauca is either a derivative of *Charax* or of *Astyanax*, both of which have a universal distribution in tropical America.

Microgenes and *Argopleura* are derivatives of *Bryconamericus*, the latter found also in the Atrato and San Juan.

Acestrocephalus replaces *Acestrorhamphus* of the east. *Ctenolucinus* replaces *Xyphostomus*.

Gilbertolus is an offshoot from *Charax*.

Othonophanes is derived from *Brycon* if distinct.

There are no genera in all of these peculiar to the Magdalena which might not equally well have developed anywhere east of the Andes. *Genycharax* and *Gilbertolus* offer the greatest difficulty. While some of them are highly interesting, even thrilling

to the naturalist, none of them are out of the ordinary evolution of genera elsewhere in tropical South America.

This brings us to the genera also found east of the Andes. A few of these belong primarily to Venezuela and the Guianas. They are:

Creagrutus, found along the eastern base of the Andes from the Rio Beni to Lake Valencia and even British Guiana.

Gephyrocharax but recently discovered about Lake Valencia. Its place of greatest abundance is western Colombia.

Hemibrycon is found as far as Trinidad.

Panaque and *Hemicetopsis* are also found in the Amazon. All of the rest of the numerous genera enjoy a universal distribution east of the Andes.

It would scarcely be possible to isolate any place as large as the Magdalena basin anywhere east of the Andes and north of the La Plata that would not contain all of the rest of the genera.

The question arises whether isolation by the formation of a barrier is not the natural, most probable explanation of the present Magdalena fauna.

It is quite out of the question to transport all of these genera over the present barrier formed by the Cordilleras of Bogota, especially if we consider that the Cauca has not been able to contribute anything to the Dagua or Patia over a divide much lower. Either the Cordillera of Bogota is younger than the Magdalena and its growth cut off the Magdalena area with its fauna from a general lowland mass extending eastward from the Cordillera Central or there has existed a possible route of migration perhaps via Lake Maracaibo. The segregation could not have taken place very recently, for in most cases the species are distinct on the two sides of the Cordilleras. The segregation took place before the lifetime of most of the present species. It is, nevertheless, startling that about 20 per cent of the species of the Magdalena are also found east of the Andes.

The species found on both sides of the Cordilleras of Bogota follow. Those marked with a star were taken between Bogota and Barrigon.

Pseudopimelodus zungaro (H.)

**Rhamdia sebæ* C. and V.

**Pimelodus clarias* (Bl.)

*?*Pimelodella chagresi* (St.)

Pseudoplatystoma fasciatum (L.)

Sorubim lima (Bl. and Sch.)

- Ageneiosus dentatus* (K.)
Astroblepus cyclopus (H.)
 **Astroblepus grivalvii* H.
 **Astroblepus longifilis* (St.)
 **Corydoras melanotænia* R.
 **Pseudancistrus daguæ* (E.)
 *? *Pseudancistrus pediculatus* (E.)
 ? *Sturisoma aurea* St.
 * *Sturisoma leightoni* (R.)
Curimatus magdalenæ St. In Maracaibo only east of the Cordilleras.
Parodon suborbitalis C. and V. In Maracaibo.
 ? *Abramites eques* (St.)
Leporinus striatus K.
Characidium fasciatum R.
Pyrrhulina semifasciata R.
Hyphessobrycon inconstans (E. and O.)
Astyanax fasciatus (C.)
 * *Creagrutus beni* E.
Rœboides dayi St.
 ? *Ctenolucinus insculptus* St. In Lake Maracaibo?
 * *Hoplias malabaricus* (Bl.)
 * *Gymnotus carapo* L.
 * *Sternopygus macrurus* (Bl and Sch.)
Eigenmannia virescens (V.)
Hypopomus brevirostris St.
Synbranchus marmoratus Bl.
Tarpon atlanticus (C. and V.)
Plagioscion surinamensis (Bl.)

One looks in vain for any common physical character in this series of species. Some are huge fishes, *Pseudoplatystoma*; others are very small, *Characidium*. The great majority are fishes of the lowlands (1,000 feet and less) and comparatively quiet waters. Such fishes as *Astroblepus* and *Pygidium* ought perhaps to be excluded, since they are found at the very highest localities where an occasional crossover may still be expected. At the other extreme such species as the Tarpon which enter the sea might also be excluded, and in fact those found on both sides in estuaries only are not given.

Leaving these out of count, the one thing most of them have in common is their very wide distribution. This signifies either facility in getting about or a greater staying quality of their specific characters under varying environments, or both. Parallel forms have developed in nearly all of the genera found on the two sides in which the species have not remained the same. It would take us too far to go into all of these.

That the similarity on the two sides is not of very recent date is shown by an examination of the fauna at the eastern base of the Andes. Very little is known of the fauna of eastern Colombia and western Venezuela. What we do know of it indicates that the Maracaibo fauna is probably identical with the Magdalena fauna, *i.e.* differs no more from it than the latter differs from the Atrato fauna. Almost all we know of Lake Maracaibo was recorded by Cuvier and Valenciennes. I have had recent opportunities to examine the fishes from and about Barrigon, Villavicencio, and the Llanos to the northeast of them. I find that a number of genera of wide eastern distribution which have not been found in the Magdalena basin come up to the base of the Cordilleras east of Bogota. They are Chasmocranes, Imparfinis and Sciades, three catfishes; Erythrinus, Copeina, Hemigrammus, Moenkhausia, Knodus, Creatochanes, Stevardia, Acestrorhynchus, all Characins; Apistogrammus, and Crenicichla of the Cichlidæ. All of them are widely distributed in the east. Did they develop in the east since the formation of the Cordilleras of Bogota or have they migrated to the base of these Cordilleras after they had become an effective barrier? Other conspicuous absentees in the Magdalena are genera of wide distribution in the east which have not been found near the base of the Andes of Colombia. They are the genera of the Hemiodinæ, Nannostomus, Tetragonopterus, the Agoniatinæ, the Stethaprioninæ, Serrasalmoninæ, Mylinæ, Acestrorhamphus, all of which belong to the Characidæ, Pachyurus of the Sciaenidæ, Chætobranchopsis and Cichla of the Cichlidæ, Electrophorus the electric eel, the gigantic Arapaima, and the ancient Osteoglossum.

It would be desirable in pursuit of a possible further study of the origin of the Magdalena fauna to make collections in the Maracaibo basin and thence east by way of the Pass of Hato, 800 feet into the Orinoco basin.

A comparison of the genera in the upper Cauca above the rapids of Antioquia and in the Potaro river of Guiana above the Kaieteur fall shows that the two regions have but three genera in common. They are Pygidium, Astyanax, and Rivulus, all genera of the very widest distribution in the whole of South America. The species of the three genera are different in the Cauca and the Potaro. In other respects the faunæ of the Cauca and the Potaro are very different.

Table of Distribution of the Fishes of the Magdalena Basin

	Marine fishes entering mouth of river	Lower Magdalena	Upper Magdalena	Cauca	Torrents and high altitude ²
1. <i>Potamotrygon magdalenæ</i> (D.)	—	—	—		
2. <i>Xyliphius magdalenæ</i> E.		—	—		
3. <i>Hexanematichthys assimilis</i> (G.)		—	—		
4. <i>Pseudopimelodus zungaro</i> (H.)		—	—		
5. <i>Perugia xanthus</i> (E.)		—	—		
6. <i>Cetopsorhamdia nasus</i> E. and F.		—	—		
7. <i>Cetopsorhamdia boquilla</i> E.		—	—		— 5,700
8. <i>Rhamdia wagneri</i> (G.)		—	—		
9. <i>Rhamdia sebæ</i> (C. and V.)		—	—		
10. <i>Nannorhamdia nemacheir</i> E. and F.		—	—	—	
11. <i>Pimelodella chagresi</i> (St.)		—	—	—	
12. <i>Pimelodus grosskopfi</i> St.		—	—	—	
13. <i>Pimelodus clarias</i> (Bl.)		—	—	—	
14. <i>Pseudoplatystoma fasciatum</i> (L.)		—	—	—	
15. <i>Sorubim lima</i> (Bl. and Sch.)		—	—	—	
16. <i>Doras crocodili</i> H.		—	—	—	
17. <i>Trachycorystes insignis</i> (St.)		—	—	—	
18. <i>Ageneiosus caucanus</i> St.		—	—	—	
19. <i>Ageneiosus dentatus</i> K.		—	—	—	
20. <i>Astroblepus homodon</i> (R.)					— 7,260
21. <i>Astroblepus guentheri</i> (B.)					—?
22. <i>Astroblepus chapmani</i> (E.)					— 5,700
23. <i>Astroblepus unifasciatus</i> E.					— 4,000
24. <i>Astroblepus unifasciatus</i> E.					— 6,000
25. <i>Astroblepus frenatus</i> E.					— 6,500
26. <i>Astroblepus grixalvii</i> H.					—10,700
27. <i>Astroblepus micrescens</i> E.					— 8,500
28. <i>Astroblepus chotæ</i> (R.)					—10,000
29. <i>Astroblepus longifilis</i> (St.)					— 6,000
30. <i>Hemicetopsis othonops</i> E.		?	—	—	
31. <i>Pygidium stellatum</i> E.			—		— 4,000
32. <i>Pygidium chapmani</i> E.					— 5,700

²The numbers in this column indicate the highest recorded altitude in feet.

Table of Distribution of the Fishes of the Magdalena Basin—Continued

	Marine fishes entering mouth of river	Lower Magdalena	Upper Magdalena	Cauca	Torrents and high altitude ²
33. <i>Pygidium caliense</i> E.				—	
34. <i>Pygidium stramineum</i> E.					— 7,400
35. <i>Pygidium bogotense</i> E.					— 9,000
36. <i>Pygidium nigromaculatum</i> (B.)					— 4,000
37. <i>Pygidium banneai</i> E.		?	—		
38. <i>Pygidium retropinne</i> R.					— 5,000
39. <i>Pygidium venulosum</i> St.					—10,000
40. <i>Pygidium latistriatum</i> E.					— 4,200
41. <i>Pygidium striatum</i> M. and H.					— 7,300
42. <i>Eremophilus mutisii</i> H.					— 9,000
43. ? <i>Corydoras melanotænia</i> R.		?	—		
44. <i>Hoplosternum magdalenæ</i> E.		—			
45. <i>Plecostomus tenuicauda</i> St.		—	—		
46. <i>Pterygoplichthys undecimalis</i> G.		—			
47. <i>Lasiancistrus caucanus</i> E.				—	
48. <i>Pseudancistrus carnegiei</i> E.					— 3,320
49. <i>Pseudancistrus setosus</i> (B.)					— 7,400?
50. <i>Panaque gibbosus</i> (St.)		—	—		
51. <i>Cochliodon hondæ</i> R.		?	—		
52. <i>Chætostomus fischeri</i> St.		?	—	—	
53. <i>Chætostomus thomsoni</i> R.					— 7,300
54. <i>Loricaria magdalenæ</i> St.		—			
55. <i>Loricaria filamentosa</i> St.		—			
56. <i>Loricaria f. seminuda</i> E. and V.			—		
57. <i>Loricaria gymnogaster</i> E. and V.			—		
58. <i>Loricaria fimbriata</i> E. and V.			—		
59. <i>Loricaria variegata</i> St.		—	—		
60. <i>Sturisoma panamense</i> E. and E.		—			
61. <i>Sturisoma aurea</i> St.		—			
62. <i>Sturisoma leightoni</i> (R.)			—	—	
63. <i>Farlowella gracilis</i> B.				—	
64. <i>Curimatus magdalenæ</i> St.		—			
65. <i>Curimatus mivartii</i> St.		—	—		
66. <i>Parodon suborbitalis</i> C. and V.		—	—		
67. <i>Parodon caliensis</i> B.				—	

Table of Distribution of the Fishes of the Magdalena Basin—Continued

	Marine fishes entering mouth of river	Lower Magdalena	Upper Magdalena	Cauca	Torrents and high altitude
68. <i>Prochilodus longirostris</i> St.....	—	—	—	—	
69. <i>Prochilodus magdalenæ</i> St.....	—	—	—	—	
70. <i>Prochilodus steindachneri</i> E.....	—	—	—	—	
71. <i>Leporinodus sexdentatus</i> E.....	—	—	—	—	
72. <i>Abramites eques</i> St.....	—	—	—	—	
73. <i>Leporinus striatus</i> K.....	—	—	—	—	
74. <i>Leporinus muyscorum</i> St.....	—	—	—	—	
75. <i>Characidium fasciatum</i> R.....	—	?	—	—	
76. <i>Characidium caucanum</i> E.....	—	—	—	—	
77. <i>Characidium phoxcephalum</i>	—	—	—	—	
78. <i>Pyrrhulina semifasciata</i> R.....	—	?	—	—	
79. <i>Grundulus bogotensis</i> H.....	—	—	—	—	— 9,000
80. <i>Odontostilbe hastata</i> E.....	—	—	—	—	
81. <i>Cheirodon insignis</i> St.....	—	—	—	—	
82. <i>Brycon rubricauda</i> St.....	—	—	—	—	
83. <i>Brycon henni</i> E.....	—	—	—	—	
84. <i>Brycon moorei</i> St.....	—	—	—	—	
85. <i>Othonophanes labiatus</i> (St.).....	—	—	—	—	
86. <i>Hyphessobrycon inconstans</i> (E. and O.).....	—	—	—	—	
87. <i>Hyphessobrycon pœcilioides</i> E.....	—	—	—	—	
88. <i>Hyphessobrycon panamensis</i> D.....	—	—	—	—	
89. <i>Astyanax bimaculatus borealis</i> E.....	—	—	—	—	
90. <i>Astyanax magdalenæ</i> E. and H.....	—	—	—	—	
91. <i>Astyanax atratcensis</i> E.....	—	—	—	—	
92. <i>Astyanax caucanus</i> (St.).....	—	—	—	—	
93. <i>Astyanax filiferus</i> (E.).....	—	—	—	—	
94. <i>Astyanax microlepis</i> E.....	—	—	—	—	
95. <i>Astyanax fasciatus</i> (C.).....	—	—	—	—	
96. <i>Astyanax aurocaudatus</i> E.....	—	—	—	—	— 5,700
97. <i>Genycharax tarpon</i> E.....	—	—	—	—	
98. <i>Creagrutus beni</i> E.....	—	—	—	—	— 3,600
99. <i>Creagrutus brevipinnis</i> E.....	—	—	—	—	
100. <i>Creagrutus magdalenæ</i> E.....	—	—	—	—	— 7,258
101. <i>Creagrutus affinis</i> St.....	—	—	—	—	
102. <i>Creagrutus caucanus</i> E.....	—	—	—	—	

Table of Distribution of the Fishes of the Magdalena Basin—Continued

	Marine fishes entering mouth of river	Lower Magdalena	Upper Magdalena	Cauca	Torrents and high altitude ²
103. <i>Microgenys minutus</i> E.....				—	
104. <i>Argopleura conventus</i> E.....		—			
105. <i>Argopleura diquensis</i> E.....		—			— 7,258
106. <i>Argopleura magdalenensis</i> E.....		—	—	—	
107. <i>Bryconamericus caucanus</i> E.....				—	— 5,700
108. <i>Hemibrycon tolimæ</i> (E.).....					— 7,000
109. <i>Hemibrycon colombianus</i> E.....					— 4,100
110. <i>Hemibrycon boquillæ</i> E.....					— 5,700
111. <i>Hemibrycon dentatus</i> E.....				—	
112. <i>Hemibrycon decurrens</i> E.....		—			
113. <i>Gephyrocharax caucanus</i> E.....				—	
114. <i>Gephyrocharax melanocheir</i> E.....		—	—		
115. <i>Chalcinus magdalenæ</i> St.....		—	—		
116. <i>Thoracocharax magdalenæ</i> E.....			—		
117. <i>Salminus affinis</i> St.....		—	—		
118. <i>Charax magdalenæ</i> St.....		—	—		
119. <i>Rœboides magdalenæ</i> E.....		—	—		
120. <i>Rœboides caucæ</i> E.....				—	
121. <i>Rœboides dayii</i> St.....		—			
122. <i>Acestrocephalus anomalus</i> (St.).....		—	—		
123. <i>Gilbertolus alatus</i> (St.).....		—			
124. <i>Ctenolucius insculptus</i> St.....		—	—		
125. <i>Hoplias malabaricus</i> (Bl.).....		—	—		
126. <i>Sternopygus macrurus</i> (Bl. and Sch.)		—	—	—	
127. <i>Eigenmannia virescens</i> (V.).....		—	—		
128. <i>Hypopomus brevirostris</i> St.....		—			
129. <i>Sternarchus rostratus</i> M. and H.....		—	—		
130. <i>Sternarchus mariæ</i> E. and F.....			—		
131. <i>Synbranchus marmoratus</i> Bl.....		—			
132. <i>Anguilla chrysypa</i> R.....		—			
133. <i>Tarpon atlanticus</i> (C. and V.).....		—			
134. <i>Gambusia caliensis</i> E. and H.....				—	
135. <i>Mollienia sphenops</i> (C. and V.)....		—			
136. <i>Mollienia caucana</i> (St.).....		—			
137. <i>Rivulus elegans</i> St.....				—	
138. <i>Rivulus magdalenæ</i> E. and H.....			—		— 4,250

Table of Distribution of the Fishes of the Magdalena Basin—Continued

	Marine fishes entering mouth of river	Lower Magdalena	Upper Magdalena	Cauca	Torrents and high altitudes
139. <i>Rivulus brevis</i> R.?					
140. <i>Mugil brasiliensis</i> A.	—				
141. <i>Mugil incilis</i> G.	—				
142. <i>Mugil liza</i> C. and V.	—				
143. <i>Agonostomus macracanthus</i> R.		—			
144. <i>Centropomus undecimalis</i> (Bl.)	—				
145. <i>Centropomus ensiferus</i> P.	—				
146. <i>Centropomus pedimacula</i> P.	—				
147. <i>Plagioscion surinamensis</i> (Bl.)		—			
<i>Hæmulon plumieri</i> L.	—				
<i>Bairdiella armata</i> Gill.	—				
<i>Gerres rhombeus</i> C. and V.	—				
<i>Gerres plumieri</i> C. and V.	—				
<i>Trichiurus lepturus</i> L.	—				
<i>Spheroides testudineus</i> (L.)	—				
148. <i>Geophagus steindachneri</i> E. and H.		—	—		— 4,250
149. <i>Aequidens latifrons</i> (St.)		—			
150. <i>Cichlasoma kraussii</i> (St.)		—			
151. <i>Cichlasoma umbriferum</i> M. and H.		—	—		
152. <i>Dormitator maculatus</i> Bl.		—			
153. <i>Eleotris pisonis</i> (Gmelin)		—			
154. <i>Sicydium salvini</i> Grant		—			
155. <i>Awaous decemlineatus</i> E.		—			
Totals		78	54	29	35
Per cent of the total, about		50	35	18.7	22.6

The categories into which I have divided the fauna of the Magdalena basin are not of equal value nor are the contents of the different regions equally well known. Certainly none of them are exhaustively known. The fishes in the first column are really marine fishes that wander into or live more or less permanently in the estuaries. The "Lower Magdalena" includes the Magdalena from its mouth to La Dorado and the Cauca to Caceres.

In the "Upper Magdalena" are included all that are known from south of La Dorado in the main stream and its larger tributaries to (including) Ibagué. It should take in the contents to Neiva. In reality all we know has come from between Honda and Girardot with the tributaries in this short stretch. Many or all of these will also be found in the lower Magdalena. There is always a reasonable expectation that the fishes in any stretch will be found lower down and there is no sharp break between Honda and the river below La Dorado.

Similarly the column for the Cauca should include everything from the rapids below Cartago to the head of navigation, but nothing is known from Cali upward.

Finally, the last column includes a variety of streams from the highest altitudes down to the mouths of the streams where torrential conditions give place to large stream conditions. I give the highest known altitude in feet where it was obtainable. In some cases the altitude may be the sole factor determining the presence or absence of a species. In many others torrential conditions that frequently go with altitude determine the distribution.

Of the species found in the upper Cauca, 11 are also found in the upper Magdalena and 5 in the lower Magdalena.

Of the 54 species in the upper Magdalena, 32 are also found in the lower Magdalena.

Conclusion. The above analysis demonstrates that the fish fauna of the Magdalena basin was derived in small part from the ocean and in larger part from Central America. It demonstrates beyond a peradventure that most of it had an origin in common with that of the Orinoco basin to the east of it, and that the fauna of the Magdalena was segregated from the general fauna of the Orinoco by the formation of the Cordillera of Bogota between the two, at a time antedating the development of most of the present species. It also demonstrates that if the above conclusions are valid some species found on both sides antedate the formation of the Cordillera of Bogota; that the stripes of the large catfish, the *Bagre tigre* have persisted during the entire time since the Cordillera of Bogota began to be an effective barrier against the intermigration of the fishes of the two sides.





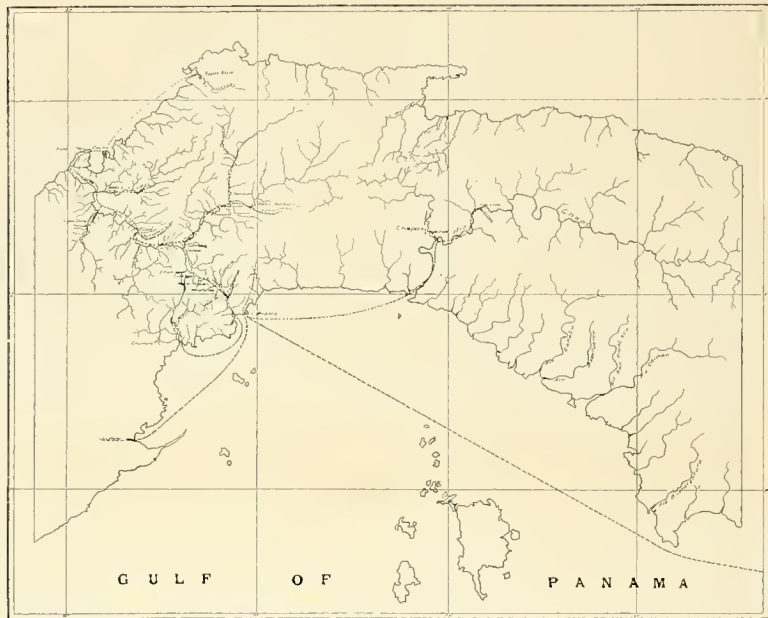


PLATE I

Panama from the 80th meridian to the mouth of the Tuira, showing lines of travel of Meek and Hildebrand while collecting fishes. For the continuation eastward and southward see Plate II. From *Report of the Isthmian Canal Commission 1899-1901*.



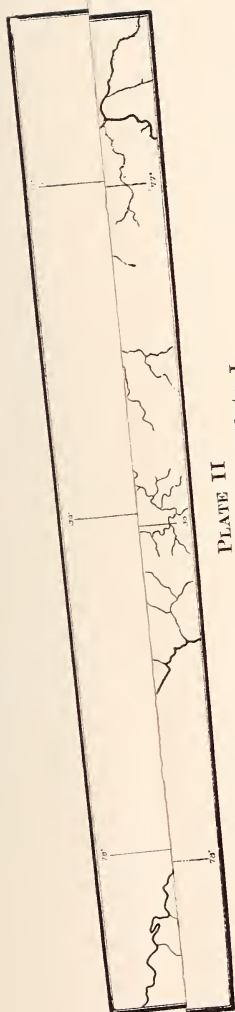


PLATE II
For explanation see Plate I.

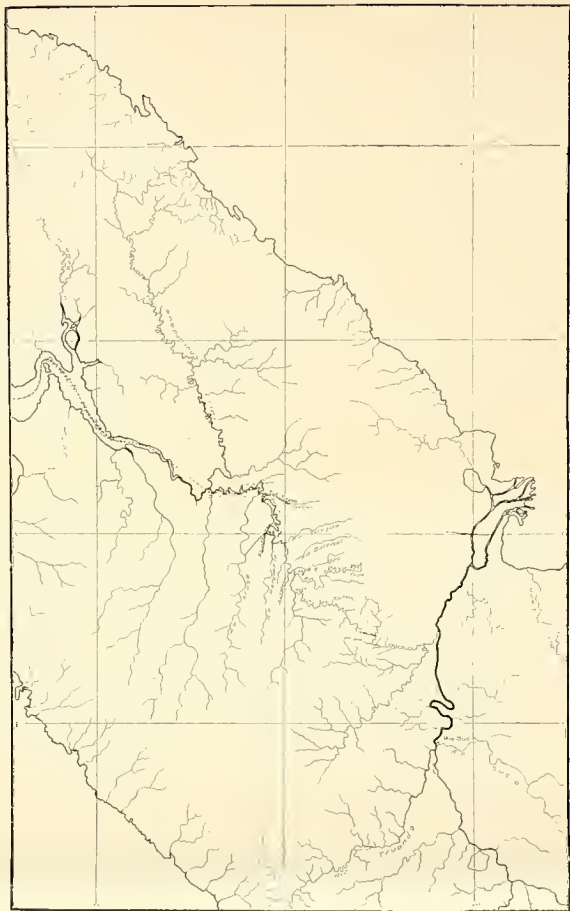


PLATE II
For explanation see Plate I.



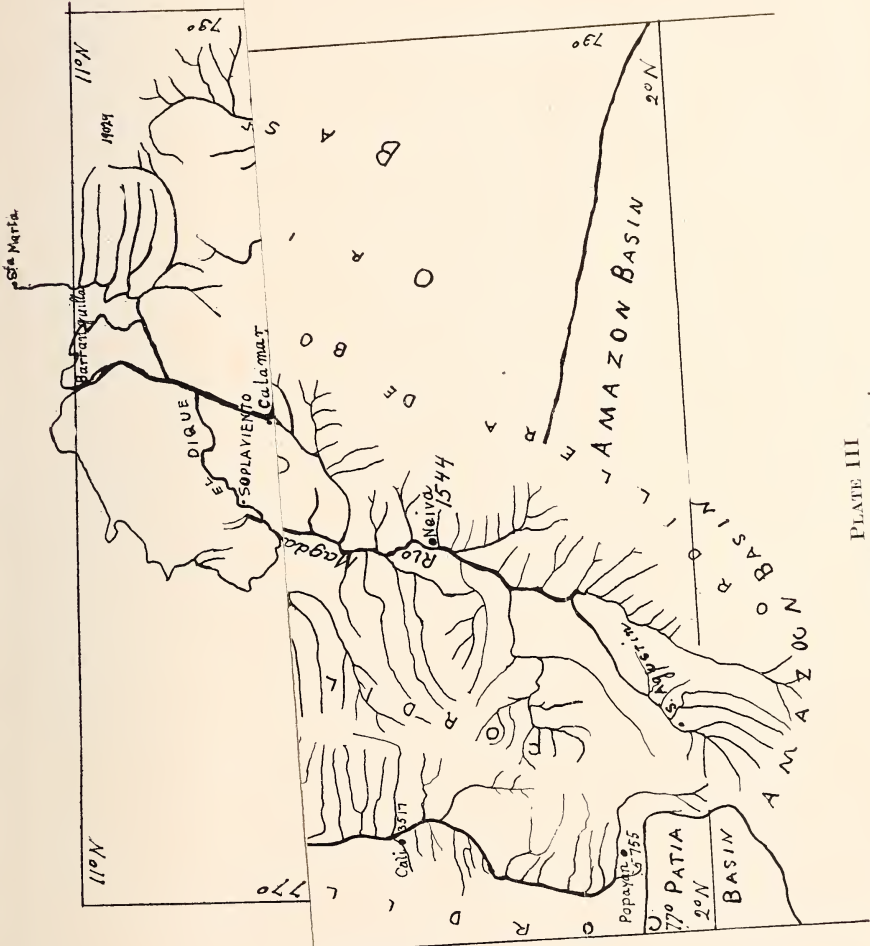


PLATE III
The Magdalena Basin.



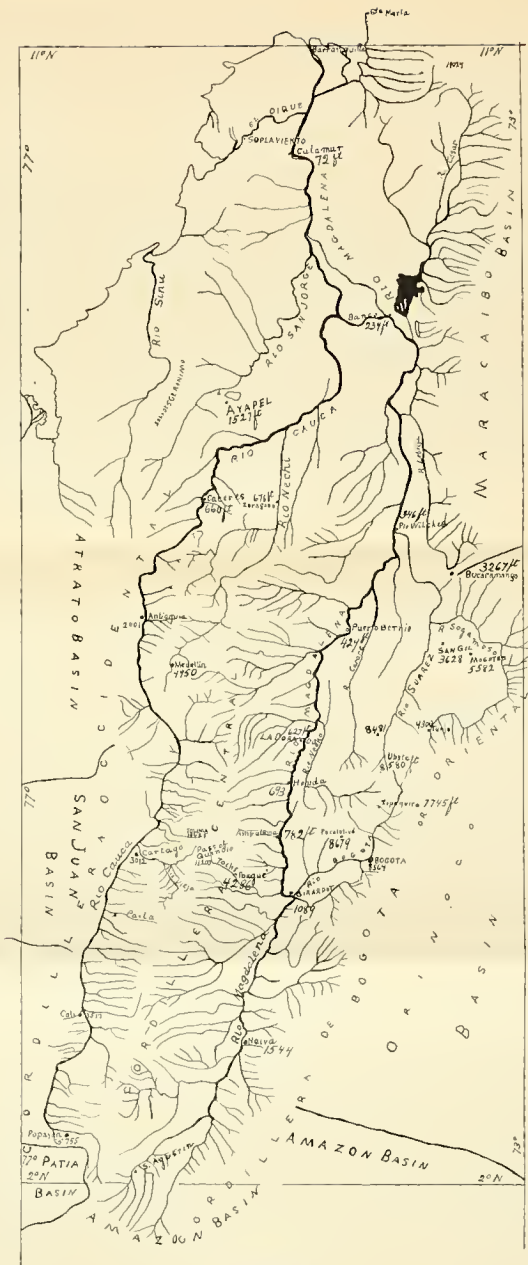


PLATE III
The Magdalena Basin.



PLATE IV.
 Section across the Magdalena Valley and Andes at the latitude of Bogotá. In part after Holton.