THE PHILIPPINE

JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., PH. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, PH. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, PH. D.; A. J. COX, PH. D.
RAYMOND F. BACON, PH. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS, B. S.; R. C. MCGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. GENERAL SCIENCE
VOLUME IV
1909

WITH 88 PLATES, 60 FIGURES, 7 CHARTS AND 1 DIAGRAM

MANILA
BUREAU OF PRINTING
1910

91701

CONTENTS.

No. 1, January, 1909.

No. 2, March, 1909.

No. 3, May, 1909.

No. 4, July, 1909.

No. 5, September, 1909.

No. 6, November, 1909.

Vol. IV JANUARY, 1909 No. 1

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., Ph. D.

CO-EDITOR,

RICHARD P. STRONG, Ph. B., M. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, Ph. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, Ph. D.; ALVIN J. COX, Ph. D.
RAYMOND F. BACON, Ph. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS, B. S.; R. C. McGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. General Science

MANILA
BUREAU OF PRINTING
1909

PREVIOUS PUBLICATIONS.

ORDER No.

Bureau of Government Laboratories.

* *No. 1, 1902, to No. 14, 1904.*

15. *No. 15, 1904, Biological and Serum Laboratories.*—Report on Bacillus Violaceous Manilæ: A Pathogenic Micro-Organism. By Paul G. Woolley, M. D.

* *No. 16, 1904, Biological Laboratory.*—Protective Inoculation against Asiatic Cholera: An Experimental Study. By Richard P. Strong, M. D.

17. *No. 17, 1904.*—New or Noteworthy Philippine Plants, II. By Elmer D. Merrill, Botanist.

* *No. 18, 1904, Biological Laboratory.*—I. Amebas: Their Cultivation and Etiologic Significance. By W. E. Musgrave, M. D., and Moses T. Clegg. II. The Treatment of Intestinal Amœbiasis (Amœbic Dysentery) in the Tropics. By W. E. Musgrave, M. D.

19. *No. 19, 1904, Biological Laboratory.*—Some Observations on the Biology of the Cholera Spirillum. By W. B. Wherry, M. D.

20. *No. 20, 1904.—Biological Laboratory:* I. Does Latent or Dormant Plague Exist Where the Disease is Endemic? By Maximilian Herzog, M. D., and Charles B. Hare. *Serum Laboratory:* II. Broncho-Pneumonia of Cattle: Its Association with B. Bovisepticus. By Paul G. Woolley, M. D., and Walter Sorrell, D. V. S. III. Pinto (Paño Blanco). By Paul G. Woolley, M. D. *Chemical Laboratory:* IV. Notes on Analysis of the Water from the Manila Water Supply. By Charles L. Bliss, M. S. *Serum Laboratory:* V. Frambœsia: Its Occurrence in Natives in the Philippine Islands. By Paul G. Woolley, M. D.

21. *No. 21, 1904, Biological Laboratory.*—Some Questions Relating to the Virulence of Micro-Organisms with Particular Reference to Their Immunizing Powers. By Richard P. Strong, M. D.

22. *No. 22, 1904, Bureau of Government Laboratories.*—I. A Description of the New Buildings of the Bureau of Government Laboratories. By Paul C. Freer, M. D., Ph. D. II. A Catalogue of the Library of the Bureau of Government Laboratories. By Mary Polk, Librarian.

* *No. 23, 1904, Biological Laboratory.*—Plague: Bacteriology, Morbid Anatomy, and Histopathology (Including a Consideration of Insects as Plague Carriers). By Maximilian Herzog, M. D.

24. *No. 24, 1904, Biological Laboratory.*—Glanders: Its Diagnosis and Prevention (Together with a Report on Two Cases of Human Glanders Occurring in Manila and Some Notes on the Bacteriology and Polymorphism of Bacterium Mallei). By William B. Wherry, M. D.

25. *No. 25, 1904.*—Birds from the Islands of Romblon, Sibuyan, and Cresta de Gallo. By Richard C. McGregor. (*For first four bulletins of the ornithological series, see Philippine Museum below.*)

26. *No. 26, 1904, Biological Laboratory.*—The Clinical and Pathological Significance of Balantidium Coli. By Richard P. Strong, M. D.

27. *No. 27, 1904.*—A Review of the Identification of the Species Described in Blanco's Flora de Filipinas. By Elmer D. Merrill, Botanist.

28. *No. 28, 1904.*—I. The Polypodiaceæ of the Philippine Islands. II. Edible Philippine Fungi. By Edwin B. Copeland, Ph. D.

29. *No. 29, 1904.*—I. New or Noteworthy Philippine Plants, III. II. The Source of Manila Elemi. By Elmer D. Merrill, Botanist.

30. *No. 30, 1905, Chemical Laboratory.*—I. Autocatalytic Decomposition of Silver Oxide. II. Hydration in Solution. By Gilbert N. Lewis, Ph. D.

31. *No. 31, 1905, Biological Laboratory.*—I. Notes on a Case of Hæmatochyluria (Together with Some Observations on the Morphology of the Embryo Nematode, Filaria Nocturna). By William B. Wherry, M. D., and John R. McDill, M. D., Manila, P. I. II. A Search into the Nitrate and Nitrite Content of Witte's "Peptone," with Special Reference to Its Influence on the Demonstration of the Indol and Cholera-Red Reactions. By William B. Wherry M. D.

32. *No. 32, 1905.—Biological Laboratory:* I. Intestinal Hæmorrhage as a Fatal Complication in Amœbic Dysentery and Its Association with Liver Abscess. By Richard P. Strong, M. D. II. The Action of Various Chemical Substances upon Cultures of Amœbæ. By J. B. Thomas, M. D., Baguio, Benguet. *Biological and Serum Laboratories:* III. The Pathology of Intestinal Amœbiasis. By Paul G. Woolley, M. D., and W. E. Musgrave, M. D.

33. *No. 33, 1905, Biological Laboratory.*—Further Observations on Fibrin Thrombosis in the Glomerular and in Other Renal Vessels in Bubonic Plague. By Maximilian Herzog, M. D.

* *No. 34, 1905.*—I. Birds from Mindoro and Small Adjacent Islands. II. Notes on Three Rare Luzon Birds. By Richard C. McGregor.

35. *No. 35, 1905.*—I. New or Noteworthy Philippine Plants, IV. II. Notes on Cuming's Philippine Plants in the Herbarium of the Bureau of Government Laboratories. III. Hackel, "Notes on Philippine Grasses." IV. Ridley, "Scitamineæ Philippinensis. V. Clarke, "Philippine Acanthaceæ." By Elmer D. Merrill, Botanist.

36. *No. 36, 1905.*—A Hand-List of the Birds of the Philippine Islands. By Richard C. McGregor and Dean C. Worcester.

* Report of the Superintendent of Government Laboratories for the Year Ending August 31, 1902. (Appendix M of Third Annual Report of the Philippine Commission.)

* Report of the Superintendent of Government Laboratories in the Philippine Islands for the Year Ending September 1, 1903. (Appendix G of the Fourth Annual Report of the Philippine Commission.)

39. Third Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1904.

40. Fourth Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1905.

Bureau of Science—Publications.

101. Price and Exchange List of Philippine Bird Skins in the Collection of the Bureau of Science, Manila, P. I. (Effective January 1, 1908.)

102. *No. 1, 1909.*—A Check-List of Philippine Fishes. By David Starr Jordan and Robert Earl Richardson. *In press.*

103. *No. 2, 1909.*—A Manual of Philippine Birds. By Richard C. McGregor, Parts I and II. A systematic index to the orders, families, and genera. Paper, ₱8 for the two parts.

---

* Out of print.

(Concluded on third page of cover.)

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV JANUARY, 1909 No. 1

PHYSIOGRAPHY OF THE PHILIPPINE ISLANDS: III. WESTERN MASBATE.

By HENRY G. FERGUSON.

(From the Division of Mines, Bureau of Science.)

INTRODUCTION.

During the winter of 1907–1908 I was engaged in topographic and geologic work in the Aroroy mining district on the Island of Masbate. Although most of the time was devoted to topographic mapping in a limited area, a short reconnaissance was made over the western part of the island, southward as far as Mandaon, thence eastward to Milagros and Malbog and northward to Mobo and Masbate; I was assisted by Mr. R. N. Clark, field assistant of the Division of Mines, during the greater part of the field work and in the preparation of the maps which accompany this paper.

POSITION.

The Island of Masbate lies almost in the exact center of the Philippine Islands, between latitudes 11° 43′ N. and 12° 36′ N. and longitudes 123° 09′ E. and 124° 05′ E., and has an area of approximately 3,200 square kilometers. Its two-pronged shape makes it unique among the islands of the Archipelago. Its main trend is to the northwest, parallel to the southeastern part of Luzon, and the islands of Burias, Ticao, and Samar. A smaller prong has a southwesterly direction and forms a part of the Panay, Negros, and Cebu series. The islands of Jintotolo, the Zapatos, and Olutaya form connecting links between the southwest extremity of Masbate, Point Pulanduta, and the north coast of Panay.

CLIMATE.

The rainfall of Masbate is well below the average for the Philippines (2,200 millimeters), observations at Port Palanoc (Masbate) for the years 1904, 1905, and 1906 giving an average annual rainfall of only 1,446 millimeters.[1] At only four out of the sixty-four stations in the Islands do the records show a smaller rainfall.

The dry season extends from February to May, inclusive, only 17 per cent of the total rainfall occurring during these four months. Throughout the remainder of the year the rainfall is fairly evenly distributed. Destructive typhoons visited the island in November, 1905, and September, 1908.

PREVIOUS WORK.

Earlier writers on the geology of the Philippines have noticed the geniculate form of this island.

Von Drasche[2] first called attention to this junction of the two principal trends of the Visayan Islands. Koto[3] suggests a similarity to the divergence of the mountain system of the Eastern Alps. Suess[4] notes a possibility of similarity of structure to that of Porto Rico. Becker[5] speaks of two main, curved fissure systems parallel to the two arms of Masbate.

In spite of its significant form it was not until several years after the American occupation that the island was visited by geologists. Gold had been discovered in workable amounts near Aroroy in 1900 or 1901 and the development of the industry led to visits by members of the Mining Bureau.[6] Mr. A. J. Eveland made a short visit to the mining district in 1904 and noted in his report[7] the topographical youth of the district and the limestone benches on the west side of Porta Barrera. Mr. H. B. McCaskey and Mr. H. M. Ickis made a more extensive visit to the mining district in 1906. Mr. McCaskey in his report[8] was the first to call attention to the fact that the great majority of the mineral veins strike in a northwestherly direction, parallel to the principal axis of the island.

TOPOGRAPHY.

It is my purpose to show that the principal topographic features of the island may be resolved into two principal series of lineaments, parallel to the general directions of the two prongs of the island, which are themselves a part of the two principal trends of the Visayan Islands

[1] Masó, Rev. M. S., S. J.: The rainfall in the Philippines. *Bull. P. I. Weather Bur.*, Manila (1907).

[2] Fragmente zu einer Geologie der Insel Luzon. Vienna, 1878.

[3] B. Koto: On the geologic structure of the Malayan Archipelago. *Journ. College Sci.*, Tokyo (1899), Pt. 2, **11**, 117.

[4] E. Suess: The face of the earth. (English translation) Oxford, (1906), **2**, 173.

[5] G. F. Becker: Report on the geology of the Philippine Islands. *Bull. U. S. Geol. Surv. 21st Ann. Rept.* (1901), Pt. 3, 546.

[6] Now Division of Mines, Bureau of Science.

[7] Manuscript in Bureau of Science.

[8] Manuscript in Bureau of Science.

and southern Luzon. Both series are present in the northern part of the island, but the northwest series is soon lost to the southwest and the last prominent northeast feature on the main range of the island is Port Palanoc. In addition to these two principal series of lineaments there is, in the northern part, a third, minor series showing the northern trend developed more extensively in western Panay and Tablas.

PORT BARRERA.

Port Barrera is a deep bay cutting far into the land in a general southwesterly direction. It is S-shaped, the deepest and widest part running westerly for about 4 kilometers. This part is about 3 kilometers wide and reaches a maximum depth of 60 meters. Southward from Point Matalantalan the bay narrows and shoals rapidly, a marked submarine escarpment running westerly from the northern part of the east shore to the coral reefs outside Point Matalantalan. This stretch of the bay extends southward for about 4 kilometers and is comparatively narrow, not over 1 kilometer wide, and shallow, nowhere over 6 meters deep. At Point Lungib the direction changes to southwest and the bay broadens out and becomes much shallower, being bordered by large mud flats and mangrove swamps. A well-defined channel, however, extends as far as the village of San Agustin.

A very peculiar feature of the topography of Port Barrera is the complete dissimilarity of the two sides of the bay, the western consisting of limestone terraces of apparently rather recent date, and the eastern of a series of older rocks eroded to a much greater extent than the limestones of the western side.

Punta Colorada owes its name to the bright red color of its cliffs and is said to be formed of iron-stained limestone. The country across the western arm of the bay from Punta Colorada consists almost entirely of coralline limestone in a series of terraces. Running northwesterly from Point Lungib the limestone forms a high, sharp ridge, with two prominent terraces. It breaks off steeply on the northeast side into a long, narrow valley separated from the bay by a smaller ridge. At the corner of the western branch of the bay the larger ridge joins a southwesterly escarpment of a similar limestone. To the southwest the main ridge slopes off comparatively gently to an irregular plateau, the floor of which is formed by one of the more resistant limestone beds. Farther to the southwest there are a great number of small, conical mesas.

In the southern part of the bay the southwestern series of lineaments is represented by a line of hills running southwest from San Agustin.

THE AROROY DISTRICT.

The country to the east of Port Barrera shows a strikingly different topography. While the western side is the result of recent elevation of coral limestones, the eastern shows a topography dependent on the more mature erosion of a complex of older sedimentary, igneous, and pyroclastic rocks without any evidence of recent elevation; on the contrary, it is not unlikely that there has been some depression in recent times.

The country lying directly east of the bay forms the Aroroy mining district, and has been mapped in detail. In the northern part of the district, near the barrio of Aroroy, there are scattered outcrops of a quartz diorite. Further south on Aroroy and Bagadilla Mountains occur metamorphosed sediments together with basic effusives. On either side of the canyon of the Guinobatan River are two small ledges of a dark, fine-grained limestone which forms a capping on two of the points. Between Kalakbao hill and the hills near the Lanang River the prevailing rock is an andesitic breccia, the beds of which dip at low angles to the southwest; some of the hills, however, such as Panique hill and two small ones near the bay are composed of andesite and may be volcanic stocks. The high range of hills cut by the Lanang River is also andesite, while to the south basalt and conglomerates with basalt pebbles come in. The topography of the region shows, even more clearly than the western side of the bay, the rectangular system of lineaments. Mounts Aroroy, Bagadilla, Kalakbao, and Cogran show a most marked northwesterly trend. These hills contain practically all the mineral veins of the district, and owe their prominence to the greater resistance offered to erosion by the quartz of the veins. The vein system shows very clearly the presence of a northwestern line of weakness, as all but two or three of the veins strike in a northwesterly direction. They all give evidence of frequent opening and recementation with several periods of mineralization. Furthermore, the three principal streams of the district, the Guinobatan, Panique, and Lanang, all follow a northwesterly course, as do the two brooks which empty into the bay near Aroroy. The southwesterly lineaments are also very strongly marked. Principal among these are the rather broad valley of Balagting Creek, Mount Vil-lon, and the two gorges of the Lanang River.

Mount Vil-lon is the highest mountain in the district, reaching an altitude of 400 meters. It has a clear and sharp northeasterly trend and breaks off precipitously at Monument Rock, near the Guinobatan River, thus differing from the other hills of the district which all trend to the northwest. The rock is an andesitic porphyry and the mountain may be a volcanic stock or more probably an intrusive mass.

A peculiar feature of Mount Vil-lon is that, while it lies on the strike of the principal veins of the Aroroy district, diligent prospecting has failed to reveal any mineral veins. Veins occur on the northeast side of the mountain, but in an irregular network and no longer showing the dominant northwesterly strike.

Nearly all the mineral bearing veins of the district occur in the comparatively small area occupied by Mounts Aroroy, Bagadilla, and Kalakbao. The summits of these hills lie in an almost direct north and south line, although the individual hills show a marked northwesterly trend. This trend is in a large measure due to the greater resistance to erosion offered by the quartz veins, which practically all show a northwesterly strike.

Mount Aroroy (elevation, 250 meters) shows this trend very clearly, in a long, cogon-covered point running out from the summit to the northwest. A large vein has been opened on the summit of the mountain and its continuation along the ridges is shown by bowlders of iron-stained quartz. Mount Bagadilla (elevation, 340 meters) shows two large ridges running off to the northwest, the southern certainly being due to the presence of quartz veins and the northern probably to the same cause. The veins of the southern ridge of Mount Bagadilla continue across the Guinobatan River and there form the backbone of Mount Kalakbao (elevation, 200 meters). Mount Kalakbao is a long ridge following the northwest strike of the veins. It contains at least ten veins, including the best known in the district. Only two veins have been found across Kaal Brook to the southeast, and apparently none continue farther southeast into Mount Vil-lon. It seems as if the northerly stretch of the Guinobatan River on the west and Mount Vil-lon on the east form the boundaries of the Aroroy vein system, a line southeast from the turn of the Guinobatan River at the Gold Bug property, and between Mount Kalakbao and Panique Hill bounding the system on the south.

The drainage features of the Aroroy district also show marked peculiarities. In the extreme north of the district the Buyuan River has a northerly course near its mouth, although farther up the stream the course is northwesterly. The two small streams near Aroroy, Ambulong and Lubigang Creeks flow northwesterly into the mangrove swamp which surrounds Aroroy, between narrow, northwesterly ridges. An unexplained feature of the course of Lubigang Creek is the sharp bend it makes into Mount Aroroy. There seems to be nothing in the structure of the rocks to account for this, nor does it seem probable that a northwesterly area of weakness would be developed for such a short distance.

Bangong Creek flows between Mount Aroroy and Mount Bagadilla, but cuts obliquely across the strike of the veins instead of running parallel, as would be the case with perfectly adjusted drainage. Another peculiarity of this stream is in its headwaters. It rises east of Mount Aroroy and flows at first to the southeast, draining country which would naturally be expected to be a part of the drainage basin of one of the creeks flowing toward Aroroy, or of the Buyuan River. It is evidently a capture of the headwaters of Balagting Creek, a stream flowing southwest, tributary to the Guinobatan River.

The Guinobatan River presents several peculiarities in its course, inexplicable except by the supposition of superimposed drainage. Rising to the east of Mount Vil-lon it flows alternately west-northwest and west. North of Mount Vil-lon it flows to the west with long, graded stretches and small rapids. At the junction with the Kaal there is a small fall and the course changes to nearly north with one sharp ox-bow, until it reaches the junction with Balagting Creek, where it turns sharply to the west and enters a deep canyon between Mounts Bagadilla and Kalakbao. This canyon, 2 kilometers long, cuts diagonally across almost the whole of the vein series. After a sharp turn to the southwest at the Gold Bug mine, the river flows north for 3 kilometers to its junction with Bangong Creek, where it turns to the west again and enters the mangrove swamps that surround the bay. On this northerly stretch the river again cuts diagonally across the trend of the veins, but here it is noteworthy that, while outcrops and bowlders show the presence of veins extending down to the river on the eastern bank, the hills to the west are entirely barren. This northern stretch is parallel to the bay and only a kilometer from it. Evidently there is a northerly element in the lineaments of this district, which, while less distinct than the northwestern and southwestern trends, shows in Port Barrera, the line of low hills on its eastern shore and the lower part of the Guinobatan.

The Lanang River also has a very peculiar course. Rising in the mountainous upland in the central part of the island, it enters the Aroroy district with a northwesterly course, then suddenly turns to the southwest and for 2 kilometers flows through a deep, narrow gorge, when it turns again at right angles and flows irregularly to the northwest for the same distance until it once more makes a sudden turn and takes a northeast course through a smaller, but similar gorge. From here on it flows to the north through a small flood plain until it enters the great mangrove swamp of the upper part of Port Barrera. Northwestward from the angle made by the river, on entering the upper gorge, a broad and rather flat valley is found between two ranges of hills. This valley would seem to be the natural course of the Lanang, and the sharp angle of the river and the small stream entering at this point suggest capture. However, there seems to be no reason why a stream having such a direct and regular course should be captured by one so unfavorably situated as is the present Lanang River. A possible explanation is that fissuring in a northeasterly direction has produced lines of weakness, allowing a stream leading in this direction an advantage over the more regular stream flowing northwest. The course of the river in the upper gorge, prolonged to the northeast, would be continued in the valley to the southwest of the hill forming the divide between the headwaters on

Panique Creek and various small tributaries of the Lanang, and would run along the northwestern flank of Mount Vil-lon. The headwaters of Panique Creek and Kaal Creek also form a northeasterly trough. It is quite probable that the cutting off of the vein series may be due to a fault along the northwestern side of Mount Vil-lon. Since the vein system is later than the andesite breccias, Mount Vil-lon can hardly be an intrusion of later date than the period of vein formation, and the vein series being regular rather than radiating, can not owe its origin to fractures formed around an intrusive mass.

In the westerly stretch of the Lanang, between the two gorges, is an abandoned meander of the river, its course having been shortened by lateral erosion on the convex sides of the two bends. The hill between the old and new courses is composed of a firm conglomerate of basalt pebbles, a common country rock of the surrounding region, and is about 50 meters above the river. The river must, therefore, have been at grade at least 50 meters above the present level, and this implies an uplift. Its course having been already determined for it, the cutting through of the lower gorge allowed the stretch above to remain at grade, and as the gorge was cut down its meander became entrenched and it could only have been in comparatively recent times that the river, being nearly at grade up to the upper gorge, cut through the neck of its old meander. The deserted meander is filled with old river gravels and furnishes promising dredging ground, as the Lanang and its tributaries cut the Mount Cogran vein and several as yet undeveloped veins to the west of Mount Cogran.

The course of the Lanang gives the impression that the present stream is the result of the union under peculiar circumstances of two streams flowing northwest, being a case where captures have tended to lengthen rather than simplify the course of the stream. The evidence of the streams in the Aroroy district seems to point to a period of elevation after the courses of the streams were in a large degree determined, followed by a period of considerable depression when deep bays were formed and the dark blue limestone found in the valley of the Guinobatan at 150 meters' elevation was deposited. Uplift followed, and during this period the readjustments of drainage of Balanting Creek and the Lanang region took place. Since then there seems again to have been some slight depression shown by the slight embayment at the mouths of rivers, and the extent of the mangrove swamps.

The growth of the mangrove swamps has played an important part in the formation of the land on this side of the bay. The mangrove tree must grow with its roots in the water, and the network of roots catches débris and soon builds up the land. As solid ground is built up, the inland trees die and the swamp keeps advancing seaward, building up the land as it goes. Lehnert[9] estimates for Borneo that under favorable circumstances land may be thus formed at the rate of 100 meters in forty to forty-five years. Near the mouth of the bay recent coral largely replaces the mangroves as an agency for upbuilding the land.

The movements of the western side of Port Barrera do not seem to have been synchronous with those of the Aroroy district. Probably during the greater part of the oscillations of the Aroroy region the opposite side of the bay was submerged and its uplift seems to have taken place contemporaneously with the depression of the opposite side. This independence of movement points to faulting along a line in the bay.

LANANG TO MANDAON.

Only a hurried reconnaissance was made southward from the Lanang Mining Company's camp on the Lanang River, and the country was studied in far less detail than the Aroroy district. Leaving the amphitheater formed by the deserted meander of the Lanang, the ground rises rather steeply to the south with hills composed of basalt, basaltic tuffs and conglomerate until Mount Nabongsuran is reached. This mountain is the highest between Mounts Vil-lon and Mandaon, probably reaching an elevation of over 300 meters, and has its long axis following the prevailing northwesterly trend. The small, triangular valley of Mandalidon is found at the foot of the mountain. The Mandalidon River flows northwest to Port Barrera and a small branch joins it here from the northeast. The two hills to the west of Mount Nabongsaran, Mount Masapinit and a smaller hill, both of conglomerate dipping to the southwest, show the northeasterly trend which now becomes the dominant feature of the country.

The hills trend to the northwest for 6 or 7 kilometers southward from the Mandalidon River. The Mabui River, where it is crossed by the trail, flows to the west, but soon turns and assumes a northwesterly course, where it flows through a broad valley, on the southwestern side of which a sharp escarpment of sedimentary rocks is encountered, showing several prominent benches. This escarpment extends to Pagbulungan Point, west of Mandaon, and is broken only by the two small canyons of the Butuan and Mombog Creeks. For about 8 kilometers this line of hills runs due south and then turns to the southwest for about 12 kilometers until it reaches Point Pagbulangan. Near this point it was found to consist of conglomerate, shale, and sandstone, evidently of marine rather than fluviatile origin, but in the northern part, as far as could be judged at a distance, there was a capping of limestone as well. This ridge forms the most prominent feature of the landscape of this

[9] Lehnert: Über Landbildungen im Sunda-Gebiet, *Deutscher Rundschau f. Geog. u. Stat.* (1882), 58. Quoted by Posewitz, Th., Borneo (English translation) London (1892), 257.

region as it rises in sharp cliffs from the plain at its foot to a height of perhaps 200 meters above the plain. To the westward its slope is gradual.

About 3 kilometers south of the Mabui River the land, which has been gradually rising from an elevation of 160 meters at the Mabui River to 240 at this point, suddenly falls off in a very steep slope to a broad, flat plain, having an average elevation of about 130 meters, the bounding escarpment running first to the southeast and then northeast. The plain is drained by two parallel streams, the Butuan and Mombog Rivers, which flow to the westward through the escarpment already described, although the principal branch of the Butuan has a southwest course parallel to the cliffs bounding the plain. The peculiarity of the courses of these rivers again suggests superposition. One would hardly expect to find two such deep, narrow canyons close together when more reasonable avenues for the drainage of the plain lie to the northwest around the end of the escarpment into the Mabui River or southwest into Nin Bay. A sharp pinnacle of limestone, Butuan Hill, stands in the center of the plain. This peak is flat-topped, rising in a sharp cliff about 70 meters above the plain; its base is elliptical, the axes being about 400 and 150 meters in length. The limestone has been largely dissolved and large caves have been formed. As several skeletons have been found in these places, it is evident that they once served for burial.

This limestone peak and the conglomerate to the west mark the present limit of a marine sedimentary series which extends northward to San Agustin and the western side of Port Barrera. The country south from the Lanang River, consisting of well-worn hills of volcanic and pyroclastic rock with occasional fluviatile sediments, clearly represents the old land upon which these sediments were laid down. That the sediments probably once covered a larger area is indicated by the peculiarities of the courses of the various streams, particularly the Lanang River and Butuan and Mombog Creeks. The present boundary of the series is well defined by a trough running northward from the Butuan plain to the head of Port Barrera. Possibly the escarpment bounding the plain on the north represents the old shore line and Butuan Peak is an isolated coral reef. Butuan plain itself drops off to the south in another escarpment similar to, although smaller, than the first. To the west the sedimentary escarpment, now turning off to the southwest, overlooks the plain, while on its eastern side the upper plain, 70 meters above, stretches away in a southeasterly cliff. In both the upper and lower plains the underlying rock is basalt, strongly magnetic. The lower plain is broken by numerous small hills and grades gently down from an elevation of about 40 meters to the mangrove swamps surrounding Port Mandaon.

NIN BAY.

The bay on which the little town of Mandaon is situated consists of three different bodies of water, Nin Bay, Loog Bay, and Port Mandaon. The outer of these, Nin Bay, has regular outlines and shoals off very evenly. At its head is a broad line of beach with lowland back of it. The town of Mandaon is at the southeast end of this. The water is very shallow along this beach and at low tide mud flats extend out for a considerable distance. Southwestward, following the long axis of the bay, the water shoals off very regularly at the rate of about 3 meters per kilometer. A line drawn across the entrance of the bay, from Pagbulungan Point to the eastern end of Puró Island, shows a fairly constant depth of about 17 meters and crosses the only shoals in the bay, Nin and Ochoa banks, which show a minimum depth of 3 meters. However, on the northwestern and southeastern sides of the bay, the water deepens much more rapidly, depths of over 15 meters being shown on the chart at distances of less than 500 meters from the two points, showing that the present shallowness of the bay is due to silting up from its head. The sedimentary escarpment already described extends along the northeast shore to Pagbulungan Point. A broken range of basalt hills exists to the southeast of the bay. The range, beginning at Mount Tuitong above Mandaon, extends through the Gapus Hills (elevation, 144 meters), Puró Island (elevation, 162 meters), and Kamasusu Island (elevation, 159 meters), being broken by deep channels between Mandaon and the Gapus Peninsula, and between Puró and Kamasusu Islands, a shallow channel being found between Puró Island and the mainland. The basalt is strongly magnetic, so much so that magnetic observations taken in 1895 for the center of Nin Bay showed an eastward declination of 3° 47′ instead of the normal eastward declination of less than one degree.

Loog Bay is south of Nin Bay and connected with it by the two inlets at the ends of Puró Island. Like its northern neighbor it has a northeasterly direction. Its maximum depth is 15 meters at the entrance, and it shoals rather more rapidly toward its head than Nin Bay. The basalt hills of Kamasusu and Puró Islands on its northern side show their steepest faces in this direction and the deepest part of the bay is close to these islands. The channel between the two is about 400 meters wide and reaches a depth of 17 meters, whereas the channel between Puró and the mainland although slightly wider, has a greatest depth of only 4 meters, a wide bench with a maximum depth of 2 meters joining the island with Gapus Peninsula. The western side of Puró Island is fringed with mangroves and the mudflats extend out for some distance. At the head of Loog Bay is a broad stretch of beach and mud flat, and the mangrove swamp extending south from Port Mandaon forms the greater part of the isthmus. The south shore of the bay is low-lying and fringed with coral reefs and mangrove swamps. Near the western point there is a smaller bay reaching to the southeast about 2 kilometers and continued inland in a large mangrove swamp. Talisay Point at the southern side of the entrance to the bay is low and fringed with mangroves, with a coral reef extending out about half a kilometer.

Port Mandaon is the third portion of the bay, a narrow stretch of water extending nearly north and south, into which flow the Mandaon and Tagpoc Rivers, as well as several smaller streams. The deepest channel is on the western side under the hills east of Mandaon. The maximum depth reached in this inner bay is 7½ meters at a point near the western shore, about 2 kilometers north of the mouth. Wide mud flats and large mangrove swamps occur on the eastern shore and at the northern and southern ends. The narrow strait connecting Port Mandaon with the outer bay is of interest because of its depth. Just inside of Sanig Point the soundings show a depth of from 3 to 6 meters; however, four are encountered in the narrowest part of the strait, giving 13, 15, 16, and 17 meters; outside in Nin Bay the water again shoals rapidly to 3 meters. This deep "pothole" and the deep channel between Kamasusu and Puró Islands seem to represent old river channels and consequently imply a considerable amount of submergence, 20 meters at the least. The "pothole" between Gapus Peninsula and Mandaon Point seems to be all that remains of a large stream valley. The broader stretches have silted up, while the former gorge, now the strait, has been kept open through tidal scour. It is not possible to venture any opinion as to the courses of these two submerged streams or as to what led to the cutting of canyons through the basalt ridge instead of their following the broad southwesterly valley now marked by Loog Bay. In all probability the conditions were not unlike those in the Lanang district, where fissuring in two directions has influenced drainage readjustments.

THE COUNTRY SOUTH OF NIN BAY.

A fine view of the country to the south may be obtained from Kamasusu Peak, this view extending as far as the Zapatos Islands, small islets between Masbate and Panay. As far as can be seen, a narrow and regular range of fairly high mountains extends to the southwest. These grade down to a constantly narrowing plain on the east. This plain, except possibly for the outer fringe where the mangroves have been at work as a land-forming agency, does not appear to be a coastal plain in the true sense of the word, but rather a plain of erosion, terrestrial, or marine, in part covered by wash from the hills.

The central range rises without foothills and the plain below may be roughly divided into three belts, the first with smooth outlines where the wash from the hills has covered previous irregularities; the second, grading into the first and in places reaching the sea, a plain broken by small, irregular hills having the appearance of "monadnocks;" and the third, an irregular fringe of mangrove swamps together with the smooth, flat stretches probably formed by this agency.

The submarine contours of Nin Bay suggest depression rather than elevation and this would be in accord with the topography of the coastal plain. An elevation of 35 meters would connect Masbate with Panay by a narrow ridge containing Jinototo and the two Zapatos Islands, which would stand out as peaks above the rest of the ridge. Mr. Worcester,[10] reasoning from zoölogical evidence, suggested that Masbate, Panay, Guimaras, and Negros were formerly connected, and at least as far as concerns Masbate and Panay, the physiographic evidence confirms this. Dr. Becker,[11] following this and from a study of the charts of these waters, suggests the separation of these islands by the submergence of a coastal peneplain. The prolongation of the southern fork of Masbate does not form a continuation of the western line of the hills of Panay, but is offset to the east so that the Jintotolo Channel is S-shaped. A deep channel extends from the mouth of the Panay River east of the connecting ridge, apparently a submarine prolongation of that river, and in that case furnishing further evidence of depression. This channel follows a northeasterly course as far as Jintotolo Island, where it makes a sharp turn and runs about S. 30° E., roughly parallel to the main prong of Masbate.

THE SOUTHWESTERN RANGE.

Leaving Port Mandaon and traveling eastward across the island, one passes through 5 or 6 kilometers of gently rolling country—the same plain as that crossed in coming from the north—and then follows the valley of the Tagpoc to the mountain range. A large hill of irregular outline stands on the north, while to the south a range of low hills extends out from the main range in a northwesterly direction. The upper part of the main ridge, here known as Mount Gantal, is very steep, rising from an elevation of about 200 meters where the main part of the ascent begins to about 550 meters at the pass, less than a kilometer distant. At this point the axis of the range has a direction of N. 10° E., but farther south it resumes its normal northwesterly direction.

The underlying rocks in the lower part are grits or pyroclastic rocks much decomposed, with one outcrop of a black slate. The summit of the ridge shows fine-grained igneous rocks also much altered, while a red slate outcrops on a spur extending eastward from the summit. After a steep descent on the eastern side a rough plain studded with small, irregular hills is reached. The Burakai River, having its head-

[10] *Proc. U. S. Nat. Mus.* (1898), **20**, 578.

[11] *U. S. Geol. Sur., 21st Ann. Rep.* (1900), Pt. 3, 567.

waters near the pass, flows west by south into the Gulf of Asid. The country between the ridge and the gulf shows even more clearly than on the west that its lack of relief is due to combined erosion accompanied by upbuilding from the wash from the ridge, rather than to uplift. In other words, it is a plain of degradation rather than a true coastal plain. The loose material is largely composed of irregular gravel and there are numerous small "monadnocks" and outcrops of a red slate.

The Gulf of Asid is a broad, shallow bay occupying the space between the two prongs of the island. The deepest portion is along its western shore, but it is nowhere over 40 meters in depth. At the head of the bay, near Milagros, it deepens so gradually that there are 2 or 3 kilometers of sand exposed at low tide. The eastern side of the gulf is very shallow and filled with numerous reefs and small islands. The barrio of Mangsalange is situated some kilometers to the east of Milagros, whence the trail leads to the copper and lead deposits. Conditions here are similar to those on the west shore of the gulf, but the plain is much rougher because the hills are farther inland and lower and consequently the surface is not smoothed by the piedmont wash deposits. A small hill of hornblende andesite rises near the coast at Mangsalange and further back is an irregular plain with numerous small hills, capped by a light-colored, coralline limestone. Outcrops of a red slate similar to that found on the western shore of the gulf, together with some jasper occur in the stream beds. Farther inland the copper and lead deposits are reached. Native copper occurs scattered irregularly through a melaphyre, which is sheared and jointed along lines running north and N. 60° E. Many veins occur nearby in a country rock of decomposed feldspar porphyry, some of these carrying copper ores and others galena. The usual strike is from 10 to 20 degrees east of north, showing that even as far east as this point the northeasterly series of lineaments is still present. The white limestone found near the shore is no longer present, but the small hills are capped with a dark limestone similar to that found in the Guinobatan canyon in the Aroroy district. Thick forest is encountered northward from this point towards Mobo, and little can be seen of the general nature of the country. To all appearances a rather low, plateau-like ridge extends in a northwesterly direction, with black limestone outcropping on its southern side and on its summit, overlying a series of volcanic rocks, which in turn overlie the older slates.

Between Masbate and Milagros the ridge is broken by a broad, northeasterly trough, extending across the island, being a southwestward prolongation of Port Palanoc. The dark limestone is also found in this depression, showing that it is of comparatively early origin.

Between Milagros and Lanang the country becomes more rugged and the hills seem to be higher. This portion of the island is for the most part heavily wooded, and little idea could be gained of the general topography. Occasional outcrops of the same dark limestone and rare outcrops of a dark slate underlying the limestone, are found near the headwaters of the Lanang basalt and basalt conglomerates are prominent. The streams cut deep cànyons and the topography is generally younger than it is nearer the sea.

The country southeast of the town of Masbate was not visited, but as far as can be seen from an examination of the charts, Port Palanoc, with the transverse trough already mentioned, forms the last important northeasterly lineament. The entrance to this bay is through a narrow channel less than 300 meters in width and about 60 meters in depth. On the northeast the deep water is close to the shore, but on the opposite side a coral reef extends out for about 600 meters. This narrow channel is nearly a kilometer long, and at the end of it the bay suddenly widens and there is a small, but deep, branch to the southwest. The town of Masbate is situated at the junction of this branch with the main bay.

THE SOUTHEASTERN PENINSULA.

I was unable to visit this part of the island, so that all my information is derived from a study of the charts. These, while complete as to coast line and soundings, are sadly lacking in interior topography, only the most prominent peaks being shown. According to the map published in the "Atlas de Filipinas" the streams flowing into the Gulf of Asid are much longer than those flowing northeast, thus implying that the crest of the range as a whole fronts the northeast side. Peaks 383, 514, and 403 meters high are shown between Mobo and Uson. Two peaks are situated near Cataingan, height not given; these are termed the *Tetas de Cataingan.* Deposits of coal have been worked between Cataingan and Palanas, and the Spanish records show that there is here a coal-bearing formation of considerable extent. Reëntrants, following the northwest-southeast trend, are shown in Uson and Naro Bays and Port Cataingan. On the southwest coast the land is generally low, except for the single peak of Mount Vigia on the coast midway between Milagros and Point Caduran.

The changes of level for western Masbate seem to have been as follows: An old land surface, which itself contained sedimentary rocks, as is shown by the red slates found in various places, was probably rather maturely dissected and the streams given something like their present courses. Depression followed, during which the black limestone was deposited, and reëlevation, during which the same limestone was largely eroded. It is probable that during this period Masbate and Panay were connected, and the Panay River flowed through what is now the Jintotolo Channel. Another period of depression separated the islands and allowed the formation of the later white coralline limestone found at lower levels. At a subsequent period a partial elevation took place in which Panay and Masbate may again have been connected, but the northern shore of Masbate, between Ports Palanoc and Barrera, does not seem to have taken part in this. Later still some small depression seems to have taken place.

RELATIONS OF MASBATE AND NEIGHBORING ISLANDS.

In the preceding pages I have tried to show that the principal features of the topograhpy of the island are referable to two main sets of lineaments, one trending in a northwesterly and the other in a northeasterly direction, with a third minor set having a northerly trend. A glance at a map of the Visayan Islands will show that this holds good in a general way for the neighboring islands as well. Surigao Peninsula of Mindanao, Leyte, Samar, eastern Masbate, Ticao, Burias, and the southern part of Luzon belong to the northwesterly group. The northeasterly series includes Cebu, Negros, Guimaras, eastern Panay, and western Masbate. Western Panay and Tablas, with possibly northern Cebu and southern Negros, show the northerly trend.

Throughout all these islands there is a curious dovetailing of the land areas with the deeper basins. This is particularly noticeable around Masbate. The southeastern point of this island is separated from Leyte by a deep channel, the soundings giving 150 meters without bottom. Between Samar and Luzon lies the northeasterly San Bernardino Strait. Ticao is connected with Vigia Point in Masbate by a chain of small islands with shoal water between them, but to the northwest the island ends abruptly in water over 180 meters deep. Between Ticao and Masbate the soundings show a maximum depth of 911 meters, but this deep water ends abruptly in Uson and Naro Bays on Masbate. The Island of Burias, instead of being a continuation of Masbate or Ticao, points toward this deep strait. Similarly, its northwestern end is offset to the west from Batangas Peninsula and points into Ragay Gulf.

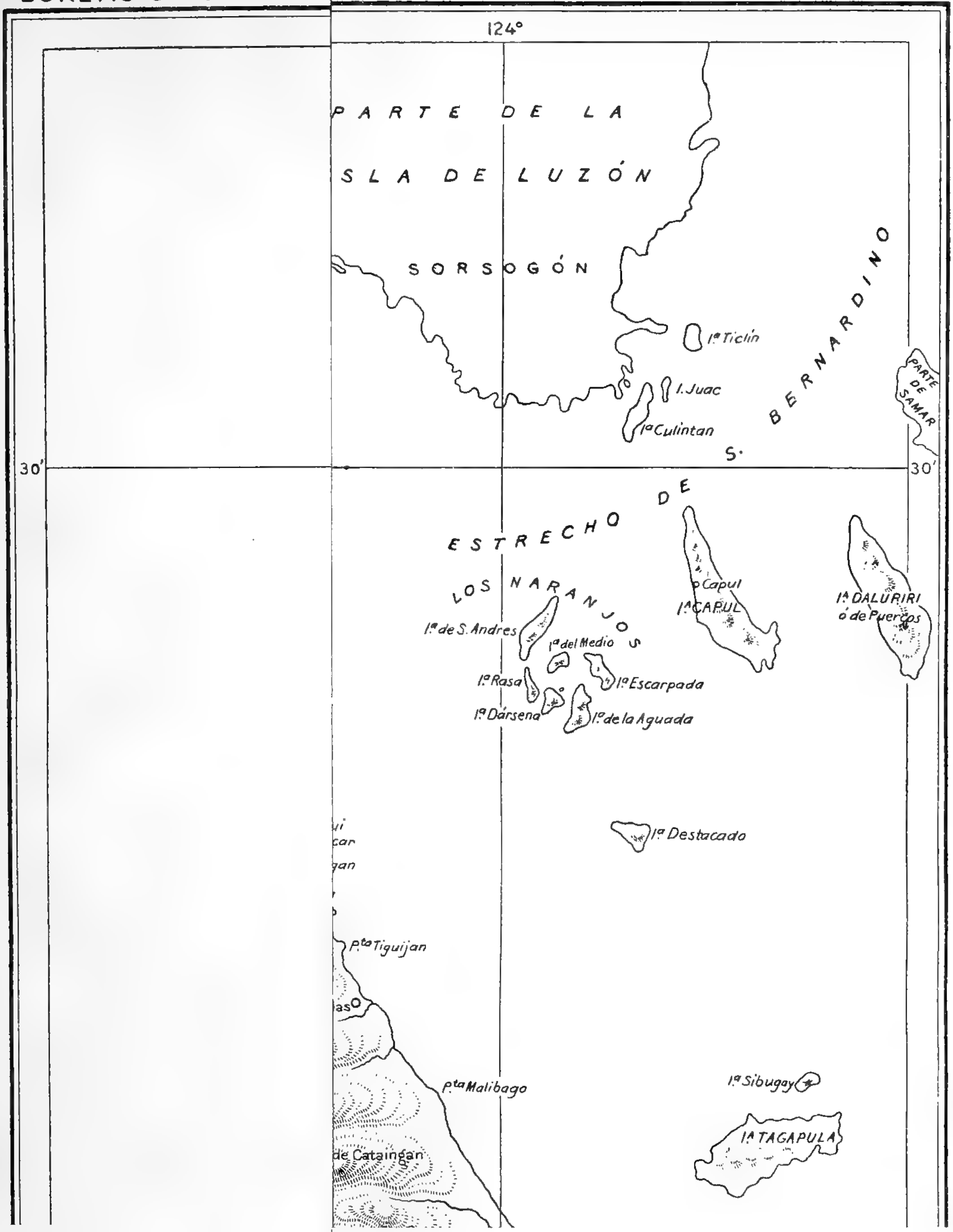
Much the same conditions exist in regard to the islands showing a northeasterly trend, Cebu, Negros, Guimaras, eastern Panay, and western Masbate. These lie to the southwest of the northwesterly series, but the northeast influence is shown in San Bernardino Strait and Sorsogon Bay on Luzon. Northern Cebu, southern Negros, and the southern part of Tañon Strait all show northerly trends. Between Cebu and Negros, Tañon Strait has a depth of over 200 meters, but is cut off on the north by the small islands west of Cebu and on the south by the coast of Negros. Southern Negros seems to follow the northerly series of lineaments, but the island as a whole has a northeasterly trend. Guimaras Strait is between northern Negros and Panay, this does not show soundings exceeding 25 meters, but a deep northeasterly embayment west of southern Negros ends abruptly at Guimaras Island. Abella [12] has called attention to the island of Guimaras and the range of hills on the southeastern coast of Panay as forming a part of the orographic line extending from Borneo through the Sulu Archipelago, Basilan, the Zamboanga Peninsula, Negros, and Masbate, but as I have already shown, the Panay range does not continue directly in western Masbate, but is there offset to the northwest.

The northern series which appears in northern Cebu and southern Negros is of minor importance in western Masbate, and attains its greatest prominence in the *Cordillera* of Panay and the Island of Tablas. Here again Tablas is not a direct continuation of the Panay *Cordillera,* but is offset to the west.

[12] Descripción física, geológica y minera en bosquejo de la Isla de Panay. Publicación oficial, Manila, 1890.

ILLUSTRATIONS.

BUREAU OF SCIENCE DIVISION OF MINES



BUREAU OF SCIENCE

DIVISION OF MINES

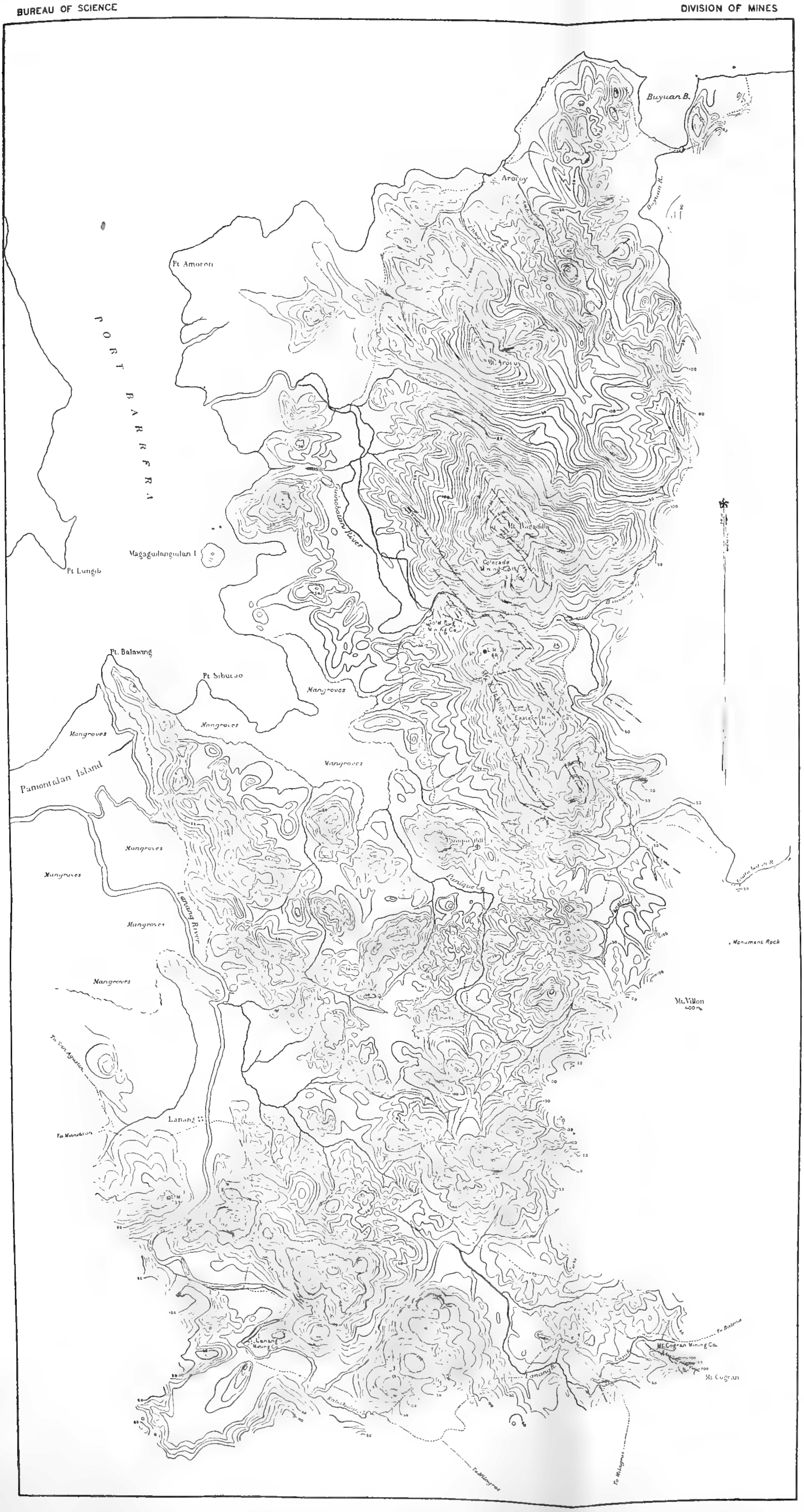
COPIED FROM
ATLAS DE FILIPINAS

Kilometres

Plate I. Map of Masbate, P. I.

BUREAU OF SCIENCE

BUREAU OF SCIENCE DIVISION OF MINES



Principal veins shown thus —·—·—·—

Contour interval=10 meters

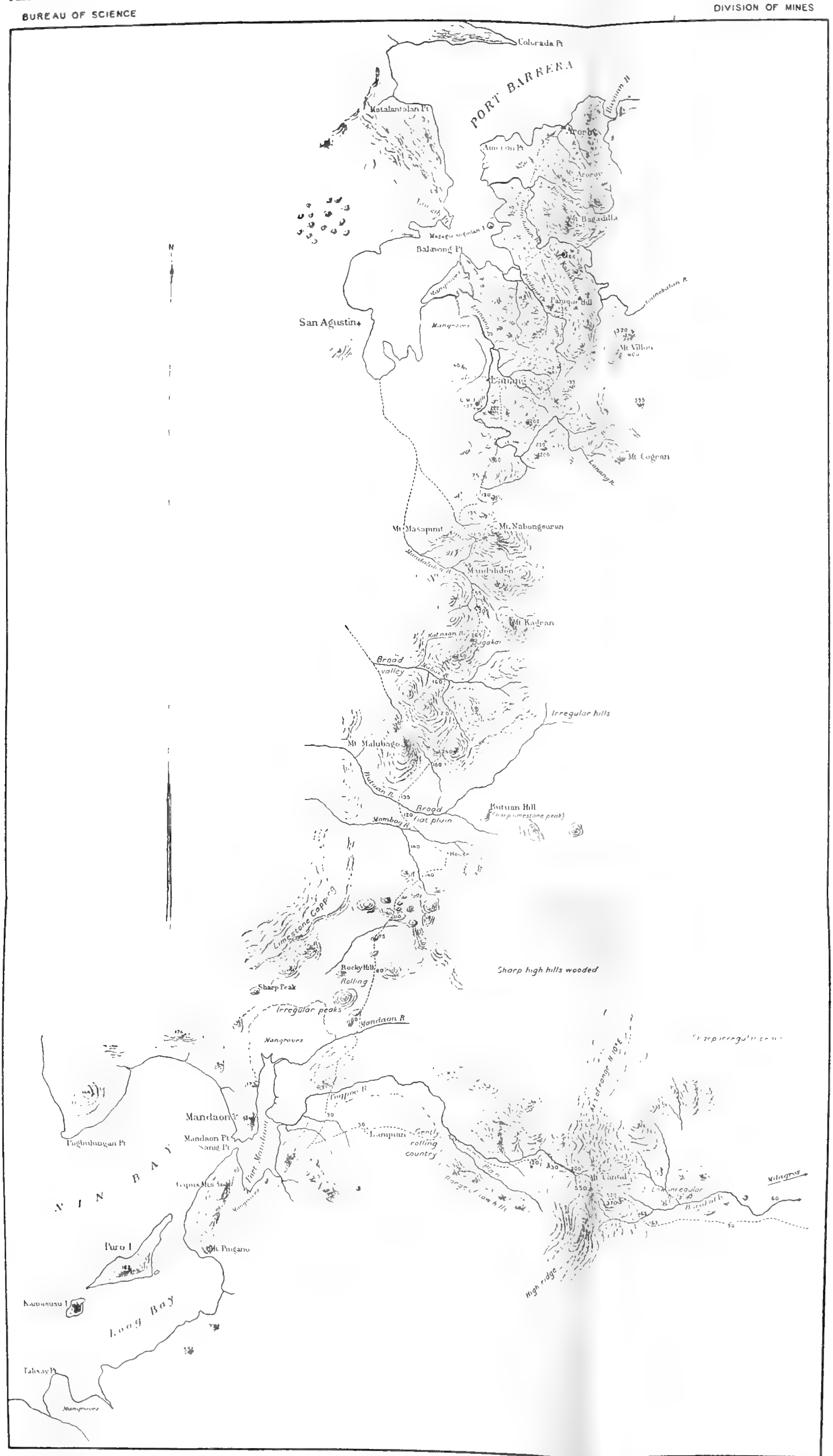
Triangulation by H. M. Ickis and M. Goodman
Topography by H. G. Ferguson
Coast line from U. S. Coast and Geodetic Survey Chart
1907-1908

PLATE II. AROROY MINING DISTRICT, MASBATE, P. I.

BUREAU OF SCIENCE

BUREAU OF SCIENCE

DIVISION OF MINES



FEBRUARY 1908

MAP OF ROUTE
AROROY TO MANDAON
MASBATE P. I.

SURVEYED BY PACING AND COMPASS
ELEVATIONS BY ANEROID, UNCHECKED
TOPOGRAPHY BY H. G. FERGUSON
COAST LINES FROM U. S. COAST SURVEY CHART
HEIGHTS IN METERS

PLATE III.

CONTRIBUTIONS TO THE PHYSIOGRAPHY OF THE PHILIPPINE ISLANDS: IV. THE COUNTRY BETWEEN SUBIG AND MOUNT PINATUBO.

By Warren D. Smith.

(From the Division of Mines, Bureau of Science.)

A practice march from Olongapó, United States naval station, to Mount Pinatubo, Zambales Province, was made in the month of April, 1907, by a batallion of the United States Marine Corps, under the command of Major E. K. Cole. The botanical notes referred to in this paper are contributed by F. W. Foxworthy, of the Bureau of Science, who accompanied the expedition; the sketch route map is by Sergeant Stockel and myself; the photographs were taken by me. Our thanks are due to Major Cole, United States Marine Corps, and to Dr. Jos. H. Thompson, assistant surgeon United States Navy, for the assistance they rendered and for the many courtesies they showed us.

The time consumed in making the trip from Olongapó to Pinatubo and return, a distance of approximately 200 kilometers, was one week; the average marching rate was therefore about 28 kilometers a day. As 20 kilometers a day is the usual rate with full equipment in the Tropics, it was not possible to make a very thorough examination of the country.

Subig Bay, our starting point, is one of the most beautiful in the Archipelago, large enough to shelter several battleship fleets as well as all the commercial vessels that visit Manila. The bay is very irregular in outline and has several islands scattered here and there. Its beauty is further enhanced by a girdle of hills, some of which are quite worthy of the name of mountains. Some of these are heavily wooded, while others are rounded and bare, thus giving a clue to the underlying rocks. The former are usually of limestone, shale, or andesite formation, the latter of serpentine or pyroxenite. Both the formation and the topography of the Cinco Picos range are remarkably similar to much of the California coast range. A thorough examination of this region will no doubt bring to light a host of minerals we have not yet found, but the presence of which we are led to suspect from the paragenesis of minerals.

We began the march proper from Subig at the head of the bay. The first day's journey took us along a comparatively level, alluvial-filled valley, or a series of valleys, separated by low spurs from the hill country to the east. This is good rice land. The soil is largely the disintegrated débris from the immediately adjacent hill country. Cuts along the road for the most part show a dioritic formation, in some places overlain by shales. At Pamatauan the country begins to undergo a noticeable change, it becoming more level and dryer. A short distance before Castillejos is reached there is a sudden and complete change both in soil and vegetation. From here on the country simulates in a remarkable degree the arid regions of the western part of the United States. Practically the only trees are *agoho* (*Casuarina equisetifolia* Forst.), which appear very much like pines. Between Santa Fé and Aglao there is some lowland which is flooded by means of ditches leading from the river and which makes good rice land.

The great flat stretch of country between Castillejos and Santa Fé is almost treeless and has a coarse, sandy floor with occasional bowlders. The Aglao River flows through this almost uninhabited stretch of country between high and steep banks of sand and gravel. The heat and glare encountered on the march across this part of the route are very trying, particularly to soldiers under full equipment.

Monadnocks of various sizes here and there are to be seen on this plain. One of these just beyond Castillejos is composed of andesite, and still a larger one near, but across the river from Aglao, 215 meters above the plain, is made up of practically the same rock as that constituting Mount Pinatubo, namely, feldspar porphyry.

A few miles east of Aglao we left the broad, nearly flat plain and entered a valley which flares widely at its mouth, but which gradually narrows toward its head. This we followed all the way to the foot of Pinatubo, crossing and recrossing the Aglao several times. At the entrance to this valley we pitched camp on the high bluff overlooking the river.

Here we were visited by a small band of wandering Negritos, a photograph of whom, together with some of the American marines, is shown on Plate I. As these little people have already been described by ethnologists, no further mention need be made of them except that they are a nomadic, extremely shy tribe. They are short, usually thick set, kinky-haired, quite dark, and resemble as their name implies little negroes. The men use bows and arrows, wear few clothes, generally only a breech clout, and are very active. They live for the most part on wild hogs and deer and probably any sort of wild meat they can find. Their houses are of the rudest kind; in fact they are nothing more than temporary shelters of grass, trees or caves. For a full description of these people I refer the reader to Mr. Reed's[1] work.

[1] Reed, W. A.: Negritos of Zambales, *Ethnol. Sur. Pub.* Manila, (1904), Pt. 1, 2.

We left part of the force behind at Camp Clinton and then proceeded up the valley, making halts as indicated on the accompanying route sketch. At the foot of the mountain proper, our force again was divided and one company took the trail over the pass and down the the long eastern slope to Camp Stotzenburg on the Pampanga side. The remaining company with us marched to the next water hole and then likewise separated, one part remaining below with the superfluous baggage and arms. Here a select number of men were chosen and we began one of the hardest pieces of mountain climbing I have engaged in in the Philippine Islands. From the 915 meters' elevation up to about 1,525 meters the trail leads over an exceedingly rocky slope where great care must be taken not to dislodge loose stones and bowlders and hurl them upon the party following.

The Negrito guides easily outdistanced us in this part of the climb. At 1,525 meters we entered the heavy growth of timber and small vegetation which so persistently clings about the summits of the majority of high mountains in the Tropics. The botanist calls this the *mossy forest.* as it is marked by a great profusion of moss covered trees.

The white men of the party kept with the Negritos after entering the forest, and one or two made even better headway. Although the trees are somewhat stunted on the summit of the mountain, the vegetation is very dense and this, together with the haze, prevented our having a very clear view over the surrounding country.

PHYSIOGRAPHY OF THE AGLAO VALLEY.

The Aglao Valley presents a physiographic puzzle which to me at least has been almost inexplicable. A cross section of it about midway in its length is given in the accompanying map. This figure shows that the valley consists of two chief parts, an upper portion wide, flat-bottomed, and with moderately steep walls, and a second and lower part, a deep gorge with exceedingly straight walls, narrow and rather more V-shaped at the bottom.

The gorge shows that the valley filling is of loose material, sand, and bowlders. As these gorges are in places, from 30 to 45 meters deep we can count on the filling extending to at least that depth, and if we continue the natural slopes of the valley walls downward so as to reconstruct the preëxisting valley, we get some idea of the probable amount of fill, which must be in the neighborhood of 120 to 150 meters in depth.

The floor of the upper valley is strewn with immense bowlders, some of them many tons in weight. They possess a remarkable similarity to a valley train in glaciated countries. In certain portions of the valley there are gorges smaller than the large one which follows more nearly the central line of the valley; these are along the sides, just as are usually found along the sides of glaciers.

Three distinct stages are to be noted in the history of the valley:

a. The erosion of the broad valley;
b. The filling of the broad valley;
c. The engorging of the Aglao River.

The first stage was that of normal erosion and began immediately as this area rose from the sea. The second points to submergence or sinking of the land mass and cessation of erosion. The third marks reëlevation of the land and quickening of the streams, so that they could again begin to cut.

It has occurred to me that very possibly when this region subsided, a tidal bore may have passed in and out of this valley and thus have spread the immense bowlders over the floor as we now find them. (Plate II.)

Plates III and IV are two photographs showing some interesting topographic features along the route. The formation is presumably the same as that composing Mount Pinatubo. However, as we had not time to examine the rocks very far from the trail, I shall not go any further into the discussion in this preliminary notice.

At about 440 meters' elevation the steep climb to the summit of Mount Pinatubo begins. The slopes from this elevation on to about 1,525 meters are quite bare and covered with small bowlders, but I saw no sign of volcanic ash, nor any of the usual indications of volcanic activity. Plate V shows this slope material at close range.

There is a small, conical peak to the right and the rear which is the highest point on Mount Pinatubo and of the whole range between Zambales and Pampanga. We reached the high point to the left, 1,705 meters aneroid reading, as the Negrito guide said this was the higher point, and then found a cañon of great depth and width cutting us off. As our rations were running short, we were forced to forego the additional descent and climb. We would not have gained much if we had undertaken the ascent, as the formation is undoubtedly the same on the two peaks. We could see that with a glass. Plate VI, taken from an elevation of 1,500 meters, will give some idea of the view toward the west over the route we came.

The Pinatubo rock is a feldspar porphyry. On weathered surfaces it is a dirty gray, giving a pepper and salt effect. On the fresh surfaces it is seen to be made up of idiomorphic crystals of glassy feldspar, or plagioclase, varying in length from 1 or 2 to 15 millimiters. The black mineral is usually a well-crystallized hornblende. The matrix is grayish to yellow. The rock is not firm so that it easily weathers. The hornblendes are invariably much smaller than the plagioclases. It is this rock which, disintegrating, furnishes the coarse sand of the valley and the plain.

I shall quote here a few sentences from Dr. Foxworthy's notes on the plant life on the mountain:

The soil seems to become progressively worse as one ascends the valley and trees almost entirely disappear, except at the edges of the formation along the water courses.

In the river valley itself there is, comparatively, a very rich vegetation. In the rocky bed of the main stream there are numerous *agoho* trees (*Casuarina equisetifolia* Forst.) and a good many ferns and herbs of various sorts. Wherever the valley widens out, there are found a number of tall trees of different kinds with undergrowth of wild banana, bejuco, etc.

In the small upper valleys of the small branch streams are found some tree ferns, several figs, *Dalbergia, Cratoxylon, Duabanga,* and *Vaccinum* species.

The coarse, rocky soil at the base of Mount Pinatubo contains practically no vegetation, the very small amount of grass which starts being periodically burned off by the Negritos.

The bare, burned surface of the mountain which is scarred by land slides goes up to about 1,400 meters, where the mossy forest begins very abruptly, being protected only by a narrow fringe of very coarse, reedy grasses. The lower part of the mossy forest contains a few figs and *Vaccinums* with some *Rubus* and *Deutzia* in the undergrowth. One of the few herbs is a *Carex.* Among the less common shrubs are *Cyrtandra* and *Geniostoma.* From about 1,525 meters to just about the top there is another type of vegetation. In this, *Medinilla whitfordii* Merr. with its brilliant purple flowers is the most conspicuous, and this one tree constitutes fully one-half of the flora. Interspersed with this are *Ficus, Alangium,* and *Vaccinum.* In the lower part of this range, the *Medinilla* reaches a height of about 30 feet and is a very clearly marked tree. In fact its shape is such as to give almost the effect of a formal Japanese garden. In the upper part of this range the tree is very stunted in habit, being only 1 or 1.5 meters in height.

One of the few flowering herbaceous plants found in this range is *Nertera depressa* Banks & Soland. In the more sheltered parts of this formation, filmy ferns, lichens, and mosses are very abundant.

At the summit all the woody plants are stunted in habit. *Sphagnum* and other mosses, and lichens are very abundant. Great masses of moss cover the tree trunks. Many orchids are found in this moss on the trunks, one yellow-flowered form being very abundant.

I shall conclude this preliminary note by saying that Mount Pinatubo is not a volcano and we saw no signs of its ever having been one, although the rock constituting it is porphyritic. The mountain and the surrounding country afford excellent opportunity for physiographic studies. The region is quite unique and I have seen nothing in the Philippines quite like it.

It is a matter of regret to me that I have not time now to return to it, and so for the present this preliminary account must suffice.

ILLUSTRATIONS.

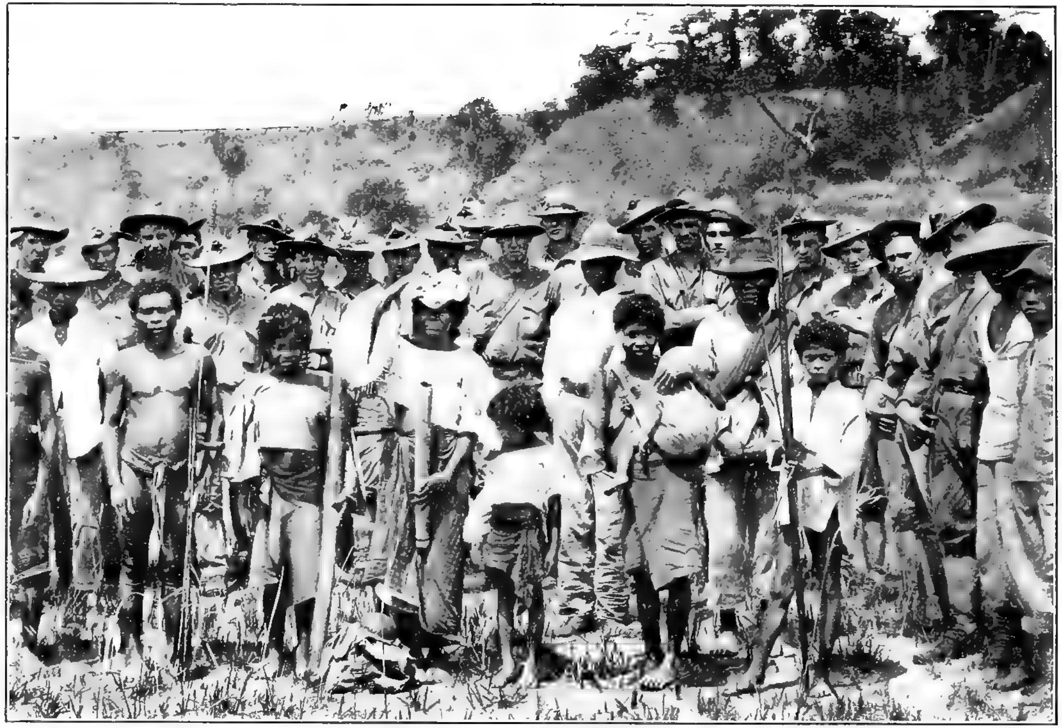


PLATE I.

PLATE II.

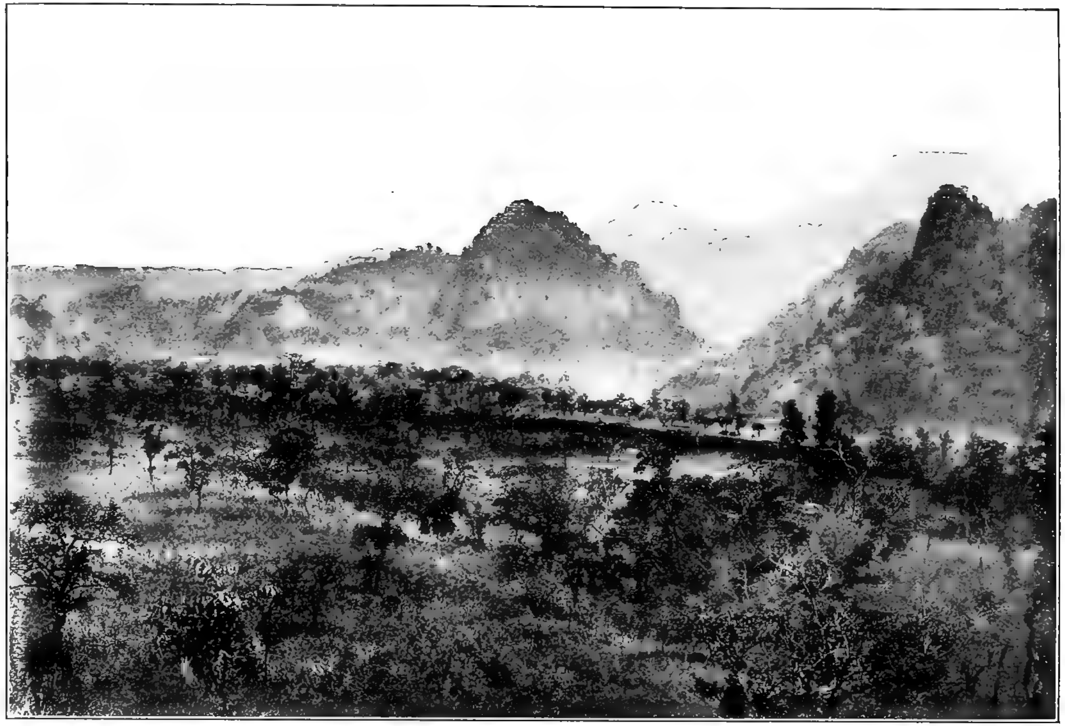
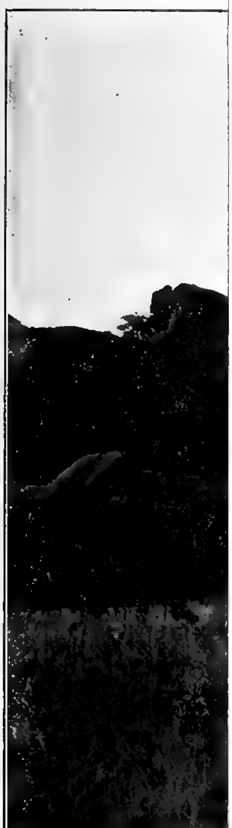


PLATE III.



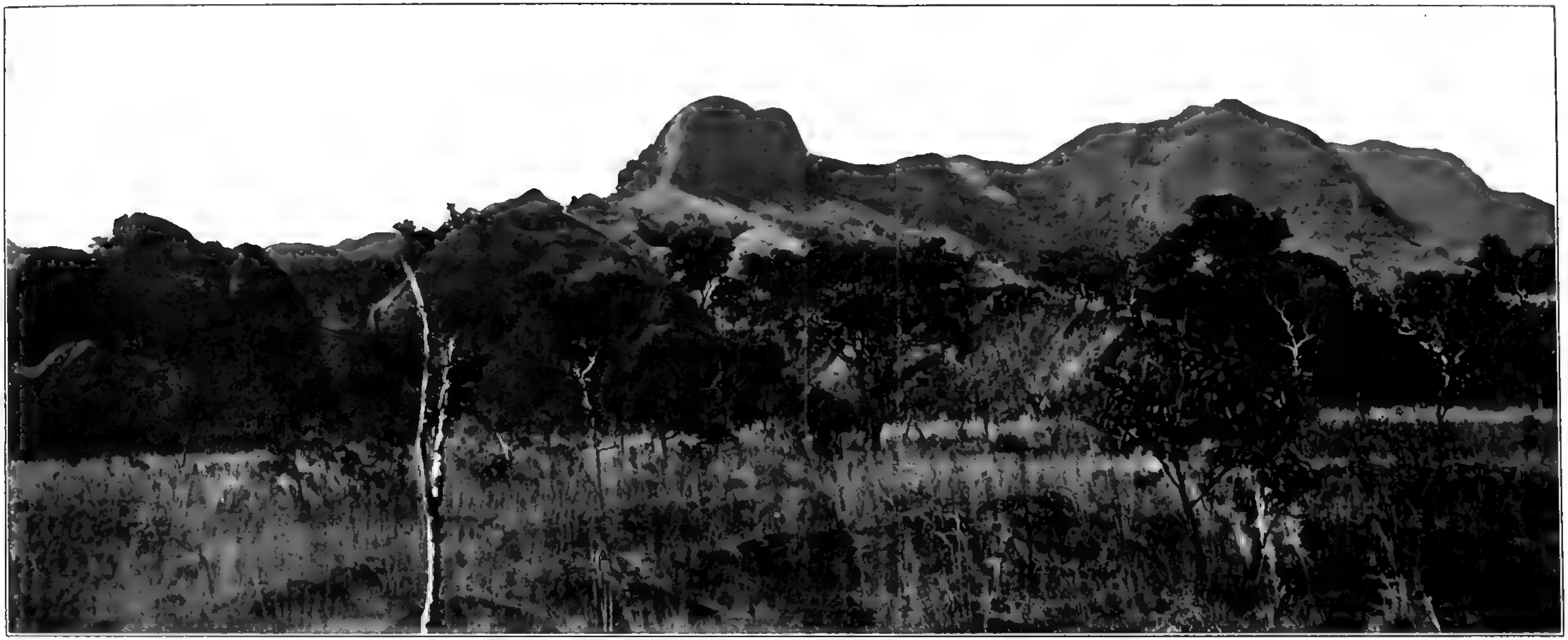


PLATE IV.

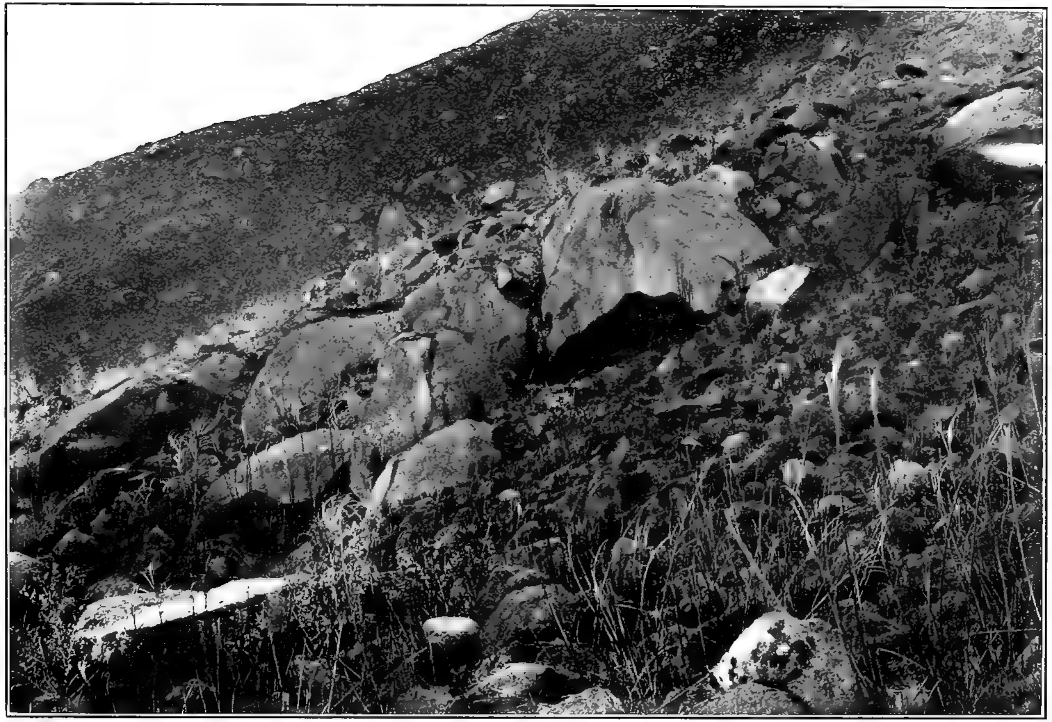
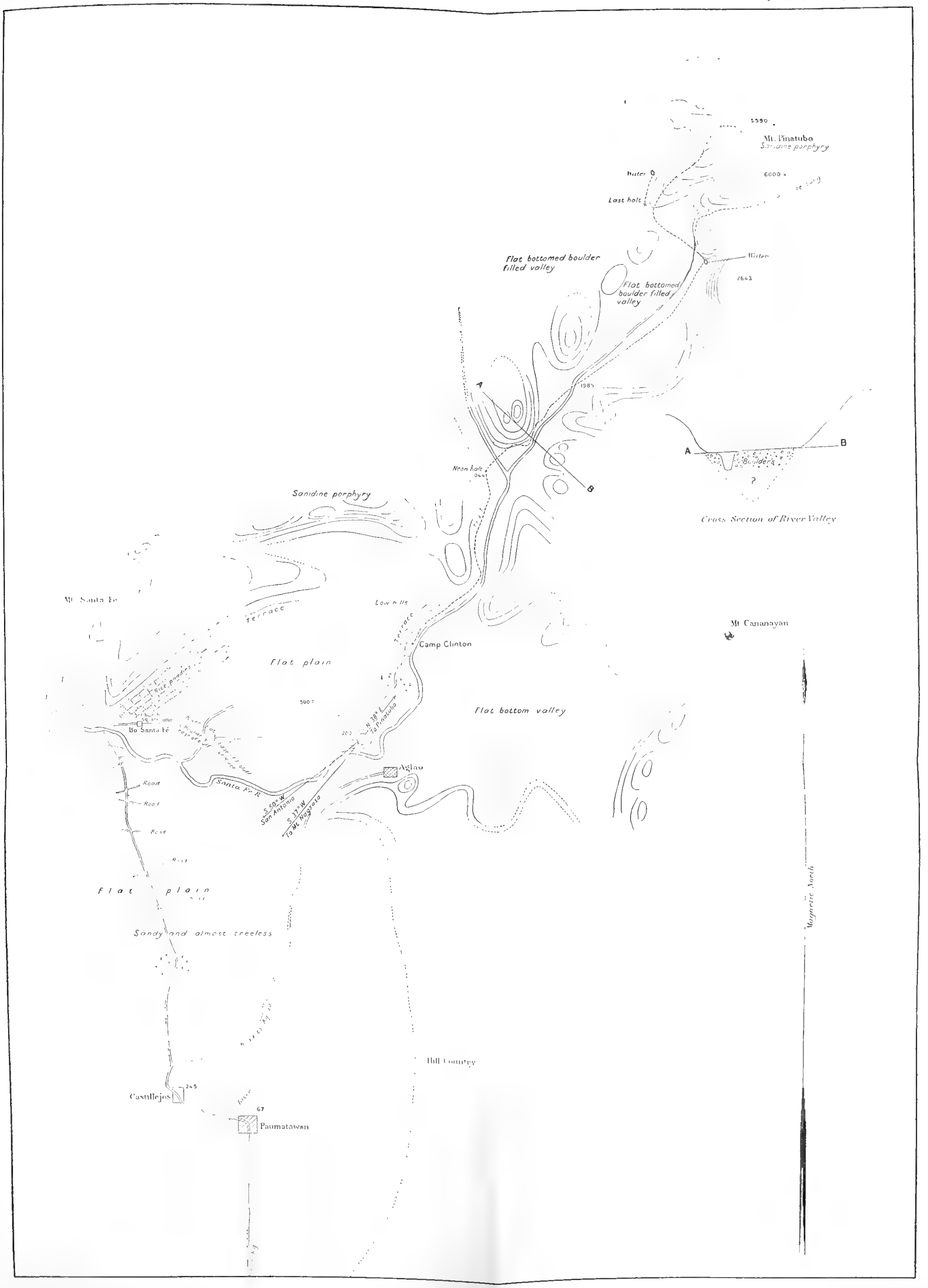


PLATE V.

PLATE VI.

Sм



Elevations on the map are in feet.

FROM COMPASS READINGS OF
SGT. STOCKEL.—2ND REG'T. U. S. M. C.
AND SKETCHES OF
W. D. SMITH, GEOLOGIST—BUREAU OF SCIENCE

April 21-23-1907

PLATE VII. MAP OF ROUTE FROM PAUMATAWAN TO MOUNT PINATUBO, LUZON, P. I.

FILIPINO EARS—A CLASSIFICATION OF EAR TYPES.

By Robert Bennett Bean.

(*From the Anatomical Laboratory, Philippine Medical School, Manila, P. I.*)

INTRODUCTION.

The cosmopolitan population of Manila affords abundant material for the study of ears of all kinds. Here, if anywhere in the world, all races and many types of mankind are represented; the white, the yellow, the red, the brown, and the black. I had previously observed ears in America and Europe for several years, and since my arrival in the Philippines, on June 29, 1907, have given particular attention to the ears of the Filipinos and the other inhabitants of these Islands. The material for this study was gathered by close inspection, sketches of dwellers in the suburbs of Manila as well as the city proper, of the Assembly, and notes made from these data and from a consideration of other collections of Filipinos. I have also included a study of the prisoners at Bilibid, the penitentiary of the Islands.

GENERAL TYPES.

Previous observations lead me to select the long ear with pendant lobule; the small, round, flaring ear, and the large, oval ear with shelf instead of lobule (three European types) as a basis for the classification of Filipino ears. Ears without lobules constitute a fourth group, and others that do not resemble any of the four have been added. After these five groups of ears have been distinguished, every individual is noted that can be observed carefully enough to be sure of the ear type. Only males are considered, although a few female Filipinos (more than 100) are also classified. The first 924 individuals are assigned to the groups just given.

Ears of adult male Filipinos.

Long	345
Oval, shelf, no lobule	86
Round, flaring	84
No lobule	122
Others	207
Total	942

The important results of these preliminary observations corroborated by further study are the facts of the occurrence of a great number of long ears and of many ears without lobules.

Karutz[1] from the literature assembles the ear length of 1,452 foreigners, to which he adds 309 further measurements on foreigners and 300 of adult men, 273 of whom are recruits of a German regiment. The results may be placed so that the longest eared people come first, each succeeding group having shorter ones than the preceding, the individuals with ears more than 6 centimeters long being termed long eared and those less than 6 centimeters short eared.

Ears of 1,452 foreigners, not German.

Long Eared.	Short Eared.
Mongolian.	Papuan.
German (Schwalbe).	Australian.
German (300 Karutz).	Negro.
Malay.	Mestizo.
Aryan.	"Niloten."
Semite.	Finn.
American.	Singalese.
	Hamites.
	Bushman.

309 further measurements.

Long Eared.	Short Eared.
Aino.	Polynesian.
Semite.	Micronesian.
Aryan.	Papuan.
Hamite.	American.
	Negro.
	Bushman.

This classification is but slightly altered when the ear length and stature or ear length and ear width are compared. The Malay is closer to the European than any of the Negroid peoples. The large number of long ears (37 per cent) encountered in the first 1,000 Filipinos examined by me indicates that the Filipino is also close to the European in ear form; and this I believe is due to the impregnation of the primary inhabitants of the Philippines by Mongolian and early European, as well as later European (Spanish) peoples. This is made clearer as the investigation advances.

The ear without lobule is present according to Karutz as follows:

Ears without lobule (Karutz.)

	Per cent.
82 Negros	36.7
55 Papuans	29
22 Micronesians	27.2
20 Polynesian	15
89 Indians	4

[1] Karutz, H. L. Ein Beitrag zur Anthropologie des Ohres. *Arch. f. Anthropol.* (1900), **27**, 732 to 746.

The same (my observations).

	Per cent.
547 Chinese	38
942 Filipinos	23

These observations may indicate Negroid affinities for the Chinese and European affinities for the Filipinos, although 20 to 30 per cent of the majority of normal Europeans have absence of lobule, and the percentage varies among Europeans from "9.2 per cent to 92 per cent." Doubtless absence of lobule is *not* a stigma of degeneration.

Five types for a new grouping are established by notes and sketches made during my preliminary observations; two from the long-eared group and one from each of the others.

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5.

FIG. 1.—Type 1 is a long, slender ear, with a straight posterior border and square lobule, the outline a parallelogram with rounded corners.

FIG. 2.—Type 2 is long and flat, with a straight posterior border, and square lower helix without lobule.

FIG. 3.—Type 3 is large and oval, with a shelf where the lobule attaches to the cheek.

FIG. 4.—Type 4 is a small, round, flaring ear, in which the lobule and superior part of the helix are symmetrical.

FIG. 5.—Type 5 is long and oval, with large helix and small lobule.

Ears that resemble any one type more than another, but are not exactly identical with it, are put into groups, six of which are differentiated:

Group 1 contains all long, slender, and heavy lobed ears.

Group 2 has long ears with no lobule and a square, inferior helix; the ear is delicately molded and oval, rounded, or irregular in its superior part.

Group 3 has small, round ears that are not always shelved.

Group 4 contains those that are symmetrically rounded, both in helix and lobule, and not always flaring.

Group 5 has ears that are large and oval, without lobules.

The groups are subordinate to the types and each contains only ears that resemble those of the type, for example: The ears of group 1 *resemble* those of type 1. Ears unlike any of the five types or the groups are included under the heading "Others."

Ears of adult male Filipinos.

Type.	Number.	Group.	Number.	Together.	Total.
1	6	1	101	1+1	107
2	25	2	282	2+2	307
3	12	3	120	3+3	132
4	20	4	83	4+4	103
5	3	5	91	5+5	94
Others	148			148	
Total	214		677		891

Type 2 is predominant and the others are each present in about equal proportions. All ear types so far considered are European and characteristic of definite somatologic types of the white man.

TYPE 1 presents itself on long, lean individuals with long heads and faces, prominent cheek bones, and usually with dark hair and eyes. This ear is designated as Cro-Magnon, because the type of man resembles the cave man of Europe.

TYPE 2 exists on medium-sized individuals of stocky build, and as it is typical of the Igorots it is designated as Igorot.[2]

TYPE 3 is found throughout middle Europe (southern Germany, Switzerland, central France) and in America along the Ohio River, in Canada, and on the shores of the Gulf of Mexico, or wherever the inhabitants of central Europe have settled. This ear is termed Alpine, from Ripley's designation of the middle European. It is associated with persons of adipose tendencies, with dark hair and eyes, and broad heads.

TYPE 4 is called Iberian, as it is found on small, dark, long-headed individuals representing the Iberian or Mediterranean race of southern Europe.

TYPE 5 occurs most frequently on tall blondes of the Nordic type of northern Europe, and for that reason is designated as Northern.

Naturally, it is surprising to find so many Filipinos with ears resembling those of the European, and in this connection emphasis should be laid upon the fact that the Filipinos examined have not been selected because of obvious European traits of physiognomy, skin color, or some other characteristic, and wherever European traits are apparent the ear of the individual is not noted. At this time, after the second thousand observations have been completed, at least two additional types stand out as predominently Filipino. These I designate as Negroid and Malay.

The Negroid ear is small, somewhat pentagonoid in shape, and without lobule. The Malay ear is small and round with a small lobule which forms a horizontal shelf, the helix often appears as if double rolled by the eversion of the edge of the concha (anthelix), and the upper and lower parts of the helix flare slightly. These two types impress themselves upon the majority of Filipino ears, even when the latter resemble European types.

One more type is selected in addition; a large, well-rounded ear with heavy

[2] Bean. The Benguet Igorots. *This Journal, Sec. A.* (1908), **3,** 413.

lobule and broad helix; distinctive of a European type that may be known as the box-headed, big-cerebellumed Bavarian of Ranke, which I designate as B.B.B. Another Iberian ear, named Iberian *b* also occurs; this has no lobule, flares upward, and has an everted concha at its outer border (anthelix), especially below.

After the above classifications were completed, the haunts of the average Filipino were again invaded and a third set of observations recorded. This time an endeavor was made to separate the masses into classes by registering pedestrians in one list and those seen in street cars and carriages (not the common street cart) in another. Only pure-type ears are recorded; no ears that show mere resemblances are tabulated; those that are not of one type or another are put under "Others."

Filipino ears.

Pedestrians.		Riders.		Totals.	
Type.	Number.	Type.	Number.	Type.	Number.
Negroid	108	B. B. B	104	B. B. B	149
Malay	88	Igorot	69	Negroid	137
Igorot	60	Alpine	52	Igorot	129
B. B. B	45	Cro-Magnon	30	Malay	104
Cro-Magnon	30	Negroid	29	Alpine	70
Iberian *a*	27	Iberian *a*	25	Cro-Magnon	60
Alpine	18	Malay	16	Iberian *a*	52
Iberian *b*	7	Iberian *b*	5	Iberian *b*	12
Others	195	Others	85	Others	280
Total	578		415		993

The totals indicate four ear types as characterizing the Filipino, and four others are not infrequently found. Six of these are European and two are not (Negroid and Malay). The inference can be drawn that the Filipinos of Manila and vicinity are more European than otherwise. The two groups, pedestrians and riders, separate the poorer classes from the well-to-do, and a notable difference in the relative number of ears of the different types in the two groups is observed. Among the pedestrians the Negroid and Malay, whereas among the riders the B. B. B. and Igorot ears predominate. These four ear types are of considerable significance. The B. B. B. and the Igorot ears are probably derivatives of the same original type, and the Negroid and the Malay are similarly related to each other. The fact that the couples of ears are so different enhances the interest attached to them. The Igorot and the B. B. B. ears are large and long, the Negroid and the Malay are small and round or pentagonoid. The Igorot and the B. B. B. ears have no rolled-in rim to the helix, the Negroid and the Malay have an inrolled rim, almost double rolled, due to the eversion of the anthelix.

The Igorot and the B. B. B. individuals are medium sized and stocky, with large, long, square heads; the Negroid and the Malay are small and spare or fat, with small, short, round, or oval heads. The Igorot and the B. B. B. are European types, the Negroid and the Malay are not.

INDIVIDUAL TYPES.

Having determined that European ear types with characteristic morphology pertaining to definite somatologic types of men are present to a large extent among Filipinos, and that other morphologic ear forms belonging intrinsically to the Filipinos are also present, material is at hand to enable us to find the type of Filipino to which each ear type appertains. This is done by confining observations to one type at a time, noting the characteristics of each individual on whom the particular ear type under consideration is found.

The majority of observations were made while walking with the crowd, driving with them, circulating among them, or while riding on street cars, because in this way each individual can be examined for a greater length of time than when the observer is standing to watch them as they pass. Each type was observed during the same length of time, over the same territory, and as far as possible with the same individuals, but the aggregate varied slightly from week to week.

The observations show in general the relative number of each type present in the population, and in this way are a check on previous work. Individuals of all nationalities are included with the following results:

Individual types of ears.

Negroid	194
B. B. B.	167
Alpine	115
Malay	108
Iberian *a*	105
Cro-Magnon	101
Igorot	73
Iberian b	18
Northern	10
Total	891

The Negroid and the B. B. B. ear have changed places but still head the list, the Alpine goes up and the Igorot down, and the Iberian *a* rises above the Cro-Magnon, which is itself above the Igorot. The Northern ear is so seldom seen that it may be neglected in considering the Filipino. The changes mentioned are due in a large measure to the inclusion of European in this classification, especially the American and Spanish. Details of the individual types are as follows:

THE NEGROID EAR.

The Negroid ear is small, somewhat pentagonoid in shape, and without lobule. It often presents a wrinkled appearance about the helix, which folds over almost to the concha; the superior border passes abruptly from the head in a horizontal direction and often joins the posterior border in the formation of a point. The posterior border is straight and appears as if it had been amputated and healed, leaving a scar that has drawn the ear while contracting. The lobule is usually absent or minute in size, the inferior border of the helix passing diagonally downward and inward to the jaw. The individuals on whom this ear is found are almost invariably small, slender, wide nosed, with oval head, straight, black hair, brown eyes, and brown skin, but three tall Filipinos and four short, stocky Filipinos are noted with Negroid ears.

THE MALAY EAR (PLATES I, II, III, AND IV).

The Malay ear is small and round with small lobule, double-rolled helix, and a slight flare at the top and at the bottom. The superior part of the helix often slants slightly downward from where it joins the head and terminates in a small, flat lobule which is horizontal. The concha is large and its edge (anthelix) frequently runs parallel to the helix which gives the appearance of a double roll. The Malay ear appears on at least four groups of Filipinos, all of whom are similar in physical attributes. The individuals are usually small, round headed, wide nosed, and dark skinned, but the following variations appear.

The Malay ear (adult males).

Slender, small, short	45
Heavy, small, short	46
Heavy, medium size	11
Heavy, small, old leather skins	4
Mestizo short	1
Chinese, short	1
Wavy or curly hair	26
Straight hair	82
Total	108

The hair form with a Mendelian proportion indicates that the kinky hair of the Negrito is recessive to the straight hair of the Malay, because the ear resembles the Negrito ear,[3] and the two types are closely related in physical characteristics.

[3] Bean, *loc cit.*

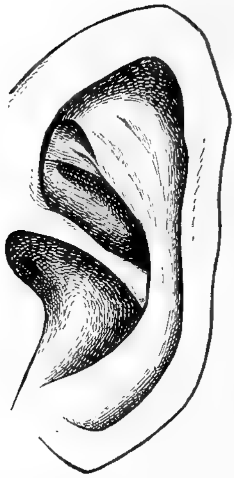


FIG. 6.—The Negroid ear. Filipino; sketch from life.

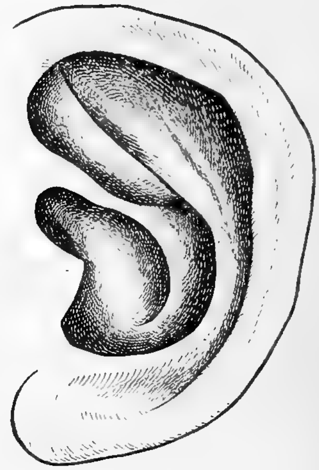


FIG. 7.—The Malay ear. Filipino; sketch from life.

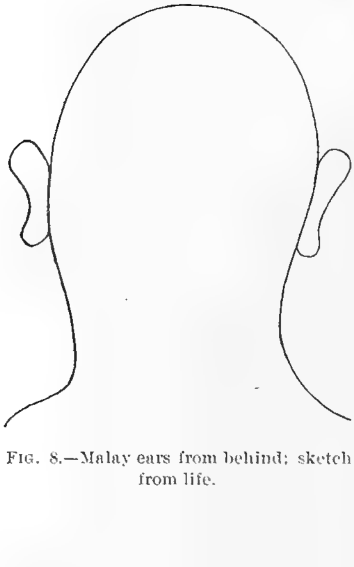


FIG. 8.—Malay ears from behind; sketch from life.

FIG. 9.—The B. B. B. ear. European; sketch from life.

THE B. B. B. EAR (PLATE VI).

This type of ear is smooth, well rounded, clear cut, and even in shape. The helix is rolled above, but flat below, the lobule is flat and broad, although it may be round or pointed. The concha is open, large, and oval, without rounded rim, and the area between the concha and helix is smooth and flat. The ear usually lies close to the head, without any evidence of flaring; it is often square, with rounded corners. The individuals on whom it is most frequently found are medium sized or large, square set, stocky, with a tendency to obesity. The heads are large and oblong in shape. This is one of the most characteristic Spanish types, but is almost universal, and I believe it will be found throughout Europe, Africa, and the East. The ears are located by nationality as follows:

The B. B. B. ear (adult males).

Filipino	108
American	36
Spanish	19
Chinese	3
Mestizo	1
Total	167

Twelve of the Americans are blonde, 1 is redheaded, and 23 are brunette or mixed, with dark hair and light eyes.

Five of the Filipinos are small and stockily built and the remainder are as described above for the type. All have light brown or yellow skins and straight, coarse, black hair, brown eyes, and large, straight, high noses.

THE IGOROT EAR.

This ear has been described by me in another publication.[4] Here it suffices to detail the characteristic individuals on whom it is found. Many are heavy set and stocky, similar to the B. B. B. type, but some are tall. The Chinese present an ear type of great frequency which is similar to that of the Igorot. However, the lobule of the Chinese ear is at right angles to the head, whereas that of the Igorot is more frequently somewhat flattened against it. The ear appears by nationality as follows:

The Igorot ear (adult males).

Filipino	50
Mestizo	9
American	5
Spanish	3
Chinese	2
Japanese	4
Total	73

[4] *Loc. cit.*

FIG. 10.—The B. B. B. ear. Mestizo; sketch from life.

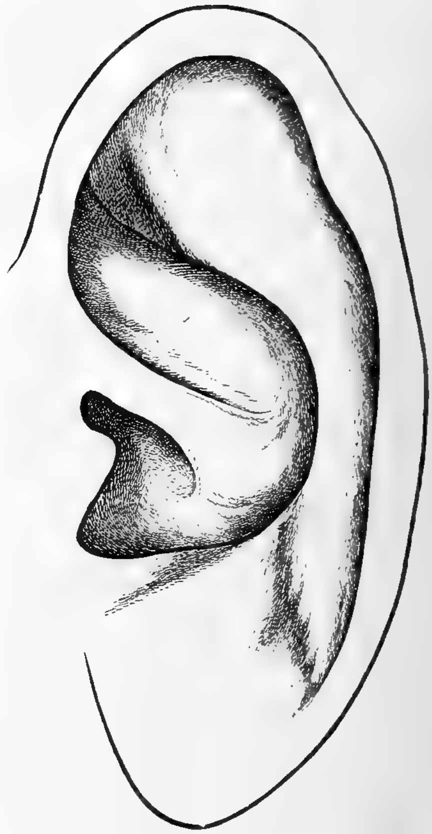


FIG. 12.—The Cro-Magnon ear. Filipino; sketch from life.

FIG. 11.—The Alpine ear. Mestizo; sketch from life.

FIG. 13.—Cro-Magnon, Filipino; sketch from life.

All individuals are similar to the B. B. B. except two Filipinos, 7 mestizos, 1 Spaniard, and 1 Chinaman, who are tall.

After careful study I am convinced that the Igorot ear is a modified form of the B. B. B. ear. As such it is well represented by a large element of the priesthood of the Philippines, by Japanese, and by Chinese types similar to the Igorots.

THE ALPINE EAR (PLATE V).

The Alpine ear is the ear of the *fat* man. It is large, round, or oval and without lobule. The helix is continuous around the ear to the lower margin, where it turns forward to terminate in the anthelix and cheek, and thus forms a shelf which is supported by the part of the ear that should be the lobule, but is firmly attached to the cheek. The concha is large and open.

The Alpine ear is related to the B. B. B. on the one hand and to the Malay on the other. The three types shade into each other insensibly. The individuals also resemble each other in size, head shape, and general appearance, which may mean that blending has taken place by continual contact of the types, or that the one is *developed* from the other, the B. B. B. from the Alpine which in turn is derived from the Malay.

Individuals with Alpine ears are usually portly, though not above medium height. They have round heads, flat and broad behind. Their features are full, with especially well-developed parotid glands that may influence the appearance of the ear by everting the lower portion of it. They walk largely along the easy ways of life and frequent the sunny paths.

The Alpine ear is found equally among mestizos and the dark-skinned Filipinos. Its frequency is as follows:

Alpine ear (adult males).

Small, short, fat, stocky, dark skinned Filipinos	46
Large, fat, yellow or white skinned mestizos	39
Short, fat, Spanish	9
Short, fat, American	8
Short, fat, Chinese	2
Tall Filipno	5
Tall American	4
Tall Spanish	1
Tall Chinese	1
Total	115

The jolly, fat, Spanish friar, the American salesman, the French good fellow, the charming celestial all have ears belonging to this type. Music and oratory live in their souls and they constitute to a great extent members of orchestras, bands, and legislative bodies.

THE CRO-MAGNON EAR (PLATE VII).

This ear is the true long ear. It is symmetrical around the base and has a helix and lobule that are equal in size and shape at the two extremities. The descending part of the helix or dorsal border of the ear is straight or gently curved, and is a narrow, round roll, neither broad nor flat. The lobule is large and hangs low to a rounded point. The concha is oval, elongated, and often reaches almost to the helix. The ear stands out well from the head, often at right angles. The individuals to whom this ear is attached are tall brunettes with dysharmonic physiognomy (long head and broad face). They often have a peculiar, wrinkled appearance as if they had dried up and their skin had been left in loose folds. The nose is large and heavy looking. Occasionally an individual with all the appearances of this type except the tall stature may be seen, particularly among the Filipino women.

The following individuals were observed with the Cro-Magnon ear:

The Cro-Magnon ear (adult males).

Tall Filipino	46
Medium Filipino	12
Small Filipino	12
Tall American	13
Tall mestizo	8
Tall Spanish	7
Tall Chinese	3
Total	101

One Filipino with ears resembling the Cro-Magnon, who is tall, rawboned, long headed, big nosed, and wide faced, with square jaws, flaring ears, and hipsistenocephalic head presented an appearance so unusual that I made a hasty sketch on the spot which gives the effect, if not the exact details of the physiognomy. Many individuals similar to this may be seen in the Philippines. (Fig. 13.)

THE IBERIAN EAR. (TYPE *a*) (PLATE VIII).

This ear is round or slightly elongated and stands out from the head. The crest of the helix (superior border) is symmetrical with the lobule; and the whole of the helix is a large, round roll, not flat, sometimes resembling the Malay ear and again the Cro-Magnon. The concha is often slightly everted at the inferior part so that the antitragus projects, carrying with it the lower portion of the anthelix, in this way resembling the Iberian type *b*.

The men of the Iberian type *a* are small, slender, delicately molded, with long heads, black hair and eyes, high, thin, "Roman" noses, and hatchet faces, long and thin, with pointed chin. Among the Filipinos, of course, this type has been modified so that the characteristics are less marked, although occasionally there are true Iberians under brown skins.

Sometimes the men of this type are tall, but in such cases the type is usually not Iberian *a* but Iberian *b*.

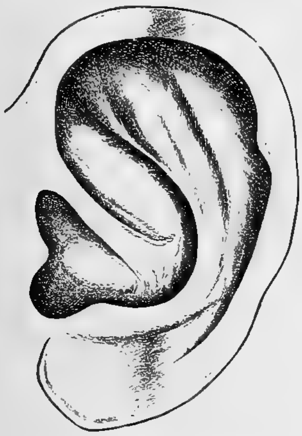


FIG. 14.—The Iberian ear, type *a*. European; sketch from life.

FIG. 15.—The Iberian ear, type *b*. American; sketch from life.

FIG. 16.—The Sub-Northern ear. Chinese: sketch from life.

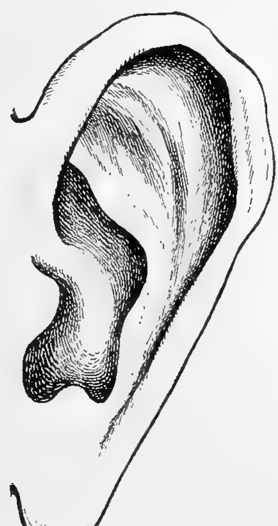


FIG. 17.—The Northern ear. American; sketch from life.

THE IBERIAN EAR (TYPE *b*) (PLATE IX).

This ear is somewhat long and slender, the crest of the helix projects upward and backward; there is no lobule, the lower border of the helix passing diagonally to be joined firmly to the cheek. The eversion of the antitragus and inferior concha is one of the most characteristic features of the ear. The edge of the helix is usually small, thin, and round, and the space between the helix and anthelix is broad above and narrow below, where they come almost into contact.

The men of the Iberian type *b* are almost invariably tall, but otherwise resemble the men of the Iberian type *a*, except that the head is higher and not so long. Among Europeans they may be blonde or brunette.

The following individuals are noted with Iberian ears:

Iberian ears (adult males).

	a	*b*
Small Filipino	68	....
Small Spanish	17	....
Small mestizo	6	....
Small American	1	....
Small Chinese	1	....
Small Japanese	2	....
Tall Filipino	5	7
Tall mestizo	4	2
Tall Chinese	1	....
Tall European	....	3
Total	105	12

THE NORTHERN EAR.

The Northern ear is seldom seen upon a Filipino, but is often found on Chinamen, as noted later.

The Northern is a long, oval, flaring ear with slender helix and small lobule. The distance between the helix and anthelix is great above and small below. The concha is irregularly oval in shape and the antitragus is sometimes slightly everted, thus resembling the Iberian ear. Europeans with this ear are tall and blonde with long heads, and these characteristics, except the coloring, impress themselves upon the Chinese and the Filipinos who have the Northern ear.

Northern ear (adult males).

Tall mestizo	5
Tall American	3
Tall Filipino	1
Tall Chinese	1
Total	10

AN ODD TYPE.

Once, when riding through Malate on the street car, I was startled by seeing an old Filipino with a most peculiar ear. The old man was small, slender, wizened, and almost baldheaded, with skin like old, washed leather. He had a short, flat nose, broad upper lip, and projecting jaws. His head sloped almost directly from heavy brow ridges to the wide parietal region, being narrow in front and flat on top and behind. The ear was triangular in shape, straight out from the head above, and from the upper border the helix passed diagonally downward and inward to the cheek, where it was firmly attached without intervening lobule. The upper border of the ear presented the form of a scroll as indicated by sketches hastily made at the time. (Fig. 19.)

Since then I have seen six men of similar type, although not so pronounced in the physical characteristics. I am inclined to believe this is an aboriginal and not a pathologic type, because the Malay and Negroid ears, although different in detail resemble this ear in some particulars. These three types of ears resemble one form of Negro ear in America as portrayed by Hrdlicka.[5]

FIG. 18.—Negro ear (Hrdlicka); copied from photograph.

FIG. 19.—An odd type. Filipino; schematic sketch from life.

[5] Hrdlicka, A.: Anthropological Investigations on One Thousand White and Colored Children of Both Sexes. The Inmates of the New York Juvenile Asylum.

BLENDED EARS.

Blends of infinite variety are continually noticed, and many ears are of such a nondescript character as to be difficult of classification. The European types of ears found upon the Filipinos resemble closely the corresponding European types, although the skin of the Filipino with European ears may be brown, and other characters of the Filipinos are not so truly European as the ears. This indicates that pure types of ears do not blend so readily as other characters, such as skin color, and the European ears grafted on the Filipino remain true to type, but slowly taking on the characteristics of the native as generations pass.

CHINESE EARS (PLATE X).

The Chinaman's ears are more largely European than those of the Filipino, and the same European ear types appear among the Chinese as among the Filipinos, although among the Chinese the European ear types are not so distinctly European as among the Filipinos. Judged by ear types the Chinese are more completely amalgamated than the Filipino and they have a larger proportion of European elements fused into their composition. The majority of the Chinese noted are in the shops along both sides of Calle Rosario and vicinity. The following table gives the types of Chinese ears observed:

Chinese ears (Adult males).

Negroid	107
Alpine	71
Igorot	46
B. B. B.	39
Northern	31
Sub-Northern	64
Iberian *a*	31
Malay	29
Iberian *b*	18
Cro-Magnon	14
Others	97
Total	547
No lobule	199
Long ears	213
Short ears	185

Among the Chinese, as among the Filipinos, the Negroid ear predominates, which points to a common origin for a portion of the two peoples. The Northern and Sub-Northern types appear frequently among the Chinese, but are rare among the Filipinos. The Sub-Northern ear is a characteristic Chinese ear and it is called Sub-Northern because it occurs on tall, long-headed Chinamen, with long, narrow faces. It stands almost at right angles to the head in its lower half, which is oblong and similar to the lobe of the Igorot ear or of the B. B. B., except that these two are usually parallel to the head, or at a more acute angle than 90 degrees.

The types of Chinamen corresponding to the ear types are in all particulars (with slight differences) like the types described under Filipino ears. A greater number of Chinese than of Filipinos are tall, and not so many of the Chinese are stocky. The relative proportion of each type among the two peoples may be of interest.

Chinese versus Filipino ear types, by percentages.

Type.	Filipino number.	Chinese number.
B. B. B	15	7
Negroid	14	20
Igorot	13	9
Malay	10	5
Alpine	7	13
Cro-Magnon	6	2
Iberian *a*	5	5
Iberian *b*	1	4
Others	29	19
Northern		5
Sub-Northern		11
Total	100	100
No lobule	23	38
Long ears	37	40

The Chinese have a greater percentage of Negroid, Alpine, Iberian *b*, Northern and Sub-Northern ears, and ears without lobules; the Filipinos have a greater percentage of B. B. B., Igorot, Malay, and Cro-Magnon ears, and each people has an equal number of Iberian *a* ears. The number of long ears is great in both people, but slightly less among the Filipinos. It is not possible to know from a random sample of the population that the types are present in the exact proportion designated, but the presence of the Igorot, the Malay, and the B. B. B. (Spanish) types in the Philippines among the non-Christian tribes leads me to believe that the three types are more frequent among the Filipinos than among the Chinese.

SPANISH EARS.

The ears of the Spaniards in Manila are largely of two types, the Iberian *a* and the B. B. B., although the Alpine ear is of frequent occurrence, but partakes of the characteristics of the B. B. B., with which it is blended so that the line of demarkation is slight. The Cro-Magnon ear must claim attention also because of its frequent occurrence.

Spanish ears.

B. B. B.	52
Iberian *a*	48
Alpine	33
Cro-Magnon	25
Iberian *b*	13
Igorot	11
Northern	2
Others	21
Total	205

The individual physical characteristics of the men agree with previous descriptions of the physical types; the ear type and the physical type coincide more nearly than among the Filipinos. The types of ears and of individuals are purer among the Spanish than among the Chinese or the Filipinos because there is no confusion of Negroid and Malay among the Spanish. There is more or less blending of the different types so that an Iberian ear may resemble the Igorot or Cro-Magnon, or one of the other types, but is none the less distinctly Iberian in character. So with the other types. The Iberian and Cro-Magnon are more often similar to each other than to other ears and the Alpine and B. B. B. are in the same category. The Northern ears are not found among the Spanish on blondes, but on brunettes. The "others" are composites or blends of the various types. The Igorot ear is European, as it is found on Spaniards.

EAST INDIAN EARS.

The ears of a few Indian merchants on the Escolta were examined, also the ears of a few Sikh night watchmen. The latter are all except two (7–2 =5) Cro-Magnon ears. The two are divided into one B. B. B. and one belonging to the class termed "others."

Adult male East Indian ears.

B. B. B.	9
Cro-Magnon	7
Iberian *a*	6
Igorot	5
Malay	2
Others	4
Total	33

One important feature of the Indian ears is the remarkably pure European types among them, purer than the Chinese or the Filipino. The skin of the Indians is usually darker than that of the other two peoples, but their features are more like the European than are those of the Chinese or Filipinos. It is to be noted that only four European types occur among the Indians, but the whole number might reveal more of other types. If one may reason from so small a number, and the purity of ear type and physical type make it justifiable, there appear to be Europeans under brown skins among the Indians, and occasionally a Malay is found. The brown skin could be due to implantation of the European on the Negrito and persistence of the brown color by selection aided by the tropical sun; the European traits to early prehistoric migrations of white men from Europe. The mingling of the European and Negrito resulted in the retention of useful characters, the color of the Negrito and the form of the European.

FEMALE FILIPINO EARS.

The difficulty of observing the ears of the women because of the hair renders the collection of data limited and not easy, therefore only 144 individuals are noted.

Adult female Filipino ears.

Negroid	48
Malay	18
Chinese [Sub-Northern[	16
Cro-Magnon	16
Igorot	14
B. B. B.	10
Alpine	7
Iberian	0
Others	15
Total	144

The female ear is esentially long, longer than that of the male, and the lobe is more pendent. There are 56 long ears and 25 short ears among the women, besides the Negroid ears which are longer for the women than for the men. Absence of the Iberian ear may be significant, or it may be because so few individuals were observed. The accumulated evidence indicates that some of the precursors of the present Filipinos were long eared and the long-eared precursors were Mongolians and Europeans. The Cro-Magnon, the Sub-Northern, the Igorot, the B. B. B. ears are long ears; the Malay and the Iberian are short ears, also the Alpine and Negroid. If the women represent the primary stocks and the men represent the invaders, then the primary stocks had less Iberian and Alpine, more Negroid and Cro-Magnon than the invaders, and Iberian and Alpine ears are more recent grafts on the Filipino than Negroid and Cro-Magnon. In other words, there were more Negroid and Cro-Magnon elements among the peoples of the Philippines before the Spanish came, and the Spanish introduced among the Filipinos a greater proportion of Alpine and Iberian than had previously existed.

THE MORPHOLOGY OF THE FILIPINO EAR.

The morphological differences in the types of Filipino ears are of significance if our present knowledge of the developmental history of the ear is accepted to indicate that the human ear is undergoing retrogade metamorphosis.

Schwalbe[6] demonstrates the similarity of the ear of human embryos at 4 to 6 months intra-uterine life to the ear of *Macacus rhesus* and *Cercopithecus engythita*, one of the chief points of resemblance being the absence of the inrolled rim of the helix. This author further states (p. 188): "Vom 8 Monat an beginnt ein Reduktionsprozess der Ohrfalte, welcher sich im wesentlichen in Einrollung des Oberrandes und stärkerer Ausbildung des Anthelix Systems ausprägt." When the adult human ear has attained its full maturity, the rim of the helix has rolled inward and forward, and the tip of the ear forms Darwin's tubercle. The extent of inrolling of the helix marks the grade of development and evolution of the ear, hence the age in the world's time of the ear type.

The types of ears under observation may be conveniently grouped into three classes:

1. Old types which have much inrolled helices, and everted anthelices.
2. Intermediate types which have rolled helices but not so marked as in old types, and
3. New types with slightly rolled helices and depressed anthelices resembling the ear of the embryo.

The Negroid and Malay ears are old types, the Cro-Magnon and Iberian ears are intermediate, the Igorot and B. B. B. ears are new types. The others are mixed, intermediate, and new. By this criterion the Filipinos are older than the Chinese, Indians, or Spanish because they have older ear types, at least a greater proportion of Filipinos than of the other peoples have old ear types. Portions of the Filipino, Chinese, and Indian populations have old ears and portions have new and intermediate forms, therefore, the three peoples were originally of the same stock, and have since received similar infusions of new stocks, although in varying proportions as regards type.

BILIBID TYPES (SEE TABLE AT END).

The inmates of Bilibid Prison are of two kinds—local, short-term prisoners, or those from the neigborhood of Manila who are serving terms of less than five years; and general, long-term prisoners, or those from all parts of the Philippine Islands except a part of the Moro dominions, who are serving terms of five years or over. The latter are representative

[6] Schwalbe, G., Das Darwinsche Spitzohr beim Menschlichen Embryo.—*Anatomischer Anzeiger*. (1889), 4, No. 6, 176 to 189.

Filipinos of the lower class, and for that reason I examined a large number of their ears with the following results:

Bilibid adult male Filipino ears.

Malay	160
Negroid	98
Cro-Magnon	61
Alpine	56
B. B. B.	40
Iberian *a*	31
Igorot	26
Iberian *b*	8
Others	386
Total	866

It must be said that this classification is somewhat misleading when compared with previous classifications because the prisoners are very rarely pure types, and those classed as Cro-Magnon, Alpine, B. B. B., Iberian *a* and *b* and Igorot have ears that merely resemble these types, and show traces of other characters. The large number of "others" indicates that many ears are unclassifiable in classes selected. Many—probably the majority—of "others" are blends of the various types, but some are types not yet described. Seventy-three of the "others" resemble the Chinese ear with large, flaring lobule (Sub-Northern).

The Bilibid types should be compared by percentages with the pedestrians of a previous classification (page 31) since they both represent Filipinos of the lowly walks of life.

Ears of Bilibid prisoners and Manila pedestrians, by percentages.

Type.	Pedestrians.	Prisoners.
Negroid	18	11
Malay	15	18
Igorot	10	3
B. B. B	8	5
Cro-Magnon	5	7
Iberian *a*	5	4
Alpine	4	6
Iberian *b*	2	1
Others	33	45
Total	100	100

The significant feature of this comparison is that the percentages are nearly equal in the two groups, although there is a greater per cent of Malay and others and a smaller per cent of Negroid, Igorot, and B. B. B. among the prisoners than among the pedestrians. When the prisoners are contrasted with the riders of a previous classification (page 31) the similarity is not so great.

Ears of Bilibid prisoners and Manila riders, by percentages.

Type.	Riders.	Prisoners.
B. B. B	24	5
Igorot	17	3
Alpine	12	6
Cro-Magnon	7	7
Negroid	7	11
Iberian *a*	6	4
Malay	4	18
Iberian *b*	1	1
Others	22	45
Total	100	100

The difference between these two groups is that the European types of Filipino constitute 65 percent of the riders whereas the Malay, Negroid, and others, constitute 74 percent of the prisoners. The Filipino prisoners of Bilibid are less European in their composition than the riders of Manila, and more like the pedestrians, but they have even less European than the pedestrians.

Photographs of inmates of Bilibid Prison selected to represent the various types are reproduced, and may be examined by reference to Plates IV to X. The photographs for Plates I, II, and III were made by Mr. Martin, of the Bureau of Science, the remainder by the official photographer at Bilibid Prison. The drawings throughout this work were executed by Mr. W. Schultze, of the Biological Laboratory, who has my sincere thanks for his personal attention to their production.

SUMMARY.

The Chinese, the Indian, the Manila rider, the Manila pedestrian, and the long-term Bilibid prisoner represent groups of men undergoing the process of fusion of similar elements and each group is a different stage of transition in the fusion process. The long-term Bilibid prisoners have less European elements than the other groups, and the European is more obscurely mixed; the Chinese have less Malay than the other groups and the European elements predominate, obscuring the remainder. Between the Chinese and the long-term Bilibid prisoners the other groups have variable proportions of the different elements, but the Indians, the Manila riders and pedestrians represent more recent minglings of the types than the Chinese and Bilibid prisoners. Among the first three groups the engrafting of Europeans is more recent than in the last two, therefore the blending has not advanced so far and more definite European types are encountered, but in the last two groups it is more difficult to detect pure European types, although the majority of the Chinese resemble Europeans more than do the majority of the prisoners.

Among the prisoners there is evidence of at least four old types besides the European types of more recent date (neolithic and later). The four are the Malay, Negroid, Cro-Magnon, and a type similar to the odd type previously described. This odd type impressed itself on the Filipino ear to a large extent by the absence of lobule, the horizontal superior border to the helix, and the flare of the ear, but the type itself is extremely rare. The following scheme seems plausible: This odd form, represented in the earliest inhabitants of the Islands, was superseded by the Cro-Magnon type and later in conjunction with another primitive European type, the early Iberian mingled with the Negrito and peopled the Islands to some extent. Still later another infusion of fused Europeans (Iberian, Alpine, B. B. B.) and Negritos came into the Islands, and these mingling types produced the Bilibid prisoner. In more recent times the modern European has impressed the Filipino, especially in the vicinity of Manila, and produced the pedestrians and riders. According to my scheme for heredity [7] the three groups of Filipinos, riders, pedestrians, and Bilibid prisoners, represent three successive stages in the blending of the European and the Filipino. The riders are in the stage of beginning blending, where the pure types persist; the pedestrians are in a stage farther advanced although a few pure types still appear; and the Bilibid prisoners are in the stage of a variable blend with all shades of intervening variations between the types, but no pure types.

The Indians are in a stage close to that of the riders where the blend is progressing, but the pure types persist, whereas the Chinese are more advanced than are the Bilibid prisoners toward a complete blend, with a much larger proportion of European than any of the Filipino groups, and probably more than the Indians; but the Chinese are composed of European types some of which are different from those that have blended in the Indian and Filipino.

If similarity of ear form indicates the degree of relationship, then on the one hand the Malay type is related to the Negroid, which is related to the Alpine, which is related to the Igorot, which is related to the B. B. B.; and on the other hand, the Malay is related to the Iberian *a*, which is related to the Iberian *b*, which is related to the Cro-Magnon, which is related to the Sub-Northern, which is related to the Northern. These relationships may indicate the relative order of the types in evolution, or what is more probable, the degree of intimacy or time of contact of the types, hence the amount of blending. The types "on the one hand" are different from the types "on the other hand."

The ear types, Malay, Negroid, Cro-Magnon, etc., may not be characteristic of the Malay, Negro, and Cro-Magnon man, etc., but all the types portrayed in this paper are definite types of ears and they are found on definite physical types of men.

[7] *This Journal, Sec. A.* (1908), 3, 215.

INFERENCES.

Types of human ears are established for the first time, and each ear type is associated with a physical type of man.

The majority of Filipino ears examined in Manila and vicinity are similar to European ears, but the majority of Filipino ears examined in Bilibid Prison on long-term inmates from all parts of the Islands except the Moro Province are not so much like European ears.

The types of ears not of European origin are morphologically older than the European ears.

The Spanish population of Manila has ear types which are closely simulated in the European types among the Filipinos.

The Chinese influence on the Filipino is evident in ear form as in other characters.

Prehistoric Europeans have probably affected the Filipino ears to some extent.

Chinese and Indian ears exhibit types similar to those of the Filipino, but different from them because of the difference in time during which the amalgamation has progressed, and because some of the types entering into the composition of one people are not found in the others.

The Chinese ears are longer than the European, Filipino, or Indian, probably because the Chinese population is composed more largely of the long-eared European types (Northern, Sub-Northern, Cro-Magnon).

Ear type seems to be independent of pigmentation to some extent, because the same type of ear is found on blonde and brunette Europeans, on dark-skinned and light-skinned Filipinos, and on dark-skinned Indians and light-skinned Chinese.

TABLE I.—*Types of Bilibid prisoners.*

No.	Nativity.	Age.	Term of imprisonment.	Stature.	Reach.	Trunk.	Head length.	Head width.	Bizygomatic.	Ear length.	Ear type.
2040	Iloilo	32	10 years	144							Alpine.
2150	Cebu	22	22 years	156							Cro-Magnon.
2276	Manila	22	16 years	156							Alpine.
2802	Ilocos Sur	23	30 years	167							Northern.
3202	Tayabas	31	25 years	167	177	88	18.8	15.3	14.6	7	Cro-Magnon.
3426	Laguna	26	20 years	168							Iberian *b*.
3851	Isabela	28	10 years	171							Do.
3865	Samar	20	12 years	147							Malay.
3958	Leyte	18	25 years	162							B. B. B.
4012	Bohol	28	20 years	160							Alpine.
4048	Bulacan	25	do	166							Iberian *a*.
4367	Manila	46	12 years	161							Cro-Magnon.
4843	Pangasinan	18	do	142							Negroid
5013	Batangas	59	Life	166							Cro-Magnon.

TABLE I.—*Types of Bilibid prisoners*—Continued.

No.	Nativity.	Age.	Term of imprisonment.	Stature.	Reach.	Trunk.	Head length.	Head width.	Bizygomatic.	Ear length.	Ear type.
5017	Mindoro	19	Life	153	----	----	----	----	----	----	Malay.
5060	Laguna	20	20 years	157	----	----	----	----	----	----	Iberian *a*.
5334	Iloilo	36	do	158	----	----	----	----	----	----	Negroid.
5450	Misamis	28	30 years	157	----	----	----	----	----	----	Iberian *a*.
5453	do	28	do	157	----	----	----	----	----	----	Malay.
5517	Iloilo	19	20 years	150	----	----	----	----	----	----	Do.
5701	Laguna	56	do	162	----	----	----	----	----	----	Cro-Magnon.
5715	Batangas	45	10 years	166	176	88	18.7	15.6	14.8	6.4	B. B. B.
5770	Samar	35	14 years	138?	----	----	----	----	----	----	Malay.
5909	Antique	35	12 years	155	161	84.6	18.9	15	14.4	5.6	Do.
5936	Nueva Ecija	26	8 years	158	164	84.3	17.7	15.2	14	6	Alpine.
5958	Manila	41	Life	173	171	91.5	19.5	15.4	14	6.9	Cro-Magnon.
5970	Laguna	44	do	172	172	95.2	18.9	16.1	15.2	6.6	B. B. B.
6161	Leyte	18	25 years	156	164	86	17.6	15	15	5.5	Malay.
6260	Ilocos Sur	20	7 years	169	174	89	18.6	15.2	13.7	6.4	Alpine.
6278	Leyte	25	25 years	161	168	86.5	17.6	16.2	14	6.4	Negroid.
6328	do	31	20 years	166	177	86.2	17.9	14.8	13.7	6.3	Malay.
6511	Manila	28	7 years	169	173	87.7	18.6	15.1	14.2	6.7	Cro-Magnon.
6534	Leyte	21	20 years	149	154	82.6	18.4	15.5	13.6	6	Iberian Malay.
6610	Nueva Ecija	28	9 years	169	173	90.1	17.7	15.1	13.7	6	Iberian *a*.
6742	Laguna	23	6 years	156	160	84.7	17.8	15	14	5.8	Malay.
6747	Cavitè	31	Life	166	----	----	----	----	----	----	
6749	do	29	do	156	160	81	17.4	14.4	13.9	5.3	Iberian *a*.
6930	Bulacan	27	16 years	164	172	85.3	19.4	15.6	14	5.8	Mestizo.
6985	Pampanga	46	18 years	171	178	93	18.1	14.3	14	7.5	B. B. B.
7100	Borongan	25	20 years	148	155	80.7	18.2	15.7	14.3	5.8	Malay.
7156	Pangasinan	38	Life	167	174	90.5	17.6	16	14	6.8	Sub-Northern.
7218	Capiz	38	12 years	162	164	85.3	17.3	14.9	13.2	6.3	Alpine.
7264	Tayabas	19	20 years	152	161	82.1	17.3	14.8	13.3	6.2	Malay.
7306	Samar	20	17 years	152	155	82	16.9	15.6	14	5.6	Negroid.
10279	Rizal	22	(?)	165	174	86.3	17.9	14.8	18	4.7	Iberian *b*.
13020	Albay	23	4 years	165	177	86.5	19.1	16.1	14.2	6.2	Alpine.
13120	Bulacan	18	2 years	151	154	82	17.4	15.2	13.3	5.6	Iberian *a*.
13734	Cebu	31	do	157	162	87.4	18.5	16.3	14.3	6	Alpine.
13885	Negros	29	do	152	155	83.6	17.4	14.7	13.9	5.5	Malay.
14085	Manila	19	1 year	150	150	83.5	19.8	13.1	13	5.8	Iberian Malay.
14183	do	20	6 months	165	174	86.3	17.9	14.8	13	4.7	Iberian *b*.
14202	Bulacan	18	2 years	151	154	82.1	17.4	15.2	13.3	5.6	Iberian *a*.
14499	Manila	44	1 year	157	163	89	19.7	15	14.2	6.9	B. B. B.
14583	Nueva Ecija	31	4 months	167	174	87.8	18.8	15.4	14.2	7	Sub-Northern.
14655	Laguna	30	4 years	159	163	86	18	15.4	13.7	5.7	Iberian *a*.
14783	China	32	6 months	----	----	----	----	----	----	----	Sub-Northern.
14811	Manila	25	2 months	159	164	86.5	18	15.2	14	7.1	Alpine.
14857	Ambos Camarines.	53	4 years	153	155	84.5	19.1	15.4	13.5	6.7	Cro-Magnon.
14867	Manila	35	2 months	160	166	88	18.6	14.7	14	6	Do.
14882	Samar	30	2 years	159	163	87.5	18.2	15.6	14.6	5.9	Negroid.
14957	Manila	40	3 months	165	170	88.2	18.5	15.3	14.6	7	Cro-Magnon.
14964	China	41	1 month	----	----	----	----	----	----	----	Do.
15006	Bulacan	18	4 months	168	170	89.3	18.2	15.1	13.4	6.1	Iberian *a*.

TABLE II.—*Averages for the various types of Bilibid prisoners.*

Ear type.	Number.	Age.	Stature.	Ear length.	Head length.[a]	Head width.	Cephalic index.	Bizygomatic.
Cro-Magnon	10	41	163	6.7	18.9	15.2	80	14.2
Iberian *a*	11	23	157	5.8	18	14.9	83	13.5
Iberian *b*	4	24	167	4.7	17.9	14.8	83	13
Malay	12	25	153	5.8	17.9	15	84	14
Negroid	5	26	157	6	17.6	15.8	90	14.2
Alpine	9	27	159	6.3	18.2	15.3	84	13.9
B. B. B	5	39	166	6.9	18.9	15.3	81	14.6

[a] The head length is measured from the nasion to the maximum occipital protuberance.

ILLUSTRATIONS.

PLATE I.

PLATE II.

PLATE III.

PLATE IV.

PLATE V.

PLATE VI.

PLATE VII.

PLATE VIII.

PLATE IX.

PLATE X.

TWO NEW SPECIES OF SNAKES FOUND IN THE PHILIPPINE ISLANDS.

By LAWRENCE E. GRIFFIN.
(*From the Department of Biology, Philippine Medical School.*)

In the collection of reptiles in the museum of the Biological Laboratory, Bureau of Science, are two species of snakes belonging to the genus *Dendrelaphis,* which appear to be new. Their descriptions follow.

Dendrelaphis caeruleatus sp. nov.

Maxillary teeth 18 or 19. Eye as long as its distance from the nostril (a little longer in young specimen). Rostral broader than deep, barely visible from above; internasals three-fourths as long as the prae-frontals; frontal once and a third as long as broad, as long as its distance from the end of the snout (longer in young specimen), shorter than the parietals; loreal twice as long as broad; one prae- and two post- oculars; temporals 2+3; nine upper labials, fifth and sixth entering the eye; five lower labials in contact with the anterior chin shields, which are considerably shorter than the posterior. Scales in 13 rows. Anal divided.

Dark brown or nearly black above; a very indistinct black stripe on each side of the head, passing through the eye; lower surface of the head cream-yellow; upper lip splotched with blue and cream-yellow, outer rows of scales and ventrals blue, slightly tinged with green; a narrow black line along the outer edge of the subcaudals and posterior ventrals; a black median line along the lower surface of the tail. When the scales of the upper surface are rubbed off the underlying skin is of a dull blue color.

Museum.	Number.	Locality.	When collected.	Collector.	Total length.	Length of tail.	Scale rows.	Ventrals.	Anals.	Subcaudals.	Temporals.	Supra-labials.
					Mm.	*Mm.*						
Bureau of Science	a	Siquijor	Mar., 1908	A. Celestino	840	225	13	173	2	104	2+2	9
Bureau of Science	b	Banton	Aug. 2, 1905	A. Celestino	1,055	287	13	186	2	105	2+2	9

Dendrelaphis fuliginosus sp. nov.

Maxillary teeth 18. Eye as long as its distance from the nostril. Rostral broader than deep, barely visible from above; internasals a little shorter than the prae-frontals; frontal once and a half as long as broad, longer than its distance from the end of the snout, a little shorter than the parietals; loreal elongate; one prae- and two post-oculars; temporals 2+2; nine upper labials, fifth and sixth entering the eye; five lower labials in contact with the anterior chin-shields, which are shorter than the posterior. Scales in 13 rows. Anal divided.

Uniform seal-brown above, shading into a slightly lighter shade beneath, upper lip and lower surface of head and throat fuscous. Scarcely visible traces of a black median line along the lower surface of the tail; a faint dark stripe on each side of the head and neck, passing through the eye; a lighter spot on each supra-ocular and near the posterior edge of each parietal.

Museum.	Number.	Locality.	When collected.	Collector.	Total length.	Length of tail.	Scale rows.	Ventrals.	Anals.	Subcaudals.	Temporals.	Supra-labials.
					Mm.	*Mm.*						
Bureau of Science	a	Negros	1902	C. S. Banks	350	90	13	179	2	105	2—2	9

THE FISHERY RESOURCES OF THE PHILIPPINE ISLANDS: II. SPONGES AND SPONGE FISHERIES.

By Alvin Seale.

(*From the Section of Fisheries, Biological Laboratory, Bureau of Science.*)

INTRODUCTION.

The past year has marked the opening of the Philippine sponge fisheries from a commercial standpoint, some thirty thousand sponges having been shipped from the Islands during the year. The greater part of these were sold in Singapore for export to London. Philippine sponges are new products to the trade and many of them are slightly different from those usually handled and therefore the prices obtained varied greatly, in some instances, no doubt, being below the real value of the export.

Specimens of all the different varieties of Philippine sponges at present obtainable were taken to the United States and shown to Dr. H. F. Moore, of the United States Bureau of Fisheries. They were compared with specimens from Florida, Cuba, and the Mediterranean. After this the same specimens were taken to some of the largest wholesale sponge dealers in New York and San Francisco, who examined them with great interest, suggested commercial names for those new to the trade, and so far as possible, gave quotations of prices of sponges of the latter class among the samples. The facts I have so far collected are given below.

SPONGES IN GENERAL.

A sponge when in its native state (see Pl. I) closely resembles a boiled plum pudding covered by a thin, dark skin. It is quite different in appearance from the ordinary sponge of commerce which is merely the bleached skeleton of the animal.

Sponges are usually classed by themselves in the faunal subkingdom *Porifera;* most of the sponges belong to the division *Keratosa;* the great majority of the Philippine forms to the genus *Euspongia.*[1]

[1] It is intended in a later paper to give a small check list with the scientific names of all the Philippine sponges.

All of the several varieties of soft sponges found in the Philippines are of more or less commercial value. In addition to these, an almost unlimited variety of silicious sponges is encountered; the fiber of these is now being used in some countries as a substitute for asbestos.

PHILIPPINE SPONGES OF COMMERCIAL VALUE.

THE SHEEP'S-WOOL SPONGE (PLATE II).

The sheep's-wool sponge is the most valuable variety found in the Philippines. It has a strong, elastic fiber, resembling in every respect the well-known sheep's-wool or bath sponge of Florida and it probably grows to about the same size. The only place where this sponge at present is known to occur in the Philippines is at Siasi, but doubtless it will also be found around Tawi-Tawi. It would be to the advantage of those interested in sponging to give particular attention to the finding and developing of these sponges, as they are well-known to the trade, are always in demand, and the supply is becoming limited. There would be no difficulty in marketing any quantity in the United States or Europe where the product would bring from 8 to 20 pesos (4 to 10 dollars, United States currency) per kilo in wholesale lots. The specimen figured is of second grade and the price quoted by the largest New York dealer was ten pesos per kilo.

THE PHILIPPINE ZOMOCCA SPONGE (PLATE III).

This is a very tough, elastic sponge of moderately coarse fiber, usually rather flat in shape. The organisms grow in shallow water of 1.2 to 2 meters' depth, on a hard rock bottom. Specimens 30 centimeters in diameter are frequently found. This sponge seems to be intermediate in grade between the sheep's-wool and grass sponges; some of the dealers classing it with the former and others with the latter. All admit it to be different from any of the American forms. Dr. Moore considered it to be the best among those submitted to him and suggested the name "flat bath sponge" for it. However, a comparison with a large number of European sponges on the market induced me to follow the suggestion of one of the sponge dealers and term it the Philippine Zomocca sponge because it most nearly resembles the well-known commercial form, the European "Zomocca."

This sponge is found in considerable numbers in the waters around Tawi-Tawi and the nearby islands; in deeper water, it will be of better quality. In all probability it occurs near other islands of the Archipelago.

The Philippine Zomocca sponge would find a ready market both in the United States and in Europe, the wholesale price quoted being from two to six pesos per kilo.

THE PHILIPPINE ROCK SPONGE (PLATE IV).

No commercial name exists for this organism. It resembles the Florida yellow sponge to a certain extent, but the fiber is not as strong and the texture is considerably softer. It is very porous and covered with small tufts. It grows attached to bowlders and rocks in water of 1.5 to 5 meters in depth, reaching a diameter of 40 centimeters. Some of the dealers whom I consulted designated this as a good sponge; others considered it to be almost worthless. As a matter of fact it is not very durable and therefore would probably not bring a large price. It is only known from the Island of Sitanki, but it probably will be found throughout the Sulu group.

THE PHILIPPINE REEF SPONGE (PLATE V).

This is a beautiful sponge of very soft, closely woven fiber; unfortunately it is quite fragile. This fact greatly detracts from its value; however, it is of a slightly better quality than the majority of American reef sponges. This specimen was termed "glove sponge" by some of the wholesale dealers of New York, but reef sponge is undoubtedly a better name. It is quite abundant in many places in the southern Philippine Islands, especially so at Sitanki, where it is found in very shallow water, usually growing on the reefs among the moss and seaweed. It reaches a diameter of 20 to 25 centimeters. It is a fine, soft, bath sponge, but because of its fragile nature its period of usefulness is short. Considering its abundance, cheapness, and the ease with which it is gathered, the probabilities are that it will play an important part in the Philippine sponge industry.

The prices quoted on this sponge ranged from 2 to 3 pesos per kilo.

PHILIPPINE GRASS SPONGES (PLATE VI).

The group of grass sponges which embraces a variety of forms representing distinct genera, contains the great majority of sponges found in almost all Philippine waters; they are especially abundant at Sitanki, Tawi-Tawi and Siasi to the south, and at Masbate and Cebu farther to the north. In these places they outnumber all the other sponges combined. They are usually encountered on reefs, in water of from 40 centimeters to 1.5 meters in depth. They are from 8 to 30 centimeters in diameter.

The best grade of Philippine grass sponge (shown by Pl. VI) is of a closely woven, fine, and soft texture; it is in every respect most desirable for bathing or general use. More than thirty thousand of these sponges were taken from the beds at Sitanki during the past year, but many were of very small size and also poorly cleaned, so that the price obtained was very low. Wholesale dealers gave the value of my specimen at 2 pesos 40 centavos per kilo for the best quality and 40 centavos to 1 peso for the smaller kind, although I have seen sponges of the same classes marked in the retail trade at from 50 cents to 2 dollars, United States currency, each. The Philippine grass sponge, in comparison with any of the American or Cuban varieties, is regarded by wholesale dealers as being softer and stronger and of a better grade. It is probable that when these sponges are better known the price will be materially increased.

THE PHILIPPINE SILK SPONGE.

A small variety of the grass sponge, usually of 10 to 15 centimeters in diameter is frequently associated with the preceding variety. It is characterized by an extremely soft, silky texture; in fact it is the softest sponge found in the Islands. Acting upon the suggestions of sponge dealers I have decided to designate it as the Philippine silk sponge. The silk sponge has been taken in shallow water at Tawi-Tawi and Sitanki and it will also probably be found near several other islands. It would be very useful as a toilet sponge for infants and should bring a slightly better price than the ordinary grass sponge.

THE SULU SEA BATH SPONGE (PLATE VII).

This is a grass sponge of very coarse, tough fiber. It is quite common near Sitanki in water of from 1.3 to 2 meters in depth; it attains a diameter of 60 centimeters or more. No sponges exactly like the Sulu Sea sponge are taken in the American fisheries and therefore the large dealers were not inclined to consider it at its full value, mainly, I believe, because of lack of familiarity with it. One dealer believes that to a certain extent it resembles the Florida yellow sponge, but it is tougher than the latter, and contrary to what might be expected, holds water well.

It could be used as a bath or horse sponge, for cleaning carriages, automobiles, large guns, or mortars, or as a stiffening for various fabrics.

The prices given for this variety are only 40 to 60 centavos per kilo, but these are probably much below the true value of the sponge and much less than they will be when it becomes known to the trade.

THE PHILIPPINE ELEPHANT'S-EAR SPONGE (PLATE VIII).

This is a true elephant's-ear sponge, but specimens so far examined do not seem to have the thickness of the Mediterranean variety; however, those secured from a depth of 15 to 30 meters are thicker and have a softer texture. The Mediterranean elephant's-ear is in great demand and brings high prices, and the Philippine variety from deep waters should compare favorably with it.

This sponge is used by glazers, and as padding in the more expensive racing saddles. The market seems to be almost entirely European, and no quotation of prices could be secured in the United States, because of the very small and unsatisfactory specimen in my collection. This sponge is found in many localities throughout the Sulu Archipelago, but it seems to be especially abundant in the vicinity of the Island of Sulu. The pearl divers frequently bring up fine specimens.

THE TUBE SPONGE (PLATE IX).

This is a peculiar sponge found in the shallow waters at Sitanki. It is of very little if any commercial value, but as sponges are becoming rarer each year and as even the smallest clippings are being utilized, it may in time come about that even this sponge will have a value.

THE PREPARATION OF SPONGES FOR THE MARKET.

The sponges are first placed in their normal position, on a platform, the deck of a vessel, flat rock, or any place where they will not become filled with sand or dirt. They are left in the sun for two or three days until killed. They are then placed in a corral (usually built at the edge of the water), where they will be covered with water; they are squeezed out from time to time and allowed to remain in this place for from five to six days, large sponges requiring more time than the small ones. The shorter the time in which they are macerated in the corral, the better for the sponges, the object being to keep them in the water only for a sufficient period to permit them to be squeezed out and cleaned easily. The corral may be constructed of any size and in almost any manner, the object being to keep the sponges covered with salt water and free from dirt. If the enclosure is made simply by driving stakes in the ground, it is best to put in a floor of bamboo or boards to keep the sponges off the bottom and thus prevent them from rotting. Mr. John Byersdoffer, of Sitanki, constructs a floating enclosure of boards and slats with cracks sufficiently wide to permit the water to enter freely. (Fig. 1.) The box is about 4 meters long, 2 meters wide,

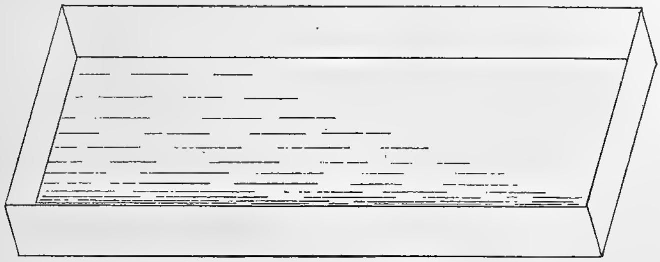


Fig. 1.

Fig. 2.

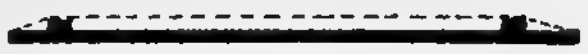


Fig. 3.

and 1.5 meters deep. Its advantages are that it keeps the sponges clean and it may be towed to any place; its own weight sinks it sufficiently to keep the sponges under water.

The cleaning is greatly facilitated by frequently squeezing out the sponges and a flat paddle of considerable weight may be used with good effect. (Fig. 2.) A washboard made by tacking a cleat 2 centimeters thick about 8 centimeters from each end of a wide board and then stretching galvanized wire netting of 2 centimeters' mesh over the cleats, tacking it to the ends of the board, is very useful. (Fig. 3.) This instrument is especially useful to remove the dead, black skin from the sponges. After five or six days in water, during which time the sponges have been thoroughly squeezed, they are washed out in clean, salt water and put in the sun to dry. They should still be kept in the same position in which they grow, otherwise they are apt to burn and become red. However, the red color should not be confused with that which many sponges naturally show in the center of their structure. The sponges may be strung on stout twine about two meters in length to facilitate handling them rapidly. Salt water only is used in curing. After the sponges are thoroughly dry they are ready to sack or bale for market. Great care should be taken that the sponges are thoroughly dry and clean, as the Philippine sponge can only obtain the best market if it is always shipped as a thoroughly cured, cleaned article.

BLEACHING SPONGES.

Sponges are always shipped to the general market in an unbleached condition, but the following method by R. F. Bacon, of the chemical laboratory, Bureau of Science, is very effective, doing the least damage to the fiber:

> The sponges are placed in a saturated solution of potassium permanganate for two minutes, then transferred to fresh water and thoroughly washed. They are then squeezed out in a 10 per cent solution of sodium bisulphite until white; then again thoroughly washed in fresh water until all the chemicals are removed. They are afterward dried in the sun.

CULTIVATION AND GROWING OF SPONGES.

The growing of sponges for commerce has become established and it promises to result in a profitable industry.

Sponges are reproduced from eggs and by budding. The eggs are formed and fertilized within the body of the sponge; they develop into minute, free-swimming forms which are thrown out into the water through the large openings. After about twenty-four hours the young settle, become attached, and grow into separate sponges. Reproduction by budding, however, is the method taken advantage of in growing sponges from cuttings. The sponge should be placed on a wet board, or better still, kept under water and cut with a very sharp knife into cubes of about 5 centimeters, care being taken to keep on as much of the thin, black skin as possible and not to squeeze the animal. These pieces are then placed on a thick, copper wire, about 4 centimeters apart, the wire being fastened to stakes at each end and about 15 centimeters above the bottom. (Fig. 4.) It is quite possible that rattan would do

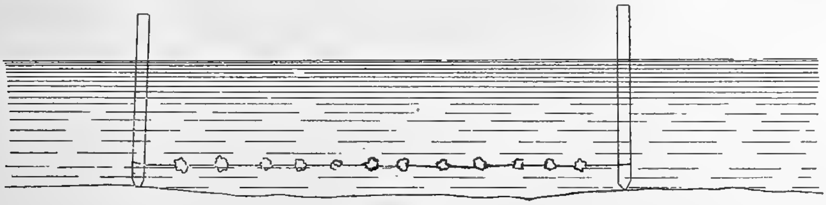


FIG. 4.

as well as copper wire; bamboo has been used with fair results. Within a day or two the sponges become attached to the wire and grow into fine, round organisms which have a much better shape than those growing naturally. These slips planted in Florida waters reached a marketable size in less than two years. The time required for them to grow in the Philippines is not known.

Sponges should always be propagated in water in which they grow well naturally and at about their normal depth. It is probable that improved varieties can be cultivated by uniting cuttings of superior sponges, and some of the best grade of European sponges might even be introduced with advantage.

It is my firm conviction that by care and work, not only in growing sponges, but by opening new beds, and fishing in deeper waters, a sponge industry amounting to several hundred thousand pesos per year may be built up in the Philippines.

Regulations governing the gathering of sponges in the waters of the Moro Province were passed in June, 1908, and copies of these regulations may be obtained from the Secretary of the Moro Province at Zamboanga.

LITERATURE.

The following is a very incomplete list of literature dealing with sponges, chiefly of this or related regions:

CARTER.

Descriptions of Sponges from the Neighborhood of Port Philip Heads, South Australia, *Ann. & Mag. Nat. Hist.* (1885), V, **16**, 277, 347; (1886), V, **17**, 40, 112, 431, 502; (1886), V, **18**, 34, 126.

Contributions to our knowledge of the Spongida, *Ibid.* (1883), V, **11**, 344; (1879), V, **3**, 343; (1875), IV, **16**, 126, 177; (1882), V, **9**, 266, 346; (1869), IV, **3**, 15; (1873), IV, **12**, 17; (1872), IV, **9**, 82; (1883), V, **12**, 308; (1879), V, **3**, 284; (1876), IV, **18**, 226, 307, 388, 458.

Denby.
The Sponge-fauna of Madras, *Ibid.* (1887), V, **20**, 153.
Report on a Second Collection of Sponges from the Gulf of Manaar, *Ibid.* (1889), VI, **3**, 73.
Report on Sponges of Ceylon, in Report on Pearl Oyster Fisheries of the Gulf of Manaar, Pt. III, Supplementary Reports (1905), **18**, 57 to 246.
Gray.
Notes on the Arrangement of Sponges, with the Description of Some New Genera, *Proc. Zoöl. Soc.*, Lond. (1867), 492.
Haeckel.
Die Kalkschwämme, 1872.
Hyatt.
Revision of the North American Poriferæ, *Mem. Boston Soc. Nat. Hist.* (1875), **2.**
Lindenfeld.
A Monograph of the Australian Sponges, *Proc. Linn. Soc.* N. S. W. (1883), **9**, 121, 310; (1884–85), **10**, 283, 475, 481, 485.
Descriptive Catalogue of the Sponges in the Australian Museum, Sidney, London, 1888.
Poléjaeff.
Report on Keratosa. Collected by H. M. S. Challenger, 1884.
Report on the Carcarea. Collected by H. M. S. Challenger, 1883.
Ridley.
Spongiidæ. Report on the Zoölogical Collections Made in the Indo-Pacific Ocean During the Voyage of H. M. S. Alert, Brit. Mus. 1884.
Schulze.
Die Familie Spongidæ, *Zeit. f. wiss. Zoöl.* (1879), **32.**
Smith.
The Florida Commercial Sponges, *Bull. U. S. Fish Com.* (1897), **17**, 225 to 240. Pl. 12 to 31.
Wilson.
The Sponges Collected in Porto Rico in 1899, *Ibid*, (1900), **2**, 375.
On the Feasibility of Raising Sponges from the Egg, *Ibid* (1897), **17**, 241 to 245.

WHOLESALE SPONGE BUYERS.

For the benefit of those interested directly in the sponge industry I am appending a list of some of the sponge buyers in the United States who would be glad to correspond with those who have sponges for sale:

Lasker & Bernstein, 161 William St., New York City.
Coffin, Redington, Co., 35 Second St., San Francisco.
Langly & Michaels Co., San Francisco.
American Sponge Co., 127 Larkin St., San Francisco.
A. Isaacs & Co., Beatman St., New York City.
Leonis Clonney & Co., 39–41 Walker St., New York City.
Smith, Kline & French, Philadelphia, Pa.
James H. Kohds & Co., 117 E. Kinzie St., Chicago, Ill.
Meyer Bros., Druggists, St. Louis, Mo.
The Greek American Sponge Co., Chicago, Ill.
John K. Cheyney, Tarpon Springs, Fla.

ILLUSTRATIONS.

81630——5

PLATE I.

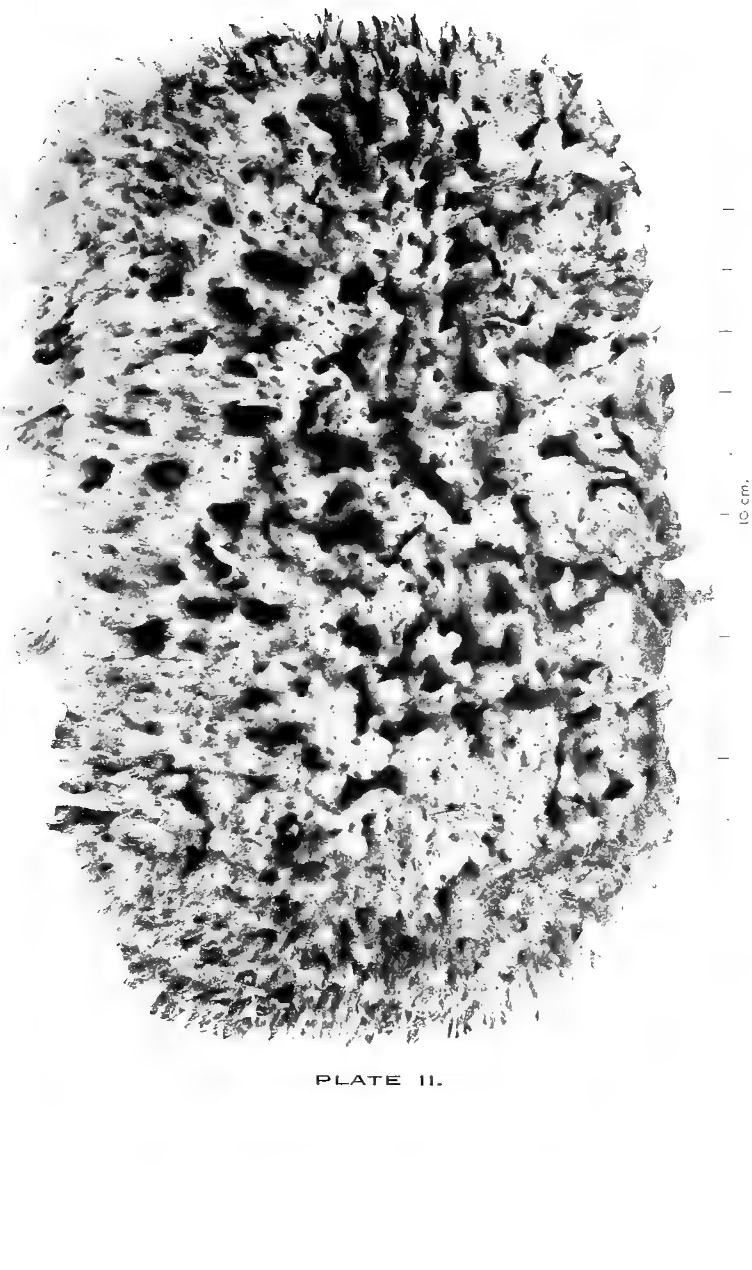


PLATE II.

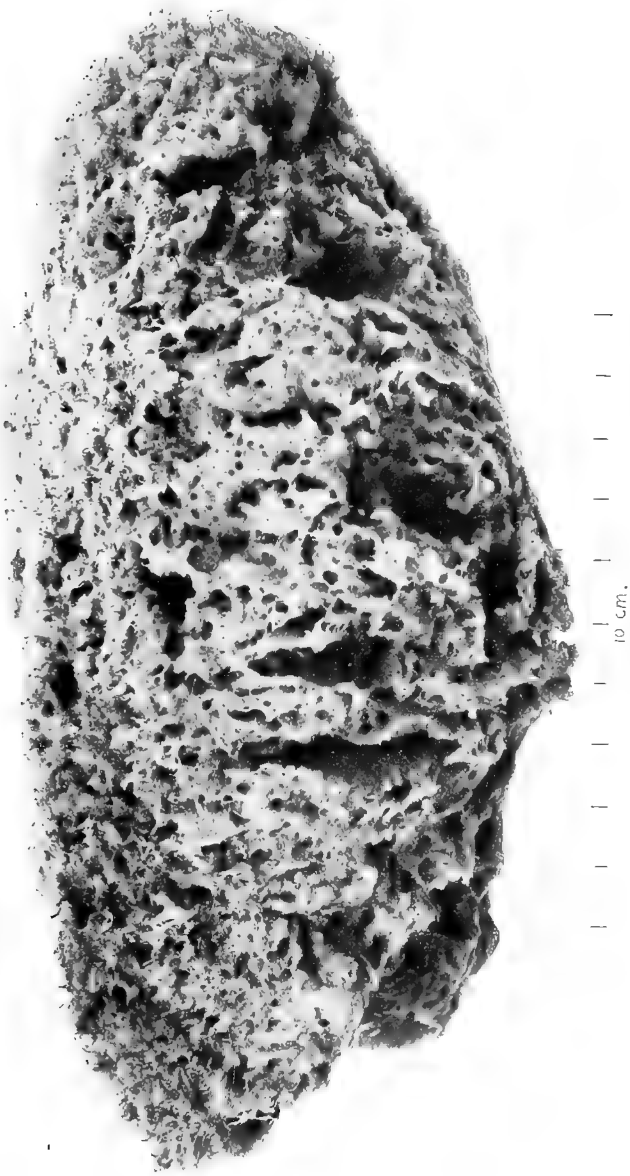


PLATE III.

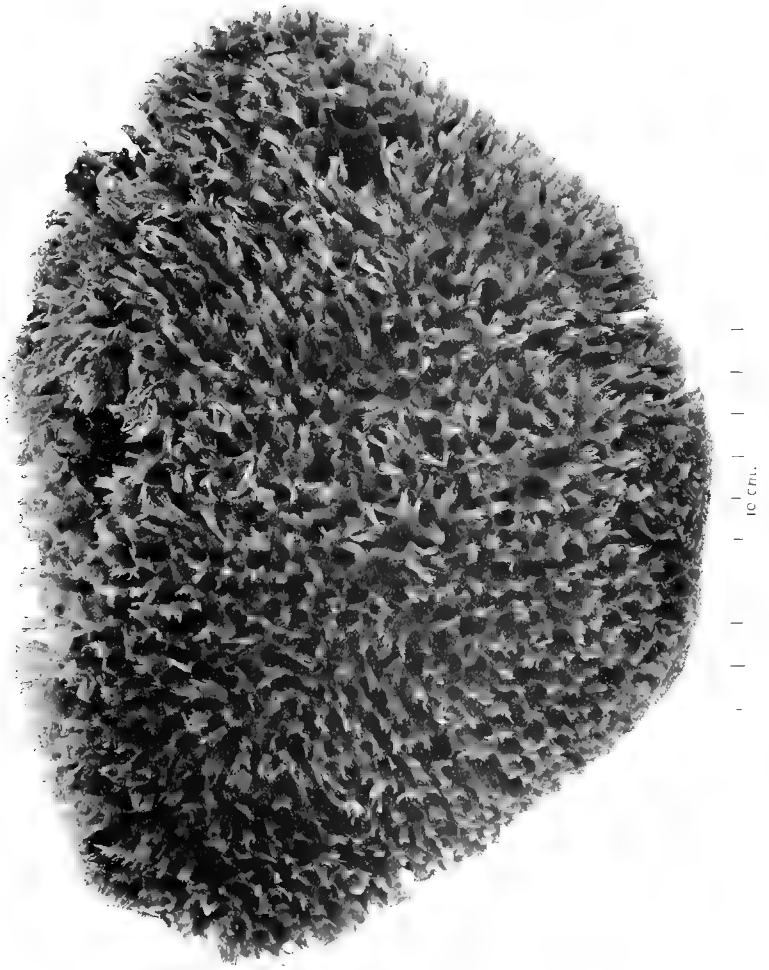


PLATE IV.

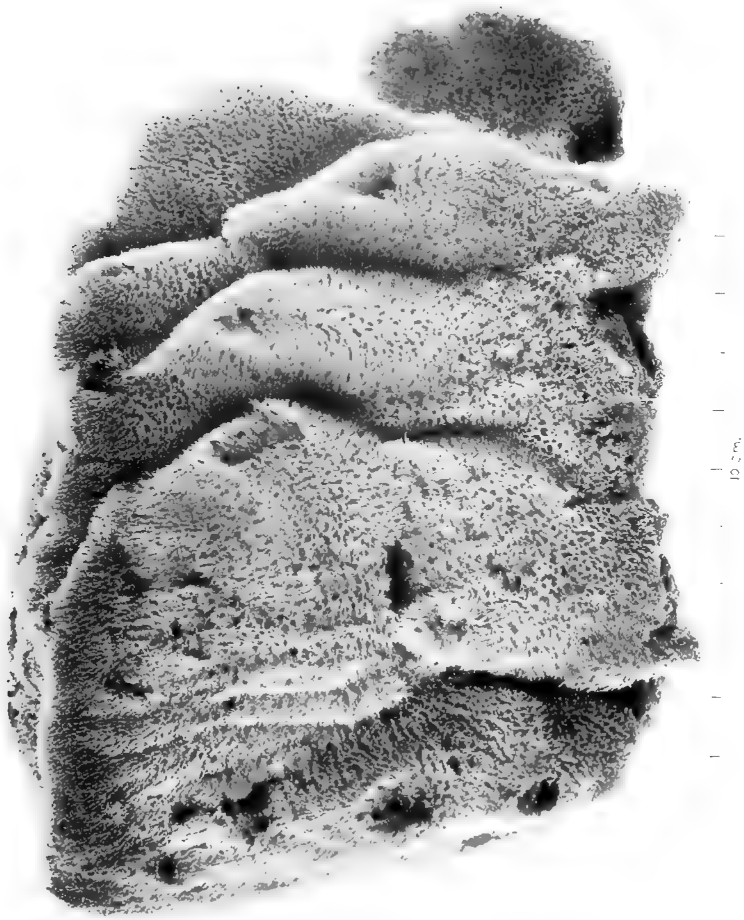


PLATE V.

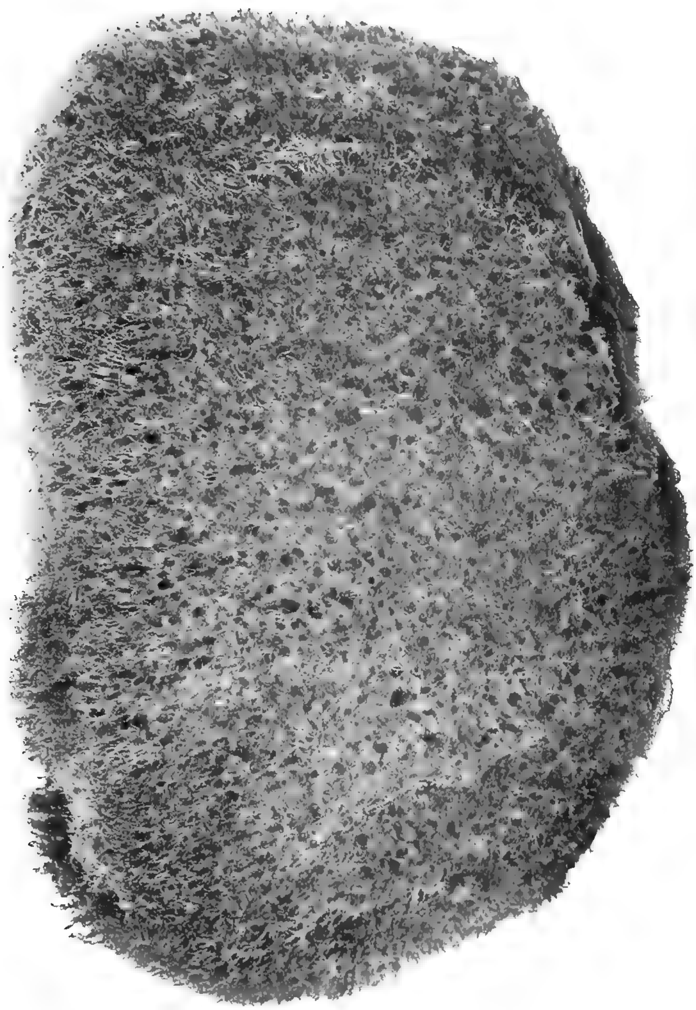


PLATE VI.

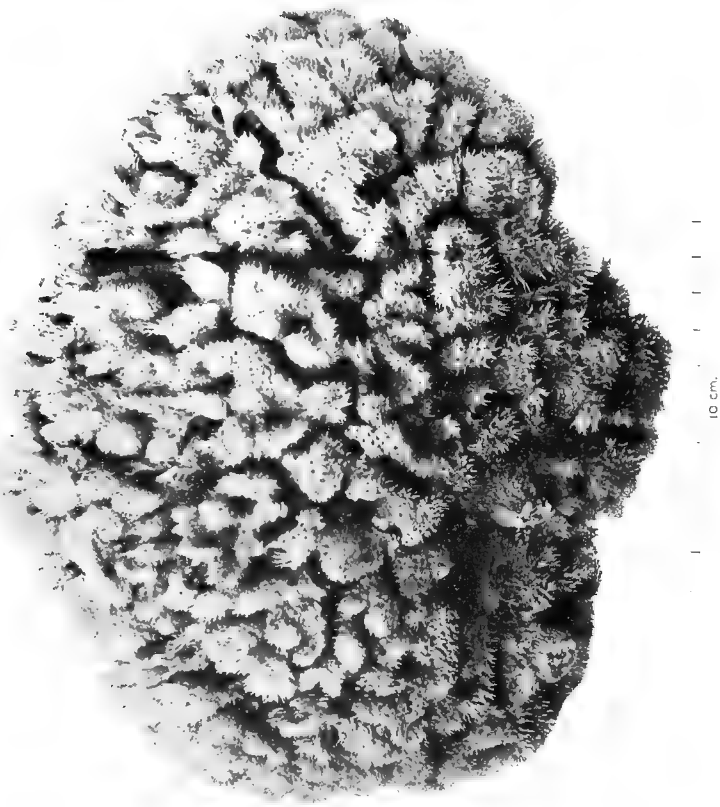


PLATE VII.

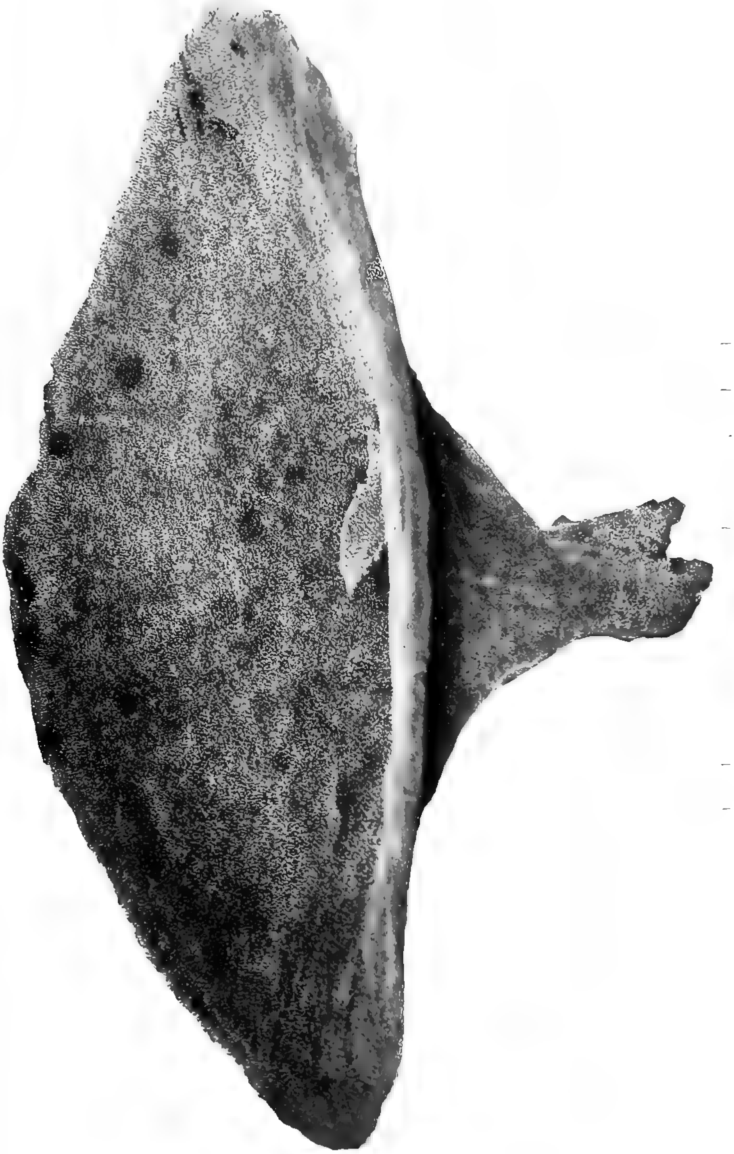


PLATE VIII.

PLATE IX.

A COLLECTION OF BIRDS FROM NORTHERN MINDANAO.

By Richard C. McGregor.
(*From the Zoölogical Section, Biological Laboratory, Bureau of Science, Manila, P. I.*)

During the months of October, November, and December, 1907, Mr. Andres Celestino, an assistant in the Bureau of Science, was engaged in collecting zoölogical specimens in northern Mindanao. He spent a few days at Cagayan and nearly a month in the vicinity of Esperanza on the Agusan River; the remaining time he employed at Butuan. The present paper is a list of the birds collected by Mr. Celestino on this trip. Most of these are species of wide distribution, or are already well known from Mindanao, but the following I believe have not been previously recorded from that island, namely: *Mareca penelope, Tachornis pallidior, Camiguinia helenæ, Eudrepanis pulcherrima, Oriolus samarensis* and *Corvus samarensis.*

The capture of *Chloropsis flavipennis* in northern Mindanao is especially noteworthy. Blasius had recorded this species from near Davao, but the record had been considered somewhat doubtful. The Island of Cebu is the only other locality where the species has been found.

LIST OF SPECIES COLLECTED.

TRERONIDÆ.

Osmotreron axillaris (Bonaparte).

One adult male.

Phapitreron amethystina Bonaparte.

Four males and one female from Butuan. These can not be distinguished from specimens collected in Bohol or in Luzon.

Phapitreron brevirostris Tweeddale.

One male and three females from Butuan. *P. albifrons* of Bohol is closely related to this species, but differs in having the forehead white and the subocular line decidedly brown instead of black.

Muscadivores chalybura (Bonaparte).

One specimen of the fruit pigeon is probably of this species.

Ptilocolpa mindanensis Grant?

The only *Ptilocolpa* in the present collection is a female and, as no other specimen from Mindanao is available, its identity is somewhat doubtful.

PERISTERIDÆ.

Chalcophaps indica (Linnæus).

One female with plumage partly immature.

CHARADRIIDÆ.

Charadrius fulvus (Gmelin).

Three specimens, taken November 2 to 17, are in winter plumage.

Himantopus leucocephalus Gould.

Six specimens from Cagayan, September 12, 1907.

Rhyacophilus glareola (Linnæus).

One female.

Pisobia ruficollis (Pallas).

Six specimens in winter plumage were collected at Butuan, November 9, 1907.

Gallinago megala Swinhoe.

Swinhoe's snipe is represented by a female, taken November 4.

CICONIIDÆ.

Dissöura episcopus (Boddaert).

A female was taken at Cagayan.

ARDEIDÆ.

Butorides javanica (Horsfield).

One male was taken November 5. This specimen appears to belong to the small-billed race and not to *B. amurensis.*

ANATIDÆ.

Mareca penelope (Linnæus).

A pair in nonbreeding plumage, taken December 27, are the third and fourth specimens to be recorded from the Philippines. This is also the first record of the occurrence of the species in Mindanao.

FALCONIDÆ.

Circus melanoleucos (Pennant).

A female in second year plumage was taken on September 13.

Astur trivirgatus (Temminck).

A pair of adults and one young female.

Accipiter manillensis (Meyen).

One male.

Lophotriorchis kieneri Sharpe.

A female of this species, killed October 12, held in its claws a *Tanygnathus everetti*. Both birds were preserved.

Spilornis holospilus (Vigors).

One male specimen.

Pernis ptilorhyncus (Temminck).

A male in perfect plumage was taken, October 21.

Microhierax meridionalis Grant.

A pair taken in Butuan, September 18. The male does not have the characters given by Grant, as the inner webs of the primaries are conspicuously barred with white. This barring is probably a character of the young and I doubt the validity of the species *M. meridionalis*.

PANDIONIDÆ.

Polioaëtus ichthyætus (Horsfield).

One specimen of this powerful fishing eagle was collected near Butuan, Mindanao. A young female was taken near Naujan, Mindoro.

BUBONIDÆ.

Ninox japonica (Temminck and Schlegel).

One female from Butuan, November 29.

Ninox spilocephala Tweeddale.

One female from Butuan.

CACATUIDÆ.

Cacatua hæmaturopygia (P. L. S. Müller).

One male and one female; the latter has the breast, abdomen, and flanks faintly washed with red.

PSITTACIDÆ.

Prioniturus discurus (Vieillot).

One male of this common species.

Tanygnathus lucionensis (Linnæus).

One adult male and two young females.

Tanygnathus everetti Tweeddale.

This distinct species is represented by three males and one female. One of the males had been killed by a Kiener's hawk. As pointed out by Grant, the female of Everett's parrot has the bill dirty white, while in the male the bill is red as in both sexes of the common species, *T. lucionensis*.

Bolbopsittacus mindanensis (Steere).

Seventeen specimens representing both sexes.

Loriculus apicalis Souancé.

Five specimens. The only male is immature so that it is useless to compare these birds with other species.

PODARGIDÆ.

Batrachostomus septimus Tweeddale.

A female taken near Butuan, October 5, differs from a female taken in Basilan, in being slightly darker and a little more rusty on the back, throat, and breast. The tail is decidedly longer; 123 mm. in the Mindanao specimen against 110 in the Basilan female.

CORACIIDÆ.

Eurystomus orientalis (Linnæus).

One specimen of this common roller.

ALCEDINIDÆ.

Pelargopsis gigantea Walden.

One male in good plumage.

Alcedo bengalensis Brisson.

A pair from Butuan.

Alcyone argentata (Tweeddale).

Sixteen specimens. Two of these are slightly bluer than the others, but do not agree with *A. flumenicola* from Samar. This species closely resembles *A. flumenicola,* but differs from that species in having the chin and throat pure white and the under parts washed with greenish-blue; the bill is slightly longer in *A. argentata.*

Ceyx mindanensis Steere.

One male and two females. These do not differ from specimens taken in Basilan. The amount of black on the back probably depends upon the age of the individual.

Halcyon coromandus (Latham).

One adult male was taken November 2; another male, taken November 22, has the feathers of throat, breast, and sides of neck edged with dark brown, forming numerous crescent-shaped marks.

Halcyon gularis (Kuhl).

One female.

Halcyon winchelli Sharpe.

One male and one female.

Halcyon chloris (Boddaert).

One female.

Halcyon hombroni (Bonaparte).

One male of this rare kingfisher was taken during October.

BUCEROTIDÆ.

Hydrocorax mindanensis (Tweeddale).

One immature female.

Penelopides affinis Tweeddale.

One young female with smooth bill was taken September 18.

Craniorrhinus leucocephalus (Vieillot).

One male and two females in adult plumage.

MEROPIDÆ.

Merops americanus P. L. S. Müller.

One female.

CAPRIMULGIDÆ.

Lyncornis macrotis (Vigors).

One female from Butuan, October 21. This specimen is exactly similar in color to a female from Bataan Province, Luzon, but is much smaller. The male collected by us in Basilan is also smaller than males from Luzon and from Mindoro. Whitehead found both large and small birds in northern Luzon. Grant,[1] who had the advantage of comparing his specimens with the types, seemed to think that *mindanensis* was not distinct from *macrotis*. Whitehead was in doubt on the subject and gave both species in his field notes.[2] The case is a very puzzling one. Were it not for Whitehead's single small specimen from Luzon I should certainly consider these two species distinct.

Measurements of Lyncornis.

Sex and locality.	Wing.	Tail.
	mm.	*mm.*
Male from Basilan	265	165
Male from Mindoro	282	180
Female from Mindanao	252	160
Female from Luzon	280	190

CYPSELIDÆ.

Collocalia troglodytes Gray.

One female was taken, September 23.

Collocalia fusciphaga (Thunberg).

A single specimen of Thunberg's swift was collected.

[1] *Ibis* (1894), VI, 6, 519; (1895), VII, 1, 463.

[2] *Ibis* (1899), VII, 5, 383.

Tachornis pallidior McGregor.

Three specimens from Butuan, November 9. These differ slightly from typical specimens in having the back darker and of a less smoky hue, but the difference does not seem to be sufficient for specific separation. This genus has not previously been recorded from Mindanao.

TROGONIDÆ.

Pyrotrogon ardens (Temminck).

One pair.

CUCULIDÆ.

Surniculus velutinus Sharpe.

Two males were taken in October.

Chalcococcyx malayanus (Raffles).

A female taken at Butuan, September 25, is in every respect similar to a female taken in Basilan.

Eudynamys mindanensis (Linnæus).

An immature female in mixed plumage was taken October 4. This specimen is similar to a female from Fuga Island in which the black plumage is partly replaced by the barred and spotted plumage of the adult.

Centropus melanops Lesson.

One female of this striking cuckoo.

CAPITONIDÆ.

Xantholæma hæmacephalum (P. L. S. Müller).

One adult male.

PICIDÆ.

Yungipicus fulvifasciatus Hargitt.

One male.

Chrysocolaptes montanus Grant.

A pair from Butuan. I have compared these two with specimens of *C. lucidus* from Basilan and with *C. rufopunctatus* from Bohol, and believe that they are specimens of Grant's *C. montanus*. The male has the shaft of one tail-feather dirty white.

Lichtensteinipicus fuliginosus (Tweeddale).

One pair of adult birds and one young female. The latter resembles the adult female, but lacks the white tips on feathers of throat and head which are indicated by faint, gray spots.

EURYLÆMIDÆ.

Sarcophanops steeri Sharpe.

Two males and one female from Butuan.

PITTIDÆ.

Pitta erythrogaster Temminck.

One adult male from Cagayan and one immature female from Butuan.

MUSCICAPIDÆ.

Muscicapula basilanica (Sharpe).

One male in poor plumage, September 21.

Hypothymis occipitalis (Vigors).

One male specimen of this common blue flycatcher.

Rhipidura superciliaris (Sharpe).

One male. This species seems to belong in the genus *Rhipidura* rather than in *Hypothymis.*

Camiguinia helenæ (Steere).

The little blue flycatcher, which was described from Camiguin Island as *Camiguinia personata,* proves to be the same as *Cyanomyias helenæ* Steere. Nevertheless I believe that the genus *Camiguinia* is a valid one. A number of specimens were collected in northern Mindanao which is a new locality for this species.

Cyanomyias cœlestis (Tweeddale).

One male and one female.

Zeocephus cinnamomeus Sharpe.

Two males without elongated central tail-feathers.

Rhinomyias ruficauda (Sharpe).

Six specimens from Mindanao differ in no way from others collected by us in Bohol and Basilan.

Cryptolopha olivacea (Moseley).

Two specimens from Butuan.

CAMPOPHAGIDÆ.

Artamides kochi Kutter.

One pair of this well-marked species was taken at Butuan on November 20.

Lalage minor (Steere).

Three males and two females from Butuan. This species, while similar to *L. melanoleuca,* is considerably smaller and the female has the throat and breast nearly uniform gray, not barred as in *L. melanoleuca.* A young male resembles the female, but has the throat and breast barred with white.

Lalage niger (Forster).

One specimen.

PYCNONOTIDÆ.

Chloropsis flavipennis (Tweeddale).

One female from Butuan, October 14, in worn plumage. Wing, 87 mm.; tail, 72; exposed culmen, 21. This is the most interesting specimen in the present collection as it confirms the record made by Blasius which for a long time was considered a mistake. Fortunately we are enabled to compare this interesting specimen directly with skins of *C. flavipennis* from Cebu. The Butuan skin is a little darker green than the Cebu skins, but with the material at hand there are no grounds for separating the Mindanao bird.

Iole philippensis (Gmelin).

One male and one female.

Iole everetti (Tweeddale).

One male in fine plumage from Butuan.

Poliolophus urostictus (Salvadori).

One specimen, October 5.

Pycnonotus goiavier (Scopoli).

One specimen.

TIMELIIDÆ.

Ptilocichla mindanensis Steere.

One male and two females. This species differs very slightly from *P. basilanica*. In the latter species the back is more olivaceous-brown, but there is no appreciable difference in the size of the two species.

Zosterornis capitalis (Tweeddale).

Seventeen specimens, including adults and young of both sexes. The young birds, taken in September, differ from the adults in having chin, throat, and rest of under parts white, faintly gray on sides of breast; forehead and fore part of crown ocherous, the shafts lighter and conspicuous. Specimens from Basilan are slightly larger than those from Mindanao but the difference is trifling.

Macronous mindanensis Steere.

Several specimens collected.

SYLVIIDÆ.

Orthotomus frontalis Sharpe.

One male from Cagayan and a pair from Butuan.

Orthotomus nigriceps Tweeddale.

Two adult males and two young females from Butuan. One of the young birds has the chin and throat spotted with white. The other young bird has chin and throat almost all white. As pointed out by

Sharpe,[1] the type figured by Tweeddale[2] is a young bird. The adult has chin, throat, and sides of head and neck black, the white being confined to lores, a ring around eye, and a line over eye which extends backward to occiput. There is also a trace of white on chin and jaw.

Megalurus tweeddalei McGregor.

One specimen of the rufous-headed grass warbler.

Acanthopneuste borealis (Blasius.)

One specimen, taken in October.

Acanthopneuste xanthodryas (Swinhoe).

A willow warbler, taken at Butuan in November, is identified as *A. xanthodryas,* because of its yellowish coloration and comparatively long first primary.

ARTAMIDÆ.

Artamus leucorynchus (Linnæus).

A pair taken in November; the female has two white feathers on the forehead.

LANIIDÆ.

Otomela lucionensis (Linnæus).

One male was taken, November 6.

Hyloterpe apoensis Mearns.

A pair from Butuan.

CERTHIIDÆ.

Rhabdornis minor Grant.

Four males and two females of this well-marked species. Males from Mindanao have the bill a trifle longer than males from Bohol, but there are no color differences correlated with this.

DICÆIDÆ.

Dicæum papuense (Gmelin).

Three specimens.

Dicæum davao Mearns.

One male taken, November 4; wing, 43 mm.; tail, 21; culmen from base, 10; tarsus, 11.

Dicæum cinereigulare Tweeddale.

Three males and three females from Butuan. The orange-breasted flowerpecker of Bohol seems to belong to this species and not to *D. besti.*

[1] Cat. Birds Brit. Mus. (1883), 7, 222.

[2] *Proc. Zoöl. Soc.* London (1877), 828, pl. 85.

Dicæum mindanense Tweeddale?

One female of a plain-colored *Dicæum* is doubtfully assigned to this species.

NECTARINIIDÆ.

Æthopyga bella Tweeddale.

Two young males in molt, three females in good plumage, and one immature female. Neither of the males shows all the specific characters, but I do not hesitate to identify them as *Æ. bella,* the type of which came from Surigao.

Eudrepanis pulcherrima (Sharpe).

Two adult males of this handsome little sunbird were taken in October. *E. decorosa* of Bohol differs from this species in being very much lighter yellow on chin, throat, and breast. *Eudrepanis pulcherrima* has not been previously recorded from Mindanao.

Cinnyris sperata (Linnæus).

One male.

Cinnyris jugularis (Linnæus).

One adult male and one immature male, the latter taken in September.

Arachnothera flammifera Tweeddale.

Three males and one female.

Anthreptes griseigularis Tweeddale.

Two males in freshly molted plumage were taken, December 26.

MOTACILLIDÆ.

Anthus rufulus Vieillot.

One female.

Anthus gustavi Swinhoe.

Two specimens. The only previous record for Mindanao is that by Grant.[1]

PLOCEIDÆ.

Munia jagori Martens.

A male from Butuan, November 17, has the head and neck extremely black.

Uroloncha everetti (Tweeddale).

One male was taken, December 27.

ORIOLIDÆ.

Oriolus samarensis Steere.

Two males and two females. These specimens are perfectly similar to a specimen of *O. samarensis* from Catbalogan, Samar.

[1] *Ibis* (1906), VIII, 6, 472.

DICRURIDÆ.

Dicrurus striatus Tweeddale.

One male and two females.

STURNIDÆ.

Sarcops melanonotus Grant.

The only specimen of bald starling in the collection from Butuan is undoubtedly of the black-backed race.

CORVIDÆ.

Corvus samarensis Steere.

A female crow from Butuan, October 18, is identified as *C. samarensis* without Samar specimens for examination. The measurements of this Butuan skin are nearly the same as those given by Steere for *C. samarensis.* The species has not been taken before in Mindanao, so far as known.

PHILIPPINE ORNITHOLOGICAL LITERATURE, II.

By Richard C. McGregor.

(*From the Zoölogical Section, Biological Laboratory, Bureau of Science, Manila, P. I.*)

This section of Philippine ornithological literature consists mainly of titles of papers by the Marquis of Tweeddale. Most of these were first published in The Ibis, in the Proceedings of the Zoölogical Society of London, or in the Annals and Magazine of Natural History and were reprinted in the Ornithological Works of Arthur, Ninth Marquis of Tweeddale, the full title of which is given below, under Ramsay. Tweeddale was particularly interested in the birds of the Malayan islands and his last papers constitute a very important part of Philippine ornithological literature.

Hay, Lord Arthur: Descriptions of some supposed new, or imperfectly described, species of birds. *Madr. Jour. Lit. & Sci.* (1845), **13**, 145–164. Reprinted in Tweeddale's Ornith. Works (1881), 1–15.

Description of *Muscicapa bella*, new species, on page 158.

Walden, Viscount: On the rufous-tailed shrikes. *Ibis* (1867), II, **3**, 211–226, pls. 5 & 6. Reprinted in Tweeddale's Ornith. Works (1881), 38–48.

Synonymy and critical notes on *Lanius cristatus*, *L. lucionensis*, and *L. superciliosus*.

Walden, Viscount: Note on Lanius melanthes, Swinhoe, and on Lanius cephalomelas, Bp. *Ibis* (1868), II, **4**, 69–71. Reprinted in Tweeddale's Ornith. Works (1881), 50–51.

Lanius cephalomelas Bonaparte is identified as *L. nasutus* Scopoli.

Walden, Arthur, Viscount: On the Cuculidæ described by Linnæus and Gmelin, with a sketch of the genus Eudynamis. *Ibis* (1869), II, **5**, 324–346, pl. 10. Reprinted in Tweeddale's Ornith. Works (1881), 57–70.

List of the cuckoos described by Linnæus and Gmelin in the 12th and 13th editions of the Systema Naturæ and a review of the genus *Eudynamys*.

Walden, Arthur, Viscount: On the sun-birds of the Indian and Australian Regions. *Ibis* (1870), II, **6**, 18–51, pl. 1. Reprinted in Tweeddale's Ornith. Works (1881), 71–93.

Synonymy and critical notes; the Philippine species considered are: *Arachnechthra jugularis*, *Nectarophila sperata*, *Chalcostetha insignis*, and *Anthreptes malaccensis*.

Walden, Arthur, Viscount: On two new species of birds from the Philippine Islands. *Ann. & Mag. Nat. Hist.* (1872), IV, **10**, 252. Reprinted in Tweeddale's Ornith. Works (1881), 234.

Hyloterpe philippinensis and *Orthotomus castaneiceps*, new species, described.

Walden, Arthur, Viscount: On a collection of birds recently made by Mr. A. H. Everett in northern Borneo. *Ibis* (1872), III, **2**, 360–383, pl. 12. Reprinted in Tweeddale's Ornith. Works (1881), 217–233.

Notes on *Spilornis bacha, Centrococcyx javanensis, Surniculus lugubris, Tchitrea affinis, Melanopitta muelleri, Oriolus xanthonotus*, and several commoner species which range to the Philippines.

Walden, Arthur, Viscount: A list of the birds known to inhabit the island of Celebes. *Trans. Zoöl. Soc.* London (1872), **8**, pt. 2, 23–118, pls. 3–10. Reprinted in Tweeddale's Ornith. Works (1881), 127–215.

Discussion of the zoölogical relationships of Celebes and notes on a number of species which range to the Philippines. *Ægialitis peronii* is figured on plate 10.

Walden, Arthur, Viscount, and **Layard, E. L.**: On birds recently observed or obtained in the Island of Negros, Philippines. *Ibis* (1872), III, **2**, 93–107, pls. 4–6. Reprinted in Tweeddale's Ornith. Works (1881), 114–123.

Notes on 22 species observed or collected by Layard; *Ianthœnas griseogularis, Chrysocolaptes xanthocephalus*, and *Dicrurus mirabilis*, new species, are figured and described.

Walden, Arthur, Viscount: Descriptions of two new species of birds. *Ann. & Mag. Nat. Hist.* (1874), IV, **13**, 123. Reprinted in Tweeddale's Ornith. Works (1881), 253.

Pelargopsis gigantea, new species, described from Salok Island.

Walden, Arthur, Viscount: A list of the birds known to inhabit the Philippine Archipelago. *Trans. Zoöl. Soc.* London (1875), **9**, pt. 2, 125–252, pls. 23–34. Reprinted in Tweeddale's Ornith. Works (1881), 293–413.

A most important review of Philippine ornithology giving a list of 218 species with critical notes and a map of the Philippine Archipelago; the following species are figured: *Limnaëtus philippensis, Ninox philippensis, Pseudoptynx philippensis, Lempijius megalotis, Merops bicolor, M. sumatranus, Cranorrhinus leucocephalus, Penelopides panini, Lanius lucionensis, Pseudolalage melanoleuca, Graucalus striatus, Volvocivora cœrulescens, Dicrurus balicassius, Hyloterpe philippensis, Philentoma cyaniceps, Pycnonotus urostictus, Copsychus mindanensis, Amaurornis olivacea, Leucotreron gironieri, Phapitreron amethystina.*

Walden, Arthur, Viscount: [Letter showing that only one species of *Artamus* is known to inhabit the Philippine Archipelago.] *Ibis* (1876), III, **6**, 133–136. Reprinted in Tweeddale's Ornith. Works (1881), 420–422.

A discussion on the various names which have been given to the Philippine swallow shrike.

Tweeddale, Marquis of: [Letter on *Anthus gustavi.*] *Ibis* (1877), IV, **1**, 258. Reprinted in Tweeddale's Ornith. Works (1881), 437.

Notes the occurrence of *Anthus gustavi* in Celebes and that it is to be looked for in the Philippines in winter.

Tweeddale, Marquis of: Descriptions of some new species of birds. *Ann. & Mag. Nat. Hist.* (1877), IV, **20**, 533–538. Reprinted in Tweeddale's Ornith. Works (1881), 561–565.

Includes first descriptions of the following Philippine birds: *Tanygnathus everetti, Ceyx argentata, Mulleripicus fuliginosus, Penelopides affinis, Mixornis (?) capitalis, Criniger everetti, Hypothymis cœlestis, Prionochilus olivaceous, Dicæum schistaceum, D. everetti, Æthopyga bella, Ptilopus incognitus.*

Tweeddale, Marquis of: Notes on the species of the genus Batrachostomus inhabiting the Indian Region. *Proc. Zoöl. Soc.* London (1877), 420–445, pls. 45–49. Reprinted in Tweeddale's Ornith. Works (1881), 438–459.

Detailed descriptions and plate (45) of *Batrachostomus affinis.*

Tweeddale, Marquis of: Reports on the collections of birds made during the voyage of H. M. S. 'Challenger' No. II. On the birds of the Philippine Islands. *Proc. Zoöl. Soc.* London (1877), 535–551. Reprinted in Report of the scientific results of the voyage of H. M. S. 'Challenger' during the years 1873–76. (1881), Zoöl. **2**, 5–25, pls. 1–6. Reprinted in Tweeddale's Ornith. Works (1881), 459–475.

Notes on 49 species; *Totanus incanus, Gallinago stenura, Demiegretta sacra,* and *Sterna bergii* are recorded for the first time from the Philippines and the following new species are described: *Loriculus panayensis, Batrachostomus septimus, Dicrurus striatus, Nectarophila juliæ. Buceros mindanensis, Dicæum mindanense, Phabotreron brevirostris.* The following species are figured with the *Challenger* reprint: *Loriculus panayensis, Batrachostomus septimus, Buceros mindanensis, Dicrurus striatus, Dicæum mindanense, Nectarophila juliæ, Phabotreron brevirostris.*

Tweeddale, Marquis of: [Letter relating to two species of *Batrachostomus* described by Mr. A. O. Hume.] *Ibis* (1877), IV, **1**, 388–392. Reprinted in Tweeddale's Ornith. Works (1881), 506–509.

The identity of *Batrachostomus affinis* Blyth is discussed.

Tweeddale, Marquis of: Description of four new species of birds from the Indian Region. *Ann. & Mag. Nat. Hist.* (1877), IV, **20**, 94–96. Reprinted in Tweeddale's Ornith. Works (1881), 509–510.

Three Philippine species described: *Megalurus ruficeps, Dicæum xanthopygium,* and *Oxycerca everetti.*

Tweeddale, Marquis of: On a new Philippine genus and species of bird. *Proc. Zoöl. Soc.* London (1878), 114, 115, pl. 9. Reprinted in Tweeddale's Ornith. Works (1881), 573, 574.

Dasycrotapha speciosa, new genus and species, described and figured.

Tweeddale, Marquis of: Notes on the Dicruridæ, and on their arrangement in the catalogue of the collection of the British Museum. *Ibis* (1878), IV, **2,** 69–84. Reprinted in Tweeddale's Ornith. Works (1881), 574–583.

Useful notes on the family *Dicruridæ* with some notes on the genus *Irena.*

Tweeddale, Marquis of: On a new species of the genus Buceros. *Proc. Zoöl. Soc.* London (1878), 277–280. Reprinted in Tweeddale's Ornith. Works (1881), 548–586.

Buceros semigaleatus, new species, described from Leyte; text figures of heads of *B. mindanensis* and *B. semigaleatus.*

Tweeddale, Marquis of: [Letter on the genus *Artamus.*] *Ibis* (1878), IV, **2,** 383–385. Reprinted in Tweeddale's Ornith. Works (1881), 625–627.

Maintains that the specific name *leucorhynchus* should be used for the Philippine swallow shrike.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. I. On the collection made by Mr. A. H. Everett in the Island of Luzon. *Proc. Zoöl. Soc.* London (1877), 686–703, pls. 72 & 73. Reprinted in Tweeddale's Ornith. Works (1881), 512–528.

A list of 86 species of which *Motacilla ocularis, Anthus maculatus,* and *Turnix fasciatus* are recorded as new to the Philippines; *Megalurus ruficeps, Oxycerca everetti,* and *Dicæum xanthopygium* are figured.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. II. On the collection made by Mr. A. H. Everett in the Island of Zebu. *Proc. Zoöl. Soc.* London (1877), 755–769, pls. 76 & 78. Reprinted in Tweeddale's Ornith. Works (1881), 529–543.

A list of 75 species of which *Hirundo javanica* and *Rallina eurizonoides* are recorded as new to the Philippines; the new species described are: *Zosterops everetti, Turnix nigrescens, Oriolus assimilis, Phyllornis flavipennis, Prionochilus quadricolor, Megapodius pusillus;* all of the new species except the first two are figured on the plates.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. III. On the collection made by Mr. A. H. Everett in the Island of Mindanao. *Proc. Zoöl. Soc.* (1877), 816–834, pls. 82–85. Reprinted in Tweeddale's Ornith. Works (1881), 543–561.

In this paper 43 species are added to the species known from Mindanao; *Cisticola greyi, Ægialitis cantianus,* and *Limnocinclus acuminatus* are recorded as new to the Philippines; *Lorinculus hartlaubi, Mulleripicus fuliginosus, Criniger everetti,* and *Orthotomus nigriceps* are figured.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. IV. On the collection made by Mr. A. H. Everett in the Islands of Dinagat, Bazol, Nipah, and Sakuyok. *Proc. Zoöl. Soc.* London (1878), 106–114, pls. 6–8. Reprinted in Tweeddale's Ornith. Works (1881), 566–573.

A list of 39 species obtained in Dinagat and 13 species obtained in the small islands of Nipah, Bazol, and Sakuyok. The species figured are: *Ceyx argentata, Hypothymis cœlestis, Mixornis capitalis, Dicæum schistaceum, D. everetti*, and *Prionochilus olivaceus*.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. V. On the collection made by Mr. A. H. Everett in the Island of Negros. *Proc. Zoöl. Soc.* London (1878), 280–288. Reprinted in Tweeddale's Ornith. Works (1881), 586–594.

A list of 56 species, 24 of which are recorded from Negros for the first time and three, *Collocalia francica, Butalis latirostris*, and *Limosa ægocephala* are new to the Philippines. *Zosterops nigrorum* and *Macropygia eurycerca* are described as new species.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. VI. On the collection made by Mr. A. H. Everett in the Island of Leyte. *Proc. Zoöl. Soc.* London (1878), 339–346. Reprinted in Tweeddale's Ornith. Works (1881), 595–602.

A list of 67 species of which *Arachnothera flammifera* is new.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. VII. On the collection made by Mr. A. H. Everett in the Island of Panaon. *Proc. Zoöl. Soc.* London (1878), 379–381. Reprinted in Tweeddale's Ornith. Works (1881), 602–604.

A list of 20 species; *Dicæum modestum* is the only new species described in this paper.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. VIII. On some Luzon birds in the museum at Darmstadt. *Proc. Zoöl. Soc.* London (1878), 429–430, pl. 26. Reprinted in Tweeddale's Ornith. Works (1881), 604–606.

Notes on 8 species collected by von Othberg, and said to have come from the vicinity of Manila. The plate illustrates *Pitta kochi*. The other species listed are: *Collocalia fuciphaga, Turdus obscurus, T. chrysolaus, T. varius, Acrocephalus fasciolatus, Anthus gustavi*, and *A. maculatus*.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. IX. On the collection made by Mr. A. H. Everett in the Island of Palawan. *Proc. Zoöl. Soc.* London (1878), 611–624, pls. 37 & 38. Reprinted in Tweeddale's Ornith. Works (1881), 606–609.

A list of 52 species of which 32 were not obtained by Steere on his first visit to Palawan. The following new species are described: *Dicrurus palawanensis, Broderipus palawanensis, Drymocataphus cinereiceps, Brachypus cinereifrons, Criniger palawanensis, Corvus pusillus, Cyrtostomus aurora, Tiga everetti*, and *Trichostoma rufifrons*. The last two species are figured on the two plates.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. X. On the collection made by Mr. A. H. Everett in the Island of Bohol. *Proc. Zoöl. Soc.* London (1878), 708–712. Reprinted in Tweeddale's Ornith. Works (1881), 620–625.

A list of 47 species collected in northern Bohol of which *Cisticola cursitans*, *Alauda wattersi*, *Terekia cinerea*, *Limicola platyrhyncha*, *Limosa lapponica*, *Tringa albescens*, and *Strepsilas interpres* are recorded as new to the Philippines.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. XI. On the collection made by Mr. A. H. Everett at Zamboanga, in the Island of Mindanao. *Proc. Zoöl. Soc.* London (1878), 936–954, pls. 57–59. Reprinted in Tweeddale's Ornith. Works (1881), 627–645.

A list of 101 species of which 65 are recorded for the first time from Mindanao; of these *Accipiter stevensoni*, *Ninox lugubris*, *Coccystes coromandus*, *Cacomantis sepulchralis*, and *Ptilopus melanocephalus* are new to the Philippines and 6 are new to science; viz: *Pseudoptynx gurneyi*, *Ninox spilocephalus*, *Scops everetti*, *Chætura picina*, *Lyncornis mindanensis*. The species figured are: *Accipiter stevensoni Pseudoptynx gurneyi*, and *Chætura picina*.

Tweeddale, Marquis of: Contributions to the ornithology of the Philippines.—No. XII. On the collection made by Mr. A. H. Everett in the Island of Basilan. *Proc. Zoöl. Soc.* London (1879), 68–73. Reprinted in Tweeddale's Ornith. Works (1881), 645–651.

A list of 56 species of which 48 were not obtained by Steere. *Totanus calidris* was obtained in Basilan thus giving it a definite locality in the Philippines.

Ramsay, R. G. W.: The ornithological works of Arthur, Ninth Marquis of Tweeddale, (* * *) reprinted from the originals by the desire of his widow. Edited and revised by his nephew, Robert G. Wardlaw Ramsay, F. L. S., F. Z. S., M. B. O. U., captain 74th Highlanders (late 67th regiment) together with a biographical sketch of the author by William Howard Russell, LL. D. for private circulation. London (1881), i–lxiv and 1–651, appendix 653–676; index 677–760.

Includes reprints of the important papers on Philippine birds by Tweeddale, mostly from the Proceedings of the Zoölogical Society, of London, The Ibis, and The Annals and Magazine of Natural History, but without the plates. The appendix contains the important "Revised list of the birds known to occur in the Philippine Islands, showing their geographical distribution," compiled by Ramsay from the writings of Tweeddale and Sharpe.

Elera, Casto de: Catálogo sistemático de toda fauna de Filipinas conocida hasta el presente y á la vez el de la colección zoológica del museo de PP. dominicos del colegio-universidad de Santo Tomas de Manila escrito con motivo de la exposición regional filipina. Manila (1895), **1** (vertibrados), 52–398 (aves).

In the pages indicated Father Casto has listed all the birds known from the Archipelago and in addition all the species of birds represented in the

Santo Tomas Museum. Native names, distribution, and copious synonymy are given for nearly every species but there are no descriptions. Some 25 new names are proposed, but as they are without the slightest diagnoses they need not be given here. A large number of species are credited to the Philippines which no previous author has recorded from the Islands; some of these species are doubtless entitled to a place on the Philippine list, but so many of these records are clearly erroneous that none of them can be accepted without the greatest caution. *Mainatus religiosus, M. javanicus,* and *M. palawanensis* are recorded from Palawan; *Calornis metallica, C. chalybœa,* and *C. panayensis* from Luzon. These and similar cases are sufficient to throw suspicion on the more plausible records.

Everett, A. H.: A list of the birds of the Island of Balabac, with some notes on and additions to the avifauna of Palawan. *Ibis* (1895), VII, **1**, 21–39.

Notes on 10 species from Palawan not enumerated in Whitehead's "Notes on the Birds of Palawan;" a list of 68 species from Balabac.

Everett, A. H.: Remarks on the zoo-geographical relationships of the Island of Palawan and some adjacent islands. *Proc. Zoöl. Soc.* London (1889), 220–228, pl. 23 (map).

Everett concludes that "Palawan and the other islands [Balabac and the Calamianes] mentioned by Prof. Steere have never been directly connected with any part of the Philippines since the former received their existing population, but that they have been almost certainly so connected with Borneo, or, more correctly perhaps, with a southeastern extension of continental Asia, of which Borneo forms a part."

Everett, A. H.: A list of the birds of the Bornean group of islands. *Jour. Straits Branch Roy. As. Soc.* (1889), **20**, 91–212.

A useful check-list of the birds of Borneo as well as of Palawan; critical remarks, names of collectors, and the leading references to literature are included.

Guillemard, F. H. H.: The cruise of the Marchesa to Kamschatka & New Guinea with notices of Formosa, Liu Kiu, and various islands of the Malay Archipelago. London 2d. ed. (1889), i–xviii, 1–455, 139 illustrations, 14 maps.

This is a popular narrative of Guillemard's experiences while naturalist on the yacht *Marchesa.* Notes are given on the birds of Cagayan Sulu, Sulu, Siasi, and Tawi Tawi (pp. 175, 187, 189, 199–200, 230–232). A full page illustration of *Macronus kettlewelli* Guillemard is given on page 232, and the head of *Sarcops calvus* is figured.

Guillemard, F. H. H.: Report on the collections of birds made during the voyage of the yacht *Marchesa.*—I. A provisional list of the birds inhabiting the Sulu Archipelago. *Proc. Zoöl. Soc.* London (1885), 247–275, pls. 17 & 18.

A list of 65 species with copious notes, largely from material collected by author. Plates and descriptions of three new species; *Iyngipicus ramsayi, Macronus kettlewelli, Pericrocotus marchesæ.* A useful map of the Sulu Archipelago is given.

Guillemard, F. H. H.: Report on the collection of birds made during the voyage of the yacht 'Marchesa.'—Part. II. Borneo and the

Island of Cagayan Sulu. *Proc. Zoöl. Soc.* London (1885), 404–420, pl. 25.

Notes on 15 species from Cagayan Sulu with description and plate of one new species, *Mixornis cagayanensis.*

Hartert, E.: Fam. Eurylæmidæ. *Gen. Avium* (1905), pt. 1, 1–8, pl. 1.

An enumeration of the broadbills with keys, references, and distribution. The head of *Sarcophanops steerii* is illustrated on the plate, fig. 6.

Jordana y Morena, R.: Bosquejo geográfico é histórico-natural del Archipiélago Filipino. Madrid (1885), 176–190, aves, pl. 5.

A general description of the commoner and more notable birds found in the Philippines, concluding with the scientific, Spanish, and Tagalog names of 110 species in the form of a table. The colored plate illustrates *Buceros hydrocorax.*

Oberholser, H. C.: The avian genus Bleda Bonaparte and some of its allies. *Smiths. Misc. Colls.* Washington (1905), **48,** No. 1588, 149–172.

Trichophorus Temminck, is revived to replace *Criniger;* the other generic names considered do not affect species on the Philippine list.

Oberholser, H. C.: Some untenable names in ornithology. *Proc. Acad. Nat. Sci. Philadelphia* (1899), **51,** 201–216.

This paper consists of proposed changes in numerous generic and in a few specific names. *Mulleripicus* Bonaparte is revived again for *Picus pulverulentus* Temminck; *Pyrotrogon* Bonnaparte is shown to be the correct generic term for *Trogon ardens* Temminck; *Calornis* Gray is found to be untenable because of the previous *Calornis* Billberg, and *Lamprocorax* Bonaparte is suggested for the glossy starlings. The other names considerel do not affect species on the Philippine list.

Richmond, C. W.: Notes on the birds described by Pallas in the "Adumbratiuncula" of Vroeg's catalogue. *Smiths. Misc. Colls.* Washington (1905), **47,** No. 1551, 342–347.

In this paper Doctor Richmond identifies the species described in the Adumbratiuncula. *Limosa lapponica, Actitis hypoleucos,* and *Calidris alba* seem to be the only species of interest to students of Philippine ornithology.

Salvadori, T.: Fam. Cacatuidæ. *Gen. Avium* (1905), pt. 5, 1–7 pls. 1 and 2.

An enumeration of the cockatoos with keys, references, and distribution.

Sherborn, C. D.: The new species of birds in Vroeg's Catalogue, 1764. *Smiths. Misc. Colls.* Washington (1905), **47,** No. 1551, 332–341.

A reprint of the "Adumbratiuncula" of P. S. Pallas in which a number of new species are described. *Trynga alba* affects the name of a species found in the Philippines.

Shufeldt, R. W.: Osteological and other notes on Sarcops calvus of the Philippines. *Phil. Jour. Sci.* Manila (1907), **2,** sec. A, 257–267, pl. 1.

A description of the skeleton of *Sarcops* with some notes on the osteology of *Oriolus* and *Lamprocorax.* The plate illustrates the skeleton of *Sarcops calvus.*

EDITORIAL.

THE MARBLE AND SCHIST FORMATIONS OF ROMBLON ISLAND.

The Island of Romblon is remembered by travelers in the Philippines because of its well-protected, deep-water harbor, its conspicuous outcrops of marble, and its coconut groves. Its longer axis, which extends from north to south, measures about 14 kilometers, and its greatest width from east to west is about 7 kilometers.

The town of Romblon, situated on the harbor in the northwestern part of the island, is picturesque in its location. The water front is in a narrow gap in a ridge, on which bowlders and ledges of marble show conspicuously through the tropical vegetation. The main portion of the town lies behind the ridge in a small, fan-shaped basin formed by the junction of several short stream valleys, which descend from the hills. From one of the streams water is brought to the town and the landing stages of the port by a gravity system.

I made an unexpected visit to Romblon on February 13 and 14 of this year. During the two days spent in port there was opportunity between the showers of rain to examine the geology of the vicinity.

ROMBLON MARBLE.

The inner shore of Romblon harbor is a nearly straight line striking approximately N. 30° E. and extending along the base of a ridge of marble broken by the gap and valley in which the town lies. The marble as seen on this ridge for the most part has a very even, fine-grained texture and is thoroughly crystalline. It does not appear as massive ledges, but in the form of jointed blocks, and on the surface occurs in irregular, weathered masses.

The dip of the marble could not be determined accurately but is probably about 30° to the westward. The color varies from a pure white to a mottled white and bluish variety which in some cases has a streaked appearance. By carefully selecting the quarries, large amounts of any particular type can be obtained, but no place was seen near the port where a large commercial quarry could be opened and operated by modern machinery. It is possible, however, that good quarries admitting of extensive operations can be found at other localities on Romblon or one of the adjacent islands. The masses of marble obtainable near the port are suitable for sawing into blocks and slabs.

The marble has been used for paving floors in a few of the better houses of Romblon and it wears well. There are six holy-water fonts in the San Sebastian Church in Manila each bearing an inscription indicating that it came from Romblon. These fonts of good workmanship and pleasing appearance indicate that the marble is suitable for many uses.

The so-called artificial stone manufactured in Manila is usually made by mixing small pieces of Romblon marble in a matrix of cement mortar colored with various pigments. After the cement has set, the surface is polished and the product is used in trimming and ornamenting buildings, and for stairways.

SCHIST.

Lying to the west of the ridge of marble and well exposed at Binagon Point on the west shore of the inner harbor, there is a schist formation which strikes approximately N. 30° E., and dips about 30° to the westward. Outcrops of the schist were seen farther to the west on Rosas Point, Macaban Point, and undoubtedly it extends to the western point of the island. It is also found on Agbatan Point to the north of the harbor. To the eastward from the ridge of marble and to the east of the town, the base of the hill slopes are composed of schist. This rock is usually yellowish, but dark varieties also are found. It shows thin laminæ and jointing in many places where it is weathered. It is micaceous and siliceous and the formation contains occasional small gash veins and stringers of quartz. In a few places schistose material was seen in the marble near the contact of the two formations.

ORIGIN AND GEOLOGICAL SIGNIFICANCE OF THE MARBLE AND SCHIST.

The marble and schist were originally deposited as limestone and shale. Their present condition is due to metamorphism produced by dynamic action. The pressure which developed the laminated structure in the schist also produced a streaked appearance in portions of the marble, which show the mixture of blue and white colors. No igneous rocks are reported from Romblon and the inhabitants say that the whole island consists of schist and marble. There are some small bowlders of igneous rocks lying on the sea wall near the landing stages, but they were brought in as ballast.

The northern point of the island is largely marble, as I observed when leaving Romblon on a steamship. Lugbung Island in front of the port appears to consist mainly of schist, with some marble. Alad Island is largely composed of marble and the northern point of Tablas Island clearly shows great slopes covered with this unmistakable rock.

Tablas, Sibuyan, and Romblon Islands, together with some lesser islands, constitute a small group in an interisland sea which is defined by Mindoro on the west, Luzon on the north and northeast, Masbate on the east, and Panay on the south. The Romblon group is more closely related geographically with Panay. Abella in his "Descripción Física. Geológica y Minera en bosquejo de la Isla de Panay" does not mention any marble or schists. Similarly, Ferguson in his study of Masbate did not find a formation similar to that of Romblon. The writer in crossing from Lucena to Atimonan in Luzon found a schist formation in the eastern *Cordillera* of Luzon a few miles west of Atimonan, but there was no marble associated with it. This schist is evidently older than the main group of sandstones, shales, and limestones, which have been folded and faulted, producing the mountain structure parallel with the eastern coast of Luzon in Tayabas Province, and extending into Tayabas peninsula. The geologic structure of Mindoro has never been studied. The marbles and schists of Romblon can not be safely correlated on lithologic appearance and in the absence of fossils their age must for the present remain unknown.

ANALYSES OF THE MARBLE AND SCHIST.

It has been proposed to establish a cement plant at Romblon, and in order to determine the adaptability of the materials available, the marble and schist have been analyzed. The analyses made in the laboratory of mineral analysis and physical chemistry of the Bureau of Science are given herewith. The marble supplies the requisite calcium, and is very low in magnesia, which is an objectionable element, but the schist is high in silica and low in alumina. Some surface clay is available which might possibly supplement the alumina of the schist, but there is not a sufficient supply to warrant the building of a cement plant. Moreover, it would be necessary to ship fuel to Romblon. Accordingly the manufacture of cement at Romblon does not seem feasible unless a schist lower in silica and higher in alumina can be found.

Average chemical analyses of Romblon marble and Romblon schist.

<table>
<tr><th>Constituents.</th><th>Marble.</th><th>Schist.</th></tr>
<tr><td></td><td>Per cent.</td><td>Per cent.</td></tr>
<tr><td>SiO_2</td><td>.10</td><td>80.12</td></tr>
<tr><td>Al_2O_3</td><td rowspan="2">.17</td><td>12.56</td></tr>
<tr><td>Fe_2O_3</td><td>1.15</td></tr>
<tr><td>CaO</td><td>55.23</td><td>.12</td></tr>
<tr><td>MgO</td><td>.45</td><td>.48</td></tr>
<tr><td>Na_2O</td><td>----------</td><td rowspan="2">3.69</td></tr>
<tr><td>K_2O</td><td>----------</td></tr>
<tr><td>Loss on ignition</td><td>43.80</td><td>2.14</td></tr>
</table>

GEORGE I. ADAMS.

REVIEW.

Human Foods and Their Nutritive Value. By Harry Snyder, B. S., Professor of Agricultural Chemistry, University of Minnesota, and Chemist of the Minnesota Experiment Station. The Macmillan Company: New York, 1908.

The book is elementary in character.

H. D. G.

ORDER No.

Bureau of Science—Annual Reports.

201. Fifth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1906.
202. Sixth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1907.
203. Seventh Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1908.

Philippine Museum.

(Now Section of Ornithology.)

**No. 1, 1903.*—On Birds from Luzon, Mindoro, Masbate, Ticao, Cuyo, Culion, Cagayan Sulu and Palawan. By Richard C. McGregor.
**No. 2, 1903.*—List of Bird Skins Offered in Exchange.
43. *No. 3, 1904.*—Birds from Benguet Province, Luzon, and from the Islands of Lubang, Mindoro, Cuyo, and Cagayancillo. By Richard C. McGregor.
**No. 4, 1904.*—The Birds of Calayan and Fuga, Babuyan Group. By Richard C. McGregor.

Mining Bureau.

(Now Division of Mines.)

45. *1890.*—Descripción física, geológica y minera en bosquejo de la Isla de Panay por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
**1890.*—Memoria descriptiva de los manantiales minero-medicinales de la Isla de Luzón, estudiados por la comisión compuesta de los Señores D. José Centeno, Ingeniero de Minas, y Vocal Presidente, D. Anacleto del Rosario y Sales, Vocal Farmacéutico, y D. José de Vera y Gómez, Vocal Médico.
47. *1893.*—Estudio descriptivo de algunos manantiales minerales de Filipinas ejecutado por la comisión formada por D. Enrique Abella y Casariego, Inspector General de Minas, D. José de Vera y Gómez, Médico, y D. Anacleto del Rosario y Sales, Farmacéutico; precedido de un prólogo escrito por el Excmo. Sr. D. Angel de Avilés, Director General de Administración Civil.
48. *1893.*—Terremotos experimentados en la Isla de Luzón durante los meses de Marzo y Abril de 1892, especialmente desastrosos en Pangasinán, Unión y Benguet. Estudio ejecutado por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
49. *1901.*—The Coal Measures of the Philippines. Charles H. Burritt.
50. *1902.*—Abstract of the Mining Laws (in force in the Philippines, 1902). Charles H. Burritt.
51. *1902., Bulletin No. 1.*—Platinum and Associated Rare Metals in Placer Formations, H. D. McCaskey, B. S.
52. *1903.*—Report of the Chief of the Mining Bureau of the Philippine Islands. Charles H. Burritt.
53. *1903, Bulletin No. 2.*—Complete List of Spanish Mining Claims Recorded in the Mining Bureau. Charles H. Burritt.
54. *1903, Bulletin No. 3.*—Report on a Geological Reconnoissance of the Iron Region of Angat, Bulacan. H. D. McCaskey, B. S.
55. *1904.*—Fifth Annual Report of the Mining Bureau. H. D. McCaskey.
56. *1905.*—Sixth Annual Report of the Chief of the Mining Bureau. H. D. McCaskey.
57. *1905, Bulletin No. 4.*—A Preliminary Reconnoissance of the Mancayan-Suyoc Mineral Region, Lepanto, P. I. A. J. Eveland, Geologist.
58. *1905, Bulletin No. 5.*—The Coal Deposits of Batan Island. Warren D. Smith, B. S., M. A., Geologist.

Division of Mines.

301. *1908.*—The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products during the year 1907, issued by Warren D. Smith, Chief of the Division of Mines.

Ethnological Survey.

(Now Division of Ethnology.)

401. *Vol. I, 1905.*—The Bontoc Igorot, by Albert Ernest Jenks. Paper, ₱2; half morocco, ₱3.
402. *Vol. II, Part 1, 1904.*—Negritos of Zambales, by William Allen Reed. Paper, ₱0.50; half morocco, ₱1.50.
403. *Vol. II, Part 2 and Part 3, 1905.*—The Nabaloi Dialect, by Otto Scheerer. The Bataks of Palawan, by Edward Y. Miller. (Bound also in one volume with Part 1, Negritos of Zambales.) Paper, ₱0.50; half morocco, ₱1.50. Combined, half morocco, ₱3.
404. *Vol. III, 1904.*—Relaciones Agustinianas de las razas del Norte de Luzon, by Perez. Paper, ₱0.75; half morocco, ₱2.
405. *Vol. IV, Part 1, 1905.*—Studies in Moro History, Law, and Religion, by Najeeb M. Saleeby. Paper, ₱0.50; half morocco, ₱1.50.

Division of Ethnology.

406. *Vol. IV, Part 2, 1908.*—History of Sulu, by Najeeb M. Saleeby. Paper, ₱1.50.
407. *Vol. V, Part 1 and Part 2, 1908.*—The Batán Dialect as a Member of the Philippine Group of Languages, by Otto Scheerer. "F" and "V" in Philippine Languages, by C. E. Conant. Paper, ₱1.60.
408. *Vol. V, Part 3.*—A Vocabulary of the Igorot Language as spoken by the Bontok Igorots, by the Rev. Walter Clayton Clapp. Igorot-English, English-Igorot. Paper, ₱1.50.
409. Directions for Ethnographic Observations and Collections, 1908. *For free distribution.*

NOTE.

Those of the above-listed publications which are for sale may be obtained from the Director of Printing, Manila, P. I. Publications for free distribution, listed above, may be had by writing to the Business Manager, Philippine Journal of Science, Manila, P. I. Please give order number.

---

* Out of print.

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.
Authors receive 100 copies of their papers free.
The numbers of each section will appear as rapidly as material is available. Each section will be separately paged and indexed.
Subscriptions may be sent to the DIRECTOR OF PRINTING, Manila, P. I. Correspondence should be addressed to the Business Manager, Philippine Journal of Science, Manila, P. I.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
Messrs. WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
Messrs. MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
Messrs. KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
Messrs. A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

VOL. IV MARCH, 1909 No. 2

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., PH. D.

CO-EDITOR,

RICHARD P. STRONG, PH. B., M. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, PH. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, PH. D.; ALVIN J. COX, PH. D.
RAYMOND F. BACON, PH. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS. B. S.; R. C. McGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. GENERAL SCIENCE

MANILA
BUREAU OF PRINTING
1909

PREVIOUS PUBLICATIONS.

ORDER No.

Bureau of Government Laboratories.

* *No. 1, 1902, to No. 14, 1904.*

15. *No. 15, 1904, Biological and Serum Laboratories.*—Report on Bacillus Violacevus Manilæ: A Pathogenic Micro-Organism. By Paul G. Woolley, M. D.

* *No. 16, 1904, Biological Laboratory.*—Protective Inoculation against Asiatic Cholera: An Experimental Study. By Richard P. Strong, M. D.

17. *No. 17, 1904.*—New or Noteworthy Philippine Plants, II. By Elmer D. Merrill, Botanist.

* *No. 18, 1904, Biological Laboratory.*—I. Amebas: Their Cultivation and Etiologic Significance. By W. E. Musgrave, M. D., and Moses T. Clegg. II. The Treatment of Intestinal Amœbiasis (Amœbic Dysentery) in the Tropics. By W. E. Musgrave, M. D.

19. *No. 19, 1904, Biological Laboratory.*—Some Observations on the Biology of the Cholera Spirillum. By W. B. Wherry, M. D.

20. *No. 20, 1904.—Biological Laboratory:* I. Does Latent or Dormant Plague Exist Where the Disease is Endemic? By Maximilian Herzog, M. D., and Charles B. Hare. *Serum Laboratory:* II. Broncho-Pneumonia of Cattle: Its Association with B. Bovisepticus. By Paul G. Woolley, M. D., and Walter Sorrell, D. V. S. III. Pinto (Paño Blanco). By Paul G. Woolley, M. D. *Chemical Laboratory:* IV. Notes on Analysis of the Water from the Manila Water Supply. By Charles L. Bliss, M. S. *Serum Laboratory:* V. Frambœsia: Its Occurrence in Natives in the Philippine Islands. By Paul G. Woolley, M. D.

21. *No. 21, 1904, Biological Laboratory.*—Some Questions Relating to the Virulence of Micro-Organisms with Particular Reference to Their Immunizing Powers. By Richard P. Strong, M. D.

22. *No. 22, 1904, Bureau of Government Laboratories.*—I. A Description of the New Buildings of the Bureau of Government Laboratories. By Paul C. Freer, M. D., Ph. D. II. A Catalogue of the Library of the Bureau of Government Laboratories. By Mary Polk, Librarian.

* *No. 23, 1904, Biological Laboratory.*—Plague: Bacteriology, Morbid Anatomy, and Histopathology (Including a Consideration of Insects as Plague Carriers). By Maximilian Herzog, M. D.

24. *No. 24, 1904, Biological Laboratory.*—Glanders: Its Diagnosis and Prevention (Together with a Report on Two Cases of Human Glanders Occurring in Manila and Some Notes on the Bacteriology and Polymorphism of Bacterium Mallei). By William B. Wherry, M. D.

25. *No. 25, 1904.*—Birds from the Islands of Romblon, Sibuyan, and Cresta de Gallo. By Richard C. McGregor. *(For first four bulletins of the ornithological series, see Philippine Museum below.)*

26. *No. 26, 1904, Biological Laboratory.*—The Clinical and Pathological Significance of Balantidium Coli. By Richard P. Strong, M. D.

27. *No. 27, 1904.*—A Review of the Identification of the Species Described in Blanco's Flora de Filipinas. By Elmer D. Merrill, Botanist.

28. *No. 28, 1904.*—I. The Polypodiaceæ of the Philippine Islands. II. Edible Philippine Fungi. By Edwin B. Copeland, Ph. D.

29. *No. 29, 1904.*—I. New or Noteworthy Philippine Plants, III. II. The Source of Manila Elemi. By Elmer D. Merrill, Botanist.

30. *No. 30, 1905, Chemical Laboratory.*—I. Autocatalytic Decomposition of Silver Oxide. II. Hydration in Solution. By Gilbert N. Lewis, Ph. D.

31. *No. 31, 1905, Biological Laboratory.*—I. Notes on a Case of Hæmatochyluria (Together with Some Observations on the Morphology of the Embryo Nematode, Filaria Nocturna). By William B. Wherry, M. D., and John R. McDill, M. D., Manila, P. I. II. A Search into the Nitrate and Nitrite Content of Witte's "Peptone," with Special Reference to Its Influence on the Demonstration of the Indol and Cholera-Red Reactions. By William B. Wherry M. D.

32. *No. 32, 1905.—Biological Laboratory:* I. Intestinal Hæmorrhage as a Fatal Complication in Amœbic Dysentery and Its Association with Liver Abscess. By Richard P. Strong, M. D. II. The Action of Various Chemical Substances upon Cultures of Amœbæ. By J. B. Thomas, M. D., Baguio, Benguet. *Biological and Serum Laboratories:* III. The Pathology of Intestinal Amœbiasis. By Paul G. Woolley, M. D., and W. E. Musgrave, M. D.

33. *No. 33, 1905, Biological Laboratory.*—Further Observations on Fibrin Thrombosis in the Glomerular and in Other Renal Vessels in Bubonic Plague. By Maximilian Herzog, M. D.

* *No. 34, 1905.*—I. Birds from Mindoro and Small Adjacent Islands. II. Notes on Three Rare Luzon Birds. By Richard C. McGregor.

35. *No. 35, 1905.*—I. New or Noteworthy Philippine Plants, IV. II. Notes on Cuming's Philippine Plants in the Herbarium of the Bureau of Government Laboratories. III. Hackel, "Notes on Philippine Grasses." IV. Ridley, "Scitamineæ Philippinenses. V. Clarke, "Philippine Acanthaceæ." By Elmer D. Merrill, Botanist.

36. *No. 36, 1905.*—A Hand-List of the Birds of the Philippine Islands. By Richard C. McGregor and Dean C. Worcester.

* Report of the Superintendent of Government Laboratories for the Year Ending August 31, 1902. (Appendix M of Third Annual Report of the Philippine Commission.)

* Report of the Superintendent of Government Laboratories in the Philippine Islands for the Year Ending September 1, 1903. (Appendix G of the Fourth Annual Report of the Philippine Commission.)

39. Third Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1904.

40. Fourth Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1905.

Bureau of Science—Publications.

101. Price and Exchange List of Philippine Bird Skins in the Collection of the Bureau of Science, Manila, P. I. (Effective January 1, 1908.)

102. *No. 1, 1909.*—A Check-List of Philippine Fishes. By David Starr Jordan and Robert Earl Richardson. *In press.*

103. *No. 2, 1909.*—A Manual of Philippine Birds. By Richard C. McGregor, Parts I and II. A systematic index to the orders, families, and genera. Paper, ₱8 for the two parts.

---

* Out of print.

(Concluded on third page of cover.)

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV MARCH, 1909 No. 2

PHILIPPINE TERPENES AND ESSENTIAL OILS, III.

By RAYMOND F. BACON.

(*From the Chemical Laboratory, Bureau of Science.*)

In endeavoring by a general survey to ascertain the economic possibilities of the Philippines in the field of terpenes and essential oils, I have found it convenient to plan the work in accord with the available material. This has made it necessary to leave many interesting oils when their study has been only well started, as the raw material is often available but once a year. The important factors of yield per hectare, the best time for harvesting, the effects of various soils, etc., must be ascertained on some of the perfume plants by slow experiments in the laboratory garden before reliable statements can be made as to the economic possibilities of these plants in the Philippines. In the present paper I present under separate subheads, the results obtained during the past year in this field. In all cases where the plant offers commercial promise the work is being continued as fast as new material is available

MANILA ELEMI.

INTRODUCTION.

A. M. Clover[1] has published the results of the examinations of the terpene oils from twenty-one authentic samples of Manila *elemi* and he thus was able to isolate pure specimens of *d*-limonene, *d*-phellandrene, dipentene, terpinene, and terpinolene. I have continued this investigation and have collected over one hundred specimens of *elemi* from

[1] *This Journal, Sec. A.* (1907), **2**, 1.

individual trees, together with botanical material corresponding to each specimen.

In spite of the very careful work on this subject, published from this laboratory, the recent literature still abounds with inaccurate statements as to this resin, especially as to its source. Tschirch [2] in his handbook, states, "Das Manila Elemi stammt von *Canarium commune,*" and again,[3] "Es darf jetzt als festgestellt betrachtet werden, dass das Manila Elemi von *Canarium commune* L. stammt." He also remarks that the tree is called by the Tagalogs *abilo,* a name which I find is wholly unknown to natives in the districts where *elemi* is collected. The native name for the tree is *pili.* Semmler [4] in discussing Manila *elemi* states that it is now well established that the resin is a product of the tree *Canarium commune* L. There is little doubt but that in India and Java a resin very similar to Manila *elemi* has as its source *Canarium commune* L., but for the Philippine *elemi,* the source has been definitely shown by Merrill to be *Canarium luzonicum* A. Gray.[5]

Tschirch [6] divides Manila *elemi* into three classes, (*a*) soft *elemi,* (*b*) hard *elemi,* (*c*) Tacamahac *elemi.* He speaks of the hard *elemi* as containing from 7 to 8 per cent of essential oil as compared with about 30 per cent for the soft variety and he gives the following constants for the two classes:

	Soft elemi.	Hard elemi.
Acid number, direct	19.6	22.4
Acid number, indirect	22.4	25.2
Saponification number, cold	29.4	30.8
Saponification number, hot	33.6	37.8

Manila *elemi* as it exudes from the trees is always soft. When it has remained on the trees exposed to the sun and air for several months it loses the greater part of its volatile constituents through evaporation and polymerization and becomes quite hard. There is no difference in the source of the *elemi,* the so-called hard *elemi* simply being more resinified by the action of the elements. There is but one *elemi* gum collected in the Philippines. While there are many species of *Canarium* in the Islands, only *Canarium luzonicum* yields an *elemi*-like resin in sufficient quantities to render its collection profitable. Tschirch gives such meager data regarding the Tacamahac *elemi* that it is impossible to identify it. It may possibly be the resin known in the Philippines as *pagsainguin* from *Canarium villosum* F.-Vill. This resin occurs in considerable quantities, but is always black or very dark, contains as the principal constituents of its volatile oil pure cymol, it does not have

[2] Die Harze and die Harzbehälter (1908), 424.

[3] *Loc. cit.*, 427.

[4] *Ber. d. deutschen chem. Ges.* (1908), **41**, 1768.

[5] The source of Manila *Elemi, Gov. Lab. Pub.*, Manila (1905), **29**, 51 to 55.

[6] *Loc. cit.*

the same odor as *elemi,* and would hardly be confused with true Manila *elemi* by anyone familiar with these resins. It is also possible that Tschirch's resin is the dipterocarpous resin from *balao* or *apitong* which in appearance is deceptively like *elemi,* but which has a decidedly different odor and the volatile oils of which are sesquiterpenes rather than terpenes.

The present condition of the Manila *elemi* industry is not very satisfactory. In several localities, especially in Tayabas Province in the neighborhood of Atimonan, the trees are regularly tapped and in past times the collection of *elemi* was one of the important industries of this province. The trees are usually owned in small holdings. The Bureau of Forestry assesses the trees at 50 centavos each and all minor forest products, such as resins, pay a tax of 10 per cent of their value at the place of collection. The resin is bought up by the small Chinese traders who then ship it to Manila. In recent years these Chinese traders have shown no eagerness to buy *elemi,* so that the native is either not able to sell his product at all or must accept a very small price for it. This price, since the collectors are a very primitive and ignorant class of men, naturally varies much with the personal needs and desires of these natives. In Calaoag, Tayabas Province, clean, white, fresh *elemi* is valued at 40 centavos per arroba of 11.5 kilos. When it is transported to Atimonan, Tayabas, 35 kilometers distant, it has a value of 1 peso for the same quantity and by the time it has reached Manila its value has risen to about 3 pesos. The market value in Europe is several times this amount. I quote these figures because they are typical of the condition under which all minor, tropical forest products are marketed. The native collectors usually live in the forests entirely out of touch with civilization, and know nothing of the real value of the products which they handle. Some of the resin is shipped from Manila to Europe for use in medicinal ointments, and to a smaller extent in lithographic inks, and in varnishes, while much of the product is sent to China, where it is used to make transparent paper to be employed for window panes, in place of glass.

The resin flows in the bark principally at the time when new leaves are coming out on the trees. This occurs most abundantly about the months of January and of June in the great collecting district around Atimonan, Tayabas. At other times of the year, when the tree is losing its leaves, it is not possible to obtain a flow of resin. The natives hack the tree with *bolos,* and the resin flows out through the cuts and collects on the bark of the trees. It is then scraped off every few days before it has an opportunity to become dirty or hard. From observations made at the time, I should estimate that healthy, mature trees will average 4 to 5 kilos of resin per year. I have seen as much as 22 kilos of *elemi* on one large tree, representing a two months' flow of the resin.

EXPERIMENTAL.

The fresh *elemi* resin was distilled *in vacuo,* the volatile oils being separated from water, shaken out with dilute alkalies, dried over calcium chloride, and redistilled *in vacuo,* only the terpene fraction being collected. The terpenes were then distilled at ordinary pressure. In Table I, the figures are given for series of these terpene oils representing samples of resin from individual trees, all being identified by Mr. Merrill from the botanical material as *C. luzonicum.* Under the column "Terpene," limonene is abbreviated as L; phellandrene, represented by P, stands for any terpene giving a crystalline nitrite of a melting point not over 121°. I will deal with the separate phellandrenes afterwards.

TABLE I.—*Manila elemis from Calaoag, Tayabas.*

No.	Terpene.	Boiling point.	Optical rotation, 10 cm. tube.	No.	Terpene.	Boiling point.	Optical rotation, 10 cc. tube.
		Degrees.	*Degrees.*			*Degrees.*	*Degrees.*
21	P	170 -173	+ 46	108	P	169 -172	+ 96.2
57	P	175 -178	+ 95	105	P	172 -174	+ 68.5
67	P	172 -175	+134.5	92	P	172 -174	— 35.6
55	P	172 -178	+126.0	111	P	169 -170	+ 70.5
69	P	172 -175	+125.5	98	P	171 -174	+ 30.3
56	P	172 -175	+ 82.2	97	P	172 -175	+ 94.8
92	P	170 -178	— 44.5	75	P	171 -174	+ 86.2
109	P	170 -173	+106.2	70	P	171 -174	+108.8
88	P	171 -174	+109.6	118	P	169 -173	+ 25.
106	P	171 -174	+119.6	72	P	172 -174.2	— 60.6
76	P	169 -172	+ 31.6	81	P	172 -175	+ 12.
78	P	169 -172	+ 31.0	91	P	172 -175	— 30.4
80	P	172 -174	— 50.5	120	P	171 -172.6	+ 99.7
86	P	173 -175	+ 83.7	84	P	172.5-174	+ 95.8
70	P	173 -175	— 24.4	95	P	171 -172.5	+117.5
73	P	169 -172	+ 42.5	74	P	169 -172	+ 24.5
117	P	169 -171	+ 46.5	63	P	170 -173	+ 84.0
82	P	171 -173	+109.0	71	P	170 -173	+ 95.5
110	P	170 -173	+ 37.9	112	P	172 -175	+ 89.9
90	L	175 -176.5	+ 96.0	113	P	168 -172	+ 88.
114	P	170 -173	— 33.3	101	P	176 -178	+ 91.8
122	P	171.5-174	+ 93.5	103	P	173 -175	+ 68.
83	P	171 -174	+116.0	102	P	176 -179	+ 85.2
116	P	172 -174	+ 7.5	85	P	169 -173	+ 48.9
77	P	169 -173	+ 65.5	119	P	172 -174	+ 54.4
99	P	169 -172	+ 78.7	115	P	173 -176	+ 48.9
100	P	172 -174	+ 16.0	46	P	175 -177	+ 45.3
13	P	171 -174	+ 66.	89	P	172 -175	+ 79.6
121	P	172 -175	+ 34.3	94	P	174 -176.5	+ 91.1
87	P	174 -176	+ 86.8	4	P	172 -174.5	+125.6
96	L	174 -176	+ 89.0	93	P	171 -174	+ 85.6

This table is striking because it shows the very great differences in boiling point and especially in optical rotation of the various terpene oils. For purposes of further purification the terpenes were now united into five classes:

1. *Laboratory number B–3.*—Lower boiling phellandrenes. Seventeen samples numbered 109, 76, 78, 73, 117, 110, 77, 99, 108, 111, 118, 74, 63, 71, 113, 85, 59.

2. *Laboratory number B–4.*—High boiling phellandrenes. Five samples numbered 94, 46, 102, 87, 101.

3. *Laboratory number B–5.*—Middle boiling phellandrenes. Thirty samples numbered 88, 106, 86, 82, 122, 83, 116, 100, 13, 121, 105, 98, 97, 75, 70, 81, 120, 84, 95, 112, 103, 119, 115, 89, 4, 93, 61, 66, 58, 60.

4. *Laboratory number B–6.*—Phellandrenes with a negative optical rotation. Six samples numbered 80, 70, 114, 92, 72, 91.

5. *Laboratory number B–7.*—Limonenes numbered 90, 96.

Before discussing the above terpenes I desire to present nine specimens of very carefully purified terpenes from *elemi* resin obtained in Gumaca, Tayabas Province:

TABLE II.—*Manila elemis from Gumaca, Tayabas.*

No.	Terpene.	$N\frac{30°}{D}$	Boiling point.	Specific gravity, $\frac{30°}{4°}$	$A\frac{30°}{D}$
			Degrees.		
1	L	1.4674	175 -177	0.8360	116.8
2	Pβ	1.4658	[a]165 -169	0.8350	92.2
3	L	1.4673	175.5-178	0.8360	117.8
4	L	1.4672	175 -178	0.8359	111.8
5	Pα	1.4680	173 -175	0.8365	107.6
6	L	1.4670	[b]175 -178	0.8358	117.9
7	L	1.4670	175 -178	0.8363	117.6
8	Pβ	1.4660	166 -169	0.8355	90.7
9	L	1.4670	176 -177	0.8364	115.6

[a] Boiling point 63° to 64° at 15 millimeters.
[b] Boiling point 60° to 65° at 9 millimeters.

It will be noted that of this last series, six terpenes are limonene, two are β phellandrene, and one α phellandrene. It is interesting to note that almost all of the *elemi* collected by me in the neighborhood of Calaoag contained phellandrene, while that collected near Gumaca showed that six of the nine samples contained limonene. Clover[7] found a large per cent of the *elemis* which he examined to contain limonene. Of all the *elemis* from various sources which I have examined, over 90 per cent contained phellandrene.

Two phellandrenes α and β have been distinguished by chemists. These phellandrenes have been differentiated not only by their physical properties, but principally by their nitrites. Wallach[8] ascribes a melting point of 113° to 114° to the α modification of the nitrite of α phellandrene, the β modification of the nitrite of this terpene having a melting

[7] *Loc. cit.*

[8] *Ann. d. Chem.*, (Liebig) (1904), **336**, 9.

point of 105°. Schreiner[9] found 120° to 121° as the melting point of the α modification of α phellandrene nitrite. My work seems to show that if the phellandrene nitrite is crystallized from cold solvents it is very easy to isolate the body of the higher melting point. Wallach heated his solvents, which probably accounts for the lower melting point. The yield of phellandrene nitrite is very far from quantitative, hence it is not possible by use of the nitrites to determine whether a phellandrene is pure or contains other terpenes. Moreover, I was able to obtain a considerable yield of a phellandrene nitrite of a melting point of 121° from a terpene which from its physical properties and its behavior on oxidation, I believed to be practically pure β phellandrene. The experiments on the phellandrene nitrites follow:

(A) Supposed α phellandrene. The united specimens B-5 were three times distilled over sodium, *in vacuo*, and in the last distillation the terpene was collected in three equal fractions to test its unformity.

Boiling point at 12 mm. pressure.	Refractive index, $N\frac{30°}{D}$	$A\frac{30°}{D}$	Specific gravity, $\frac{30°}{4°}$
(1) 62 to 62.3	1.4680	92.2	0.8363
(2) 62.3 to 62.8	1.4680	91.2	0.8364
(3) 62.8 to 63.5	1.4683	91.0	0.8363

The whole, once redistilled at ordinary pressure, had a boiling point of 172° to 174°; specific gravity, $\frac{30°}{4°}=0.8363$ $N\frac{30°}{D}=1.4681$; $A\frac{30°}{D}=91°.4$. This terpene corresponds very well in its physical properties with the best published data for α phellandrene.

(1) 13.6 grams of this α phellandrene were added to 12 grams of sodium nitrite (Kahlbaum fused) dissolved in a small amount of water, and while the whole was immersed in a freezing mixture, with vigorous shaking, 12 grams of cold glacial acetic acid were added drop by drop. There were obtained 6 grams of crude phellandrene nitrite. This was purified by dissolving in cold chloroform and precipitating by ether. It was then recrystallized once from cold acetic ether, when 1.6 gram of a substance having a melting point of 120° to 121° was obtained.

(2) 13.6 grams α phellandrene obtained as in experiment (A) with 16 grams of sodium nitrite and 16 grams of glacial acetic acid, gave 8 grams of crude nitrite, which purified as above gave 2.2 grams of pure nitrite melting at 120°.

(B) Fractions 2 and 8 of the Gumaca terpenes were united and twice distilled over sodium, giving an oil of the following properties: Boiling point, 760 millimeters, 166° to 168°.2; specific gravity, $\frac{30°}{4°}=0.8354$; $N\frac{30°}{D}=1.4658$; $A\frac{30°}{D}=91°.2$. To judge from its boiling point, this terpene would be taken for β phellandrene and it seems hardly possible that it could contain any quantity of α phellandrene, yet it gives large quantities of the same nitrite as the α phellandrene.

(1) 13.6 grams β phellandrene, 12 grams of sodium nitrite, 12 grams of glacial acetic acid treated exactly as above gave 5 grams of crude nitrite which gave 1.2 grams of pure nitrite of a melting point of 121°.

[9] *Chem. Centralbl.* (1901), 2, 544.

In addition to the α and β phellandrene above noted, there would seem to be a higher boiling phellandrene in *elemi* resin, boiling point 175° to 178° at 760 millimeters; specific gravity, $\frac{30^\circ}{4^\circ}=0.8375$; $N\frac{30^\circ}{D}=1.4685$; $A\frac{30^\circ}{D}$ 82.4. This phellandrene by the above treatment also gives the phellandrene nitrite melting at 121°. β phellandrene on oxidation with dilute potassium permanganate gives the aldehyde, phellandral, with an odor like cuminol, while this is not obtained with my α phellandrene. It is evident that much more extensive study is necessary to clear up the difficulties noted here and I will again take up this subject when I have obtained the two standard phellandrenes, the α from bitter-fennel oil, *Fœniculum vulgare* Mill, and the β from waterfennel oil, *Phellandrium aquaticum* L. for comparative purposes. Semmler [10] oxidized phellandrenes with dilute potassium permanganate and the first products which he obtained he subsequently oxidized with lead superoxide, thus separating *quantitively* 1-isopropyl succinic acid from α phellandrene, and from β phellandrene α isopropyl glutaric acid, both being crystalline compounds easily identified. Semmler does not give the exact conditions under which he made these oxidations. I have oxidized my α and β phellandrenes with potassium permanganate under various conditions, but have never been able to obtain *quantitative* yields of these acids.[11] Unless quantitative yields can be obtained, it is evident that the method is not of much value in deciding the difficult question as to whether a sample of a phellandrene contains a small quantity of another phellandrene.

THE RESIDUE FROM THE DISTILLATION OF ELEMI.

From 12 to 18 per cent of terpenes are obtained by the distillation *of elemi in vacuo,* and from 12 to 15 per cent of a higher boiling oil, of which one of the constituents has recently been proved by Semmler [12] to be elemicin, (allyl-1-trimethoxy-3,4,5-benzol). The distillation residue, usually amounting to about 70 per cent of the *elemi,* is a light brown, transparent, solid resin, with a brillant fracture. This *elemi* residue is completely and easily soluble in the cold in the following solvents: Alcohol; ether; benzol; petroleum ether; ligroin; xylol; choloroform; amyl acetate; acetone; methyl alcohol; carbon tetrachloride; ethyl acetate; turpentine; amyl alcohol, and glacial acetic acid.

[10] *Ber. d. deutschen chem. Ges.* (1903), **36**, 1749.

[11] Kondakow (*Journ. f. prakt. Chem.* (1908), n. s. **78**, 42) has recently proved that, contrary to the long accepted view, the phellandrene from *Phellandrium aquaticum* is not an individual terpene, but contains over 20 per cent of pinene. He announces a thorough investigation of the whole phellandrene chemistry. Kondakow's work throws grave doubt on the quantitative yields claimed by Semmler for the oxidation of these terpenes with potassium permanganate.

[12] *Ber. d. deutschen chem. Ges.* (1908), **41**, 1768, 1918, 2183.

Solutions in these solvents leave a brillant varnish coat which, however, dries quite slowly. The resin dissolves only very slowly in cold kerosene and in chloral hydrate, but quite easily on warming with these solvents.

The use of *elemi* residues with turpentine and linseed oil has not given us very satisfactory varnishes, for even with excessive quantities of driers, the varnish coat remains somewhat sticky for three or four days. This *elemi* residue, however, mixed with varying proportions of Manila copal, melted with boiled linseed oil, and properly thinned with turpentine has given us most excellent varnishes, which give a hard, brillant, and elastic coating on wood. The use of the *elemi* resin residue for varnishes seems not only to give a paler and more brilliant varnish than copal alone, but renders the melting of the copal much easier. I believe this *elemi* resin distillation residue has a future as a varnish gum. This entire question will be taken up by George F. Richmond, Bureau of Science, who is now studying Manila copals.

In this connection I desire to note a few further experiments on the distillation of Manila *elemi*. The resin as it comes into the market is often mixed with bark, dirt, and other impurities. Before shipment to Europe these impurities are usually picked out by hand as far as possible. Solution of the resin in alcohol, filtering, and distilling off the alcohol even *in vacuo,* leaves a dark colored resin, which in appearance is not at all like elemi. The best method of purifying *elemi* resin is by solution in benzol, filtering, and distillation of the benzol, when a white resin of the same leafy appearance as *elemi* is obtained.

Six and five-tenths kilos of commercial *elemi* were distilled in the usual manner *in vacuo,* and the volatile oil redistilled at ordinary pressure. The following fractions, each of about 135 cubic centimeters, were obtained:

	Boiling point, degrees (760 mm.).	Rotation in a 10 cm. tube (degrees).
(1)	168–174	99.1
(2)	174–177	95.5
(3)	177–179	95.0
(4)	179–181	92.0
(5)	181–183	90.0
(6)	183–190	83.0
(7)	190–210	63.0

These fractions were now washed with dilute alkalies, dried and refractioned with the following results:

No.	Quantity.	Boiling point, degrees (760 mm.).	$A\frac{30^\circ}{D}$	10 cm. tube.	$N\frac{30^\circ}{D}$	Specific gravity, $\frac{30^\circ}{4^\circ}$
	cc.					
1	100	169–170	118.8	99.0	1.4680	0.8345
2	440	170–173	113.9	95.0	1.4680	0.8357
3	170	173–175	103.4	86.5	1.4684	0.8363
4	160	175–180	88.1	74.0	1.4697	0.8396
5	45	180–190	76.8	65.0	1.4712	0.8463

The total yield of terpene oil was 14 per cent. The greater part of these terpenes consisted of phellandrenes, although in the higher boiling fractions, dipentene (present only a very small amount) could be detected by the formation of dipentene tetrabromide melting at 124°. It is evident from the two above-mentioned distillations that there is very little decomposition caused in phellandrenes by distilling them at ordinary pressure. To test more thoroughly the effect of such distillations, 2 kilos of the same lot of *elemi* resin were worked up just as in the above experiments, save that all distillations were made *in vacuo*. After the second distillation of the terpene oil, the following fractions were obtained, each number representing about 55 cubic centimeters of oil in a 10-centimeter tube.

	Boiling point, degrees (6 mm.).	Optical rotation, 10 cm. tube, $N \frac{30°}{D}$ (degrees).
(1)	51 –51	101
(2)	51 –52	101
(3)	52 –52.5	98
(4)	52.5–54	93
(5)	54 –57	83
(6)	57 –60	83

This experiment shows that there has been a slight lowering of the optical activity of the phellandrene due to distillation at ordinary pressure. This has been my experience in other experiments. In repeatedly distilling 300 grams of α phellandrene, I have noted, after each distillation, that the optical rotation is lowered by 0°.5 to 1°.0. None of the other constants of the terpene are affected, and phellandrenes are not as sensitive to heat as would be judged from the statements on this subject in the literature. Sunlight affects the optical activity of phellandrenes much more markedly than heat, as is shown by the following:

Sample 55, Calaoag resins, α phellandrene. Rotation in a 10-centimeter tube, 134°.5. After two hours in the sunlight, 132°.0. After eight hours more of sunlight, 124°.7.

Sample 69, α phellandrene. Rotation in a 10 centimeter tube, 125°.5; after one week's exposure to the sun 101°.5.

Sample 99, β phellandrene. Optical rotation in a 10-centimeter tube, 78°.7. After one week's exposure to the sunlight, 32°.1. This phellandrene had then become markedly thicker and more viscous. Pesci[13] obtained a glassy mass $(C_{10}H_{16})x$, melting at 86°, by heating β phellandrene for twenty hours in a sealed tube from 140° to 150°. The β phellandrene from *elemi* is not nearly as sensitive to heat as this phellandrene from waterfennel oil, which Pesci used.

Sample 90, α limonene. Optical rotation in a 10-centimeter tube, 96°.0. After one week's exposure to the sunlight, 94°.9. Sunlight, therefore, has very little effect on limonene.

[13] *Gazz. chim. ital.* (1886), **16**, 225; *Ber. d. deutschen chem. Ges.* (1886), Ref. **19**, 874.

The following experiments probably throw a little light on the whole question of the sensitiveness of various terpenes to heat, light, etc.

Two sealed tubes were heated in a bomb furnace from 270° to 300°, one containing limonene from *elemi*, the other limonene from orange-peel oil. After five hours the limonene from *elemi* had decreased in its optical rotation by only 1°.3, while that from orange oil had decreased 14°.7. Wallach[14] states that by several hours' heating at 250° to 270°, hesperidene (*d*–limonene from orange-peel oil) is changed to dipentene. Clover[15] found limonene from *elemi* to be little changed by heat. The above experiments would seem to show that both statements are correct, and it seems probable to me that the change in the limonene from orange-peel oil is due to a small amount of a catalyzing impurity in this substance. I am strengthened in this supposition by the fact that whereas limonene is relatively stable in light and air, orange-peel oil containing over 90 per cent of limonene is exceedingly sensitive to light and air, and very readily change into a resinous mass. Some experiments which I made on Philippine oranges point in the same direction. The peel of the native orange contains a very large quantity of oil, but this is so unstable that in the course of two minutes a rather thick layer of it will be completely converted into a solid resin. I finally succeeded in obtaining a small quantity of this orange-peel oil by squeezing it onto sponges soaked in sodium carbonate solution, and over 90 per cent of the oil proved to be a *d*–limonene boiling at 174° to 176°, giving a tetrabromide melting at 104° and limonene nitrolbenzylamine melting at 93°. I consider, therefore, that many cases of observed changes in terpenes on heating may not represent intrinsic properties of the terpene itself, but may be due to small traces of impurity, for in layers of similar thickness, Philippine orange-peel oil, consisting of 90 per cent of limonene, changes to a resin several hundred times as fast as limonene itself.

DESTRUCTIVE DISTILLATION OF THE "ELEMI" RESIN.

The residue of *elemi* from which the volatile oils had been distilled *in vacuo* was used in this experiment, as there is very little destruction at the temperature at which the terpenes distill at ordinary pressure, and I did not wish to contaminate the resin oil with the terpene.

One kilo of this residue was distilled in a 2-liter Jena flask. It melts quietly with very little darkening and no foaming, evolution of gas, or other signs of decomposition. As the temperature is increased, considerable cracking and evolution of water soon takes place and the whole mass becomes very dark, the oil beginning to distill at a vapor temperature of 200°. The whole distillation is very quiet with no foaming or frothing and very little evolution of gas. The oil at first is green, then an intense, fluorescent blue and toward the close of the distillation almost white. The total distilled was 670 cubic centimeters of which 40 were the aqueous layer. Three hundred and ten grams of black tar were left in the distilling flask. The oil, shaken out with dilute alkalies, gave 18 grams of acids, while after saponification with alcoholic potash a further 7 grams

[14] *Ann. d. Chem.*, (Liebig), (1885), **227**, 289.
[15] *Loc. cit.*

of acids were obtained. The neutral oils distilled *in vacuo* gave fractions at 10 millimeters of about 90 grams each, as follows:

No.	Boiling point. 10 m. m.	$N\frac{30°}{D}$	Specific gravity, $\frac{30°}{4°}$	$A\frac{30°}{D}$
	Degrees.			*Degrees.*
1	80–89	1.4650	0.842	18.1
2	89–130	1.4830	0.871	12.2
3	130–145	1.4970	0.916	----------
4	145–155	1.5030	0.932	----------
5	155–158	1.5100	0.952	----------
6	160–180	1.5270	0.968	----------
7	Residue a thick, viscous, tarry oil.			

There were no indications of any separable, individual products, and nitration and oxidation of these fractions under various conditions gave no promise of obtaining individual compounds. This oil obtained by the destructive distillation of *elemi* is evidently a resin oil of the same general character and useful for the same purposes as other resin oils.

I have examined two specimens of *elemi* resin, one being from Culion and the other from the Island of Mindanao, which were unusual in that the terpene was almost entirely pinene, a solid hydrochloride melting at 125° being obtained from each specimen. A few *elemis* from Mindoro gave the following results:

(1) Two kilos resin gave 240 cubic centimeters terpenes. Boiling point, 172° to 174°; specific gravity, $\frac{30°}{4°}$=0.8344; $N\frac{30°}{D}$=1.4680; $A\frac{30°}{D}$=115.5. The terpene proves to be phellandrene, giving a crystalline nitrite melting at 121°. Probably this is α phellandrene.

(2) One kilo resin, which has become somewhat hard, gave 95 cubic centimeters terpene. Boiling point, 175° to 177° at 760 millimeters; specific gravity, $\frac{30°}{4°}$ =0.8383; $N\frac{20°}{D}$=1.4687; $A\frac{30°}{D}$=111.0. This gave a good yield of tetrabromide melting at 105°. Therefore, the terpene is α limonene.

(3) Five hundred grams resin gave 60 cubic centimeters terpenes. Boiling point, 177° to 180° at 760 millimeters; specific gravity = 0.8383; $N\frac{30°}{D}$=1.4687; $A\frac{30°}{D}$=7.3; tetrabromide melts at 124°. This terpene is principally dipentene.

(4) Five hundred and twenty grams resin gave 74 cubic centimeters oil. Boiling point, 172° to 173°.5 at 760 millimeters; specific gravity, $\frac{30°}{4°}$=0.8341; $N\frac{30°}{D}$=1.4678; $A\frac{30°}{D}$=114.8. Abundant precipitate of phellandrene nitrite melting after purification at 120°. Probably α phellandrene.

(5) One and one-tenth kilos resin gave 140 cubic centimeters terpene. Boiling

point, 166° to 168° at 760 millimeters; specific gravity, $\frac{30°}{4°}$=0.8354; N$\frac{30°}{D}$=1.4658; A$\frac{30°}{D}$=91.5. This terpene oil gave an abundant precipitate of phellandrene nitrite and was considered to be β phellandrene.

LIMONENE.

The various samples of terpenes from *elemi* which were considered to be pure *d*–limonene were united and after three distillations over sodium gave an oil boiling between 176° to 177°.4 (thermometer wholly in vapor); with a specific gravity, $\frac{30°}{4°}$=0.8356; N$\frac{30°}{D}$=1.4670; A$\frac{30°}{D}$=115.7. This oil yielded limonene tetrabromide melting at 104°. Repeated distillations over sodium always gave the same range in the boiling point and no change in the optical activity, and therefore, I consider this to be a very pure sample of limonene.

I have obtained more satisfactory results in preparing the hydrochlorides and hydrobromides of terpenes, by using petroleum ether to dilute the terpene, instead of carbon bisulphide as recommended by Wallach. Petroleum ether has the advantage of permitting the terpene and the solvent to be distilled over sodium directly before the dry hydrogen halide is run into the mixture and absolute certainty that everything is anhydrous is assured. Limonene hydrochloride prepared with petroleum ether as a solvent is a much purer product than when carbon bisulphide or any other solvents are used; the body made in this way boils within 2° or 3° on the first distillation *in vacuo*, while with carbon bisulphide a range of 10° to 15° is common and several fractionations are necessary to obtain a pure product.

I have also been able to prepare pure limonene hydrobromide and phellandrene hydrochloride by this method; the properties of these bodies are not recorded in the literature.[16]

In a previous article[17] in this series, I have shown that limonene hydrochloride reacts with magnesium according to the Grignard reaction, the product of the decomposition of the hydro-limonene magnesium chloride with water being a dihydroterpene $C_{10}H_{18}$. This dihydroterpene instead of the expected carbinol was also obtained with benzaldehyde, the benzaldehyde behaving as if it contained a hydroxyl group. A continuation of this line of research has shown that while terpene halides in general easily react with magnesium in the presence of ether, the addition products so formed do not readily enter into reaction with other

[16] A uniform, easily controlled stream of dry hydrogen bromide may be obtained by the following method: Red phosphorus is covered with a layer of completely saturated, aqueous hydrobromic acid, and a mixture of 3 parts bromine and 1 part saturated hydrobromic acid is dropped slowly into this mixture. The gas is evolved quietly and regularly and after passing two wash bottles containing red phosphorus, suspended in saturated hydrobromic acid, is dried by means of a long tube of granulated calcium chloride. There is practically no contamination with hydrochloric acid by this method, although calcium bromide would be better for drying purposes.

[17] *This Journal, Sec. A.* (1908), **3**, 49.

substances, as would be expected from bodies of this nature formed according to the reaction of Grignard. I will record but a few of the experiments performed to show the type of reactions.

LIMONENE HYDROCHLORIDE.

(1) Limonene from *elemi*, distilled over sodium with an equal volume of petroleum ether, was saturated with dry hydrochloric acid gas; limonene hydrochloride with the following properties was obtained on distilling this product *in vacuo:*

Boiling point at 12 millimeters' pressure, 95° to 97°, specific gravity, $\frac{30^\circ}{4^\circ}$ = 0.9616; $N\frac{30^\circ}{D}=1.4758$; $A\frac{30^\circ}{D}=80^\circ.1$; yield, 90 per cent.

	Found (per cent).	Calculated (per cent).
Cl	20.2	20.3

Fifty grams of this limonene hydrochloride, 10 grams of magnesium, and 100 cubic centimeters of absolute ether were allowed to react in an atmosphere of dry hydrogen. When the reaction was over, 45 grams (calculated 43 grams of ortho-formic ester) were added.[18] The resulting reaction was not violent and, therefore, the mixture was heated for two hours on a steam bath, the greater part of the ether escaping through the reflux condenser. The yellowish, solid reaction product was during the next morning treated in the usual manner by placing it upon crushed ice and adding dilute, cold sulphuric acid. There were thus obtained 48 grams of an oil (calculated 85 grams). This oil consisted principally of the dihydroterpene $C_{10}H_{18}$ boiling at 171° to 173°; $N\frac{30^\circ}{D}=1.4610$. The ortho-formic ester had apparently disappeared in the aqueous solution, as alcohol and formic acid were both easily detected therein.

(2) Limonene hydrochloride 60 grams, absolute ether 150 cubic centimeters, magnesium 10 grams. After the reaction was over, 60 grams of ortho-formic ester were added with very vigorous stirring. The apparatus was arranged to catch any gas which might be evolved during the reaction, but none was obtained. After heating for two hours on a steam bath, the reaction mass was separated into ether soluble and ether insoluble portions, and each portion was decomposed separately with ice and dilute sulphuric acid.

Portion soluble in ether.

Alcohol, 23.1 grams.

Formic acid, 8 grams.

Oil, 45 grams, which consisted of 7 grams "Vorlauf," 31 grams of $C_{10}H_{18}$, and 4 grams of a high boiling oil. The "Vorlauf" contained considerable quantities of ethyl formate and the high boiling oil gave no reaction with phenylhydrazine, even after boiling with dilute acids and was probably principally a diterpene.

Portion insoluble in ether.

Alcohol, 12.5 grams.

Formic acid, 7.5 grams.

High boiling oil, 5 grams. This latter oil boils at 150° to 220° at 10 millimeters, leaving a tarry residue of 2.3 grams. The 2.5 grams high boiling oil, distilled once gave no reaction with phenylhydrazine, and dilute boiling acids had no effect on it.

[18] Kahlbaum fractioned several times over small amounts of sodium with which it reacts only slightly; boiling point, 144° to 146°; $N\frac{30^\circ}{D}=1.3935$.

These experiments show that a reaction, which is very different from the normal one between ortho-formic ester and organo-magnesium halides, had taken place. It is to be noted that the great tendency in the terpene series during reactions of this nature, is to produce the reduced terpenes. To exclude any possibility that these reduced terpenes might result from the action of the sulphuric acid used in decomposing the reaction mass, or any excess of magnesium, I attempted to reduce limonene, α phellandrene, and β phellandrene with magnesium and dilute sulphuric acid. The results were absolutely negative. The refractive index of the terpene was in each case the same before as after the attempt at reduction.

Oxygen reacts with hydrolimonene magnesium chloride to give terpineol as is shown by the following result:

One hundred and ten grams of limonene hydrochloride, 20 grams of magnesium, 300 cubic centimeters of absolute ether. After the reaction according to Grignard was completed, I ran a copious stream of dry oxygen into the apparatus during eight hours. There was a considerable evolution of heat and reddening of the mass. The products of the reaction were decomposed by means of a cold solution of ammonium chloride, and the resulting oils were fractional *in vacuo*. Nine grams of terpineol, boiling between 98° and 102° at 9 millimeters' pressure were thus obtained; specific gravity, $\frac{30^\circ}{4^\circ}=0.930$; $N\frac{30^\circ}{D}=1.4805$; $A\frac{30^\circ}{D}=15^\circ.2$. The phenyl urethane derivative was prepared in a solution of petroleum ether and when once recrystallized melted at 112° to 113°. The lower boiling fractions of this oil (78 grams), boiling between 172° and 175° at ordinary pressure, still had some terpeneol odor. Specific gravity, $\frac{30^\circ}{4^\circ}=0.8250$; $N\frac{30^\circ}{D}=1.4617$. Therefore, this oil probably consisted largely of the dihydroterpene $C_{10}H_{18}$.

LIMONENE HYDROBROMIDE.

Seventy-five grams of dry limonene, dissolved in an equal volume of dry petroleum ether, were saturated with dry hydrogen bromide. Distillation *in vacuo* gave 45 grams of limonene hydrobromide, boiling between 108° and 112° at 12 millimeters' pressure; specific gravity, $\frac{30^\circ}{4^\circ}=1.1209$; $N\frac{30^\circ}{D}=1.5006$.

	Found (per cent).	Calculated (per cent).
Br.	35.8	36.4

Limonene hydrobromide was allowed to react according to the method of Grignard with 8 grams of magnesium. The reaction is more vigorous than with the corresponding hydrochloride. A test-tube experiment showed that the hydrolimonene magnesium bromide did not react with chlorocarbonic ester. Twenty grams of benzaldehyde were then added to the hydrolimonene magnesium bromide. The reaction was very vigorous, a yellow solid separating just as in the similar reaction with the hydrochloride. The products obtained were principally benzaldehyde and dihydrolimonene. The reaction with benzaldehyde is, therefore, exactly the same as when limonene hydrochloride is used.

LIMONENE HYDROBROMIDE AND ACETALDEHYDE.

Limonene hydrobromide with the following properties, boiling point at 10 millimeters, 106° to 109°, specific gravity, $\frac{30^\circ}{4^\circ}$ =1.1211; $N\frac{30^\circ}{D}$ =1.5012; bromine found, 36.1; calculated, 36.4 per cent. Fifty grams of this hydrobromide were subjected to the Grignard reaction with 10 grams of magnesium. After the reaction was complete, 15 grams of acetaldehyde were slowly distilled into the mixture. There is marked heating and a yellowish, sticky solid separates. From this solid, using the usual method of treatment, there were obtained 27.0 grams of $C_{10}H_{18}$ (calculated, 31.3 grams), boiling point, 173° to 175° at 760 millimeters, specific gravity, $\frac{30^\circ}{4^\circ}$ =0.8256; $N\frac{30^\circ}{D}$ =1.4583. The residual oil, 3.5 grams, contained a trace of halogen, had no hydroxyl groups, and was probably a diterpene. Acetaldehyde, therefore, reacts on hydrolimonene magnesium bromide just as does benzaldehyde.

It is very interesting to note that hydrolimonene magnesium bromide is, when first formed, a liquid insoluble in ether. After lying under the ether for a few days it changes into a crystalline solid insoluble in ether.

LIMONENE DIHYDROBROMIDE AND BENZALDEHYDE.

One hundred grams of limonene from orange-peel were mixed with an equal volume of absolute ether and saturated with dry hydrogen bromide, 150 grams of crystalline dihydrobromide melting at 64° (from ether) resulted.[10] A mixture of 150 grams of limonene dihydrobromide and 150 grams of benzaldehyde was slowly added to 35 grams magnesium, which had been rendered active, in 400 cubic centimeters of ether. A fairly vigorous reaction took place. The reaction mixture was decomposed with ice and dilute sulphuric acid, the oils were poured into petroleum ether, and 14 grams of a crystalline solid separated. This was recrystallized several times from benzol. It is moderately soluble in hot benzol, insoluble in the cold, almost insoluble, hot or cold, in ether, petroleum ether, ligroin, acetic ester, methyl or ethyl alcohol, acetone, or carbon bisulphide. The melting point is not sharp. At 195° the compound begins to darken and at about 212° it melts with marked decomposition. The compound used in the following analysis had been recrystallized 15 times from benzol and consisted of beautiful, white crystals which under the microscope seemed to be homogenous.

0.2000 gram substance gave 0.2181 gram AgBr.
0.2000 gram substance gave 0.2180 gram AgBr.
0.2340 gram substance gave 0.4365 gram CO_2 and 0.0590 gram H_2O.
0.2730 gram substance gave 0.5100 gram CO_2 and 0.0700 gram H_2O.
0.5 gram dissolved in 27 grams benzol raised the boiling point 0°.065.

	Calculated for $C_{30}H_{20}Br_4$ (per cent).	Calculated $C_{29}H_{20}Br_4$ (per cent).	Found (per cent).	Found (per cent).
C	51.40	50.58	50.93	50.90
H	2.85	2.90	2.80	2.84
Br	45.70	46.49	46.40	46.40
Molecular weight	700.00	690.00	745.00	....

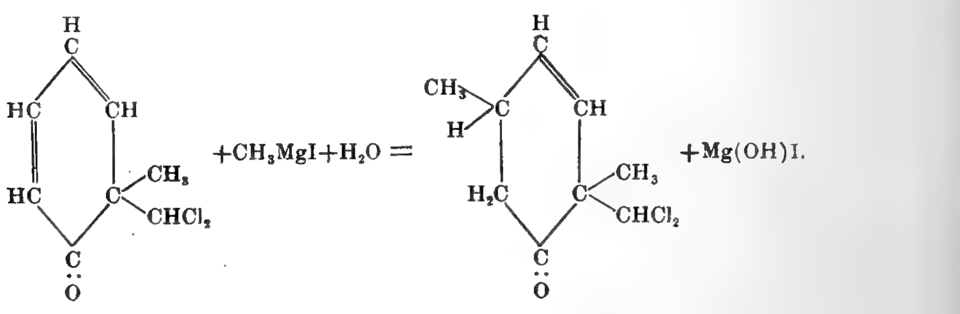
[10] The dihydrohalide always results no matter how thoroughly dried the solvent has been, when hydrogen halides are run, to saturation, into limonene dissolved in ether, while with petroleum ether, only the mono compound is obtained.

The other principal products of the reaction are benzaldehyde and tetrahydrolimonene $C_{10}H_{20}$.

Another bromine determination was made on some of the compound, the analysis of which is given above, crystalized eight times from benzol. 0.2000 gram substance gave 0.221 gram AgBr. Bromine found, 46.8 per cent.

This would seem to show that I was dealing with a pure compound. The reaction which has taken place is so entirely different from the normal course of the Grignard reaction that even speculation as to the nature of this crystalline compound is out of the question. The percentage of hydrogen is so low that it would seem as if limonene had taken no part in the reaction. It is still more difficult to see how bromine could unite with a benzaldehyde derivative in the presence of activated magnesium. The extensive literature of the Grignard reaction shows that, while this method has a very wide applicability, there nevertheless are very many cases in which the reaction proceeds in an abnormal direction, especially when other than the halides of the first members of any given series are used.

Thus, isoamyl magnesium bromide with benzophenone does not give the diphenyl isoamyl carbinol which would be expected, or the dehydrated hydrocarbon derived from it, but benzhydrol and benzhydrol ether.[20] Similarly, benzyl alcohol is one of the reaction products in the action of ethyl magnesium iodide on benzaldehyde.[21] J. Schmidlin and H. Hodgson,[22] in speaking of the action of various reagents on β triphenyl magnesiumchlormethane $(C_6H_5)_3C.MgCl$, say "Es scheinen somit diese Reagenzien, Aceton, Acetaldehyd, Acetylchlorid, so zu wirken, dass sie die MgCl-Gruppe abreissen, ohne sich mit dem verbleibenden Triphenylmethylrest zu verbinden." Auwers and Hessenland[23] found that it was impossible to obtain a normal reaction with alkyl magnesium halides and 2-methyl-2-dichlormethyl 1-keto-dihydrobenzol. With methyl magnesium iodide they observed the following reaction:



[20] Schorigin, *Ber. d. deutschen chem. Ges.* (1908), **41**, 2715. Konowalow, *Journ. Russ. phys. chem. Ges.* (1902), **34**, 26; (1908), **38**, 447.

[21] Schorigin, *Ber. d. deutschen chem. Ges.* (1908), **41**, 2721.

[22] *Ibid.*, 431.

[23] *Ibid.*, 1790.

There was no action on the carbonyl group. It is well-known that very many reactions carried out according to the Grignard method give yields which are not by any means quantitative. The secondary products which will throw so much light on the mechanism of this reaction have, as a general rule, been utterly neglected. It is exceedingly probable that these reactions take place in many different directions, depending upon the conditions and upon the reacting masses, as is shown by my work in the terpene series.

PHELLANDRENE.

PHELLANDRENE HYDROCHLORIDE.

The united terpenes of series Calaoag B–3 were distilled over sodium *in vacuo;* boiling point, 64°.5 to 65° at 15 millimeters (62° to 62°.5 at 10 millimeters); specific gravity, $\frac{30^\circ}{4^\circ}=0.8349$; $N\frac{30^\circ}{D}=1.4657$; $A\frac{30^\circ}{D}=77^\circ.8$. An equal volume of dry ligroin was added and the terpene was then saturated with dry hydrogen chloride. After removing the liquid, the residual oil was distilled at 1 millimeter pressure; boiling point, 80° to 83°; specific gravity, $\frac{30^\circ}{4^\circ}=0.960$; $N\frac{30^\circ}{D}=1.4770$; chlorine found, 20.2 per cent; chlorine calculated, 20.3 per cent.

The odor of this hydrochloride is much like that of the corresponding limonene derivative. Phellandrene hydrochloride did not react completely with magnesium in the presence of ether; therefore, phellandrene hydrobromide was prepared. This compound can not be distilled *in vacuo* without decomposition and in fact it slowly decomposes with evolution of hydrobromic acid even at the ordinary temperature. Phellandrene hydrochloride begins to split off hydrochloric acid at about 85°, and must be distilled below that temperature.

PHELLANDRENE HYDROBROMIDE.

α phellandrene, boiling point at 9 millimeters 62° to 63°; specific gravity, $\frac{30^\circ}{4^\circ}=0.8364$; $N\frac{30^\circ}{D}=1.4673$, was mixed with an equal volume of dry petroleum ether and saturated with dry hydrogen bromide. After removing the petroleum ether the crude hydrobromide had the following properties: Specific gravity, $\frac{30^\circ}{4^\circ}=1.1302$; $N\frac{30^\circ}{D}=1.5018$; bromine found, 37.6 per cent; calculated, 36.8 per cent. 70 grams of this hydrobromide were subjected to the Grignard reaction with 10 grams of magnesium and 200 cubic centimeters of absolute ether, and after the reaction was complete, 40 grams of benzaldehyde were added. A yellow-white solid separated. The reaction mixture was separated into ether soluble and ether insoluble substances, and each portion was separately decomposed with ice and dilute sulphuric acid.

Portion soluble in ether.

0.3 gram magnesium, 29 grams benzaldehyde phenylhydrazone corresponding to 15.6 grams benzaldehyde; 34 grams $C_{10}H_{18}$, boiling point, 169° to 173°; specific gravity, 0.8220; $N\frac{30°}{D}=$ 1.4600. 11 grams higher boiling oil from which there were separated by means of ligroin 0.8 gram of a halogen-free, crystalline solid. After purification by several crystallizations from petroleum ether, it melted at 137° and proved to be benzoïn, by melting it with that substance.

Portion insoluble in ether.

2.5 grams benzoïn, melting point 136° to 137°, 38 grams phenylhydrazone of benzaldehyde corresponding to 20.5 grams benzaldehyde.

The reaction between hydrophellandrene magnesium bromide and benzaldehyde thus corresponds exactly to the similar limonene reaction already studied in a previous paper.[24] Several additional experiments were performed with phellandrene hydrobromide and benzaldehyde under varying conditions, but in every case dihydrophellandrene and benzaldehyde were the principal products of the reaction.[25]

PHELLANDRENE DIHYDROCHLORIDE.

The dihydrochloride of phellandrene was also prepared. It does not crystallize and is quite unstable, evolving hydrogen chloride at the ordinary temperature. It does not react well with magnesium according to the Grignard reaction.

THE FORMATION OF DIPENTENE.

I have succeeded in converting *a* phellandrene into dipentene.

The chloride of *a* phellandrene was heated for six hours on a reflux condenser with an excess of alcoholic potash, and the product shaken out well with water, dried with calcium chloride and distilled. The greater part of the terpene now boiled at 178° to 180° and had no optical activity. This terpene was dissolved in an equal volume of amyl alcohol and two volumes of ether, together with 0.7 volume of bromine, were added slowly on a freezing mixture. After several weeks in the ice box, a large yield of crystalline dipentene tetrabromide, which after crystallization from acetic ether melted at 124°, was obtained. The original *a* phellandrene treated in the same manner and then inoculated with a crystal of the tetrabromide showed the presence of no dipentene.

[24] *Loc. cit.*

[25] The majority of terpenes when treated with iodine are oxidized to *p* cymol. Specimens of *a* and of *β* phellandrene were allowed to stand for two months with an excess of iodine. They were then shaken out with alkalies, dried and distilled and each gave a large yield of *p* cymol, with the following properties: Boiling point, 174° to 176°; specific gravity, $\frac{30°}{4°}=0.8489$; $N\frac{30°}{D}=1.4970$.

BROMINE ADDITION PRODUCT OF PHELLANDRENE.

One hundred and six grams of bromine were slowly added to 80 grams of α phellandrene dissolved in 100 grams glacial acetic acid. The bromination proceeded quite smoothly, without any evolution of hydrobromic acid. When treated in this manner one molecule of α phellandrene adds only two atoms of bromine. This dibromophellandrene reacts very satisfactorily according to the method of Grignard, and by decomposing the reaction products with water, 25 grams of a dihydroterpene $C_{10}H_{18}$ were obtained boiling between 170° and 172°; specific gravity, $\frac{30°}{4°}=0.8231$; $N\frac{30°}{D}=1.4590$; and 13 grams of terpene polymerization products still containing a small amount of bromine.

LEMON GRASS OIL.

Andropogon citratus DC. is not cultivated on a large scale in the Philippines, although it is found growing as a garden herb and also in the wild state in all parts of the Islands, being quite abundant in the highlands of the Province of Benguet. No commercial distillation of the oil is carried on at the present time. The first mention of lemon grass from the Philippines dates from 1635, when Juan Eusebeus Nuremberg, a Spanish Jesuit, describes it quite unmistakably under the name of *"tanglat."* This is still the Tagalog name for the plant. The correct spelling is *"tañglad."* Another name is *salai,* and in the Visayas this grass is termed *balyoco,* while the Spanish name is *Paja de Meca.* Many Filipinos have small patches of the grass. It is cooked with stale fish to improve the taste and is used as a flavor in wines and various sauces and spices; it is also used medicinally, being applied to the forehead and face as a cure for headache, and an infusion is held in the mouth to alleviate the suffering of toothache. It is also used for baths and fomentations, particularly in female complaints. The writings of the older botanists show that these uses date back to the first mention of the plant from the Malay regions. A perusal of the extensive literature on lemon grass oil leaves considerable doubt as to whether the cultivation of the grass for oil distillation in the Philippines should be recommended. The market for lemon grass oil must always remain quite limited, and it has been stated that the oil from one of the species of Australian eucalyptus, *Backhousia citriodora* F. Muell. would soon drive out that from lemon grass as a source of citral. The oil from this Australian plant has a citral content which is from 10 to 20 per cent higher than that from lemon grass, still it seems probable, in view of the great differences in the price of labor in Australia and in tropical countries, that lemon grass will be able to hold its own as the source of the world's supply of citral. The price of lemon grass oil has been very low during the past two years and the further cultivation of it has been strongly discouraged by European essential-oil houses. Still the plant has some advantages. It gives quick results, the first returns coming in about six months after planting, and on the virgin soils of the Philippines it grows luxuriantly without any cultivation or care. I am strongly inclined to recommend it as a catch crop to help pay plantation expenses until the slower growing staple crops are ready to be harvested.

It is almost impossible to obtain from the literature any idea as to the yield of oil per hectare. On this point I note the following statements. About 300 kilos lemon grass yield 1 kilo oil.[26] Under normal conditions an annual yield of 8,000 ounces oil per acre can be reckoned upon. The grass is cut twice a year.[27] 496 pounds fresh lemon grass yield 1 pound of crude oil (0.2 per cent). The annul yield per acre amounts to about 20 pounds of crude oil. The grass is cut three to four times per year.[28] The average yield per acre is 49 quarts of lemon grass oil.[29] One acre yields 100 quarts of oil (lemon grass oil).[30] From thoroughly dried leaves, which had lost 70 per cent of their original weight, 8 to 8.5 per cent of oil was obtained, while leaves distilled immediately after the harvest yielded in the rainy season 2 per cent and in the dry season 5.5 per cent oil.[31]

Perhaps, considering the many possible variations of soil, climatic conditions, etc., these wide differences of oil yield are not remarkable. It must also be remembered that there are many varieties of lemon grass. We have never been able to obtain Philippine lemon grass in flower and hence can give no data as to the variety or varieties growing wild on these Islands. In fact, no accurate botanical determinations of the grass have been made for the same reason and it is assigned to *Andropogon citratus* DC. solely from the character of the oil obtained from the grass.[32] We obtained one shipment from Benguet which we worked up directly, but, in view of all these facts it was considered necessary to plant experimental plots of lemon grass. One lot was grown from grass obtained in Manila, at the Singalong experiment station of the Bureau of Agriculture on ground which has at various times had abundant applications of fertilizers, and another from Lamao plants was grown at the Government agricultural farm at Lamao, Bataan, on unfertilized virgin soil. The results obtained from these plots of grass were as follows:

Lamao.—Planted February 14, 1908. First cutting July 29, 1908. Obtained 432 kilos grass, from 57 square meters of ground, distilled two days after cutting, the yield was 900 grams of oil (0.2 per cent) of the following properties: Specific gravity, $\frac{30^\circ}{4^\circ}=0.894$; $N\frac{30^\circ}{D}=1.4857$; $A\frac{30^\circ}{D}=+8.1$; citral=79 per cent; Shimmel's test passes the oil.

[26] *Journ. agr. trop.* (1905), **5**, 42.
[27] *Kew Bull.* (1906), No. 8,364.
[28] *Bull. Imp. Inst.*, London (1907), **5**, 300.
[29] *Trop. Agr.* (1904), **24**, 35.
[30] *Ibid.*, (1905), **25**, 672.
[31] *Bull. Chambre Agr. Cochinchine* (1908), **11**, 218.
[32] The very confused botany of the oil-producing grasses has only recently been cleared up by the excellent monograph of Otto Stapf. *Kew Bull.* (1906), No. 8, 297.

The grass from the same plot was again cut about four months later (November 23, 1908) and yielded 230 kilos, giving on distillation 467 grams of oil of the following properties: Specific gravity, $\frac{30°}{4°}=0.8841$; $N\frac{30°}{D}=1.4765$; $A\frac{30°}{D}=+2.1$; citral=77 per cent; Schimmel's test passes the oil.

Singalong station plot.—134 square meters planted on November 6, 1907, and cut July 27, 1908, gave 545 kilos grass which distilled immediately gave 1,145 grams (0.21 per cent) oil of the following properties: Specific gravity, $\frac{30°}{4°}=0.891$; $N\frac{30°}{D}=1.4812$; $A\frac{30°}{D}=+7.76$; citral=78 per cent; Schimmel's test passes the oil.

All of these oils were distilled with steam in this laboratory and were of a very light yellow color when first distilled. It was noted that on standing in colorless, glass-stoppered bottles in the light, they darken to a brown color in a few months.

Three hundred and thirty-five grams of the Singalong oil were distilled *in vacuo* at 16 millimeters and gave the following fractions:

No.	Boiling point.	Quantity.	$N\frac{30°}{D}$ properties.
	Degrees.	*Grams.*	
1	Up to 118	20	1.4681 colorless.
2	118–121	62	1.4808 colorless.
3	121–124	65	1.4810 colorless.
4	124–127	63	1.4813 colorless.
5	127–133	58	1.4820 slightly yellow.
6	Residue.	53	Dark, thick resin.

None of the fractions 1 to 5 showed any optical rotation, and united they gave an almost colorless, very fragrant oil, which was completely soluble in 65 per cent alcohol. The resinous residue, saponified with alcoholic potash, gave considerable quantities of higher boiling, fatty acids, and a thick, neutral oil which to judge from the odor, probably contained geraniol. The results of our experiments would seem to show, assuming, as the young leaves contain a higher per cent of oil than the old ones, at least three cuttings of the grass per year, that a yield of from 240 to 300 kilos of oil per hectare can be obtained on good ground in the Philippines. Considering that the demand for this oil is increasing (due partially to the expiration of the ionone patents), I think lemon grass should be considered as a possible catch crop for the first few years of new Philippine plantations. As large stills are necessary, I would suggest that these be built of reënforced concrete on the place. This can be done by any intelligent manager at a much cheaper price than it is possible to purchase metal stills and they can be set up on the ground. For a permanent crop, I do not recommend lemon grass because of the present limited demand for the oil. The grass from which the oil has been distilled is dried and burned under the distilling boilers, and the ashes are distributed over the fields for fertilizing purposes. The exhausted grass is also used for making paper. The crop is rather an exhausting one for the soil, so that after three years it is usually considered necessary to transplant the grass into a fresh field.

CINNAMOMUM MERCADOI VID.

This large tree, the Tagalog name of which is *calingag,* is very widely distributed throughout the Philippine Islands. The laboratory has botanical collections showing this species of *Cinnamomum* to occur in Davao, Rizal, Pampanga, Bataan, Antipolo, the Camarines, and Tayabas, and it is probably found throughout all parts of the Islands. Tropical forests do not often have many trees of the same species growing together, as is the case with the almost pure stands of the temperate zones, but as many as 150 trees of *Cinnamomum mercadoi* Vid. have frequently been noted on one hectare, and quantities of the bark sufficient for commercial utilization could be obtained if it were of sufficient value. Hence, I obtained 25 kilos of bark from the Lamao region, Bataan Province. This bark was ground and distilled with steam, giving 260 grams (1.04 per cent) of a light yellow oil. The oil had an odor like sassafras and the following properties: Specific gravity, $\frac{30^\circ}{4^\circ}=1.0461$; $N\frac{30^\circ}{D}=1.5270$; $A\frac{30^\circ}{D}=+4^\circ$.

There are no aldehydes in this oil, neither sodium bisulphite nor phenylhydrazine react. I consider that cinnamic adehyde could be detected in this way by distilling a very small percentage in petroleum ether; experiment demonstrated that cinnamic aldehyde instantly gave a crystalline precipitate of the phenylhydrazone with phenylhydrazine.

The oil was distilled at 10 millimeters and gave the following fractions:

No.	Boiling point.	Quantity.	$N\frac{30^\circ}{D}$
	Degrees.	*Grams.*	
1	119-124	77°	1.5333
2	124-130	9.2	1.5320
3	Residue.	11.5	1.5278

Fraction No. 1 redistilled at ordinary pressure had a boiling point 235° to 238° at 760 millimeters; specific gravity, $\frac{30^\circ}{4^\circ}=1.0631$; $N\frac{30^\circ}{D}=1.5335$; $A\frac{30^\circ}{D}=+0.9$. By oxidation with chromic acid this fraction gives piperonylic acid melting at 227°. Piperonal was obtained by heating with alcoholic potash and then oxidizing with potassium permanganate.

These results leave no doubt but that the oil from *Cinnamomum mercadoi* Vid. is almost entirely safrol, and it is remarkable in this respect as most oils from *Cinnamomum* species contain only small amounts of safrol and large percentages of cinnamic aldehyde. I have also examined two samples of bark of *Cinnamomum* sp. from the Davao region of Mindanao. No sufficient botanical material was sent with these barks to permit the identification of the species, but from the taste and odor of the bark and from the oil obtained by distillation (yield 1.1 per cent) there is little doubt but that they represent the true cinnamon of commerce. Older accounts from Philippine travelers speak of *Cinnamomum zeylanicum* Nees as occurring in Mindanao, and American planters state that the true cinnamon occurs in some quantity in the region back of Davao, and that a small amount of trading in it is carried on among the natives. We have not yet been able to obtain any quantity of this bark or any botanical material for its identification, but expect to be able to do so soon.

PETROLEUM NUTS.

The fruits of *Pittosporum resinifevrum* Hemsl. are known in the Philippines as petroleum nuts, because of a fancied resemblance in the odor of the oil to that of petroleum, and because even the green, fresh fruits will burn brilliantly when a match is applied to them. The tree is essentially an inhabitant of the high mountain ridges, being usually found at an elevation of 500 meters or more. However, one tree was found in Mindoro at an altitude of 170 meters, although it was found in the same region again at 2,500 meters (Mount Halcon). The tree is not very abundant in any part of the Islands, but it is widely distributed, botanical material having been collected from Tayabas, Zambales, Pampanga, Cagayan, Mindoro, Benguet, and Bataan. There is no Tagalog name for the plant as the natives generally do not know the high mountain flora. The oil from the petroleum nut proved to be very interesting as it contained considerable quantities of normal heptane, which has only once before been found in nature, occurring in the digger pine of California, *Pinus sabiniana* Dougl.,[33] and also a dihydroterpene, $C_{10}H_{18}$.

In working up the various lots of *Pittosporum* fruits, considerable differences were noted in the proportions of heptane and dihydroterpene found in the oil, and the season and degree of ripeness of the fruits undoubtedly play a considerable rôle in this respect.

The first lot of nuts was obtained from Baguio, Benguet, in the autumn of 1907. One kilo of whole, fresh nuts gave 52 grams of oil on a press. The residue ground up and again pressed yielded an additional 16 grams of oil; specific gravity=0.883; $N\frac{30^\circ}{D}=1.4577$. It was not possible to determine the optical rotation. The oil is quite sticky, and in a thin layer rapidly becomes resinous. In an open dish it burns strongly, with a sooty flame. It distills unchanged up to 165°, then with decomposition to give a resin oil. The oil distilling from 100° to

[33] *Ann. d. Chem.*, (Liebig), (1879), **198**, 364.

165° is colorless, with an orange-like odor; specific gravity, $\frac{30^\circ}{4^\circ}=0.7692$; $A\frac{30^\circ}{D}=+37^\circ.0$. By two careful distillations the following fractions were obtained:

	Fraction (degrees).	Grams.
(1)	98–103	41
(2)	103–110	18
(3)	110–120	21
(4)	120–140	12
(5)	140–150	7
(6)	150–155	47
(7)	155–160	49

Fraction No. 1 had a pleasant odor recalling oranges, and the following properties: specific gravity, $\frac{25^\circ}{4^\circ}=0.6831$; $N\frac{30^\circ}{D}=1.3898$; optical rotation=0.

Fraction No. 7 had a turpentine-like odor. Specific gravity, $\frac{30^\circ}{4}=0.8263$, $N\frac{30^\circ}{D}=1.4630$.

The properties of fraction No. 1 leave little doubt of the identity of this compound with normal heptane.

A second lot of petroleum nuts was obtained in December, 1908, from one of the upper ridges of Mount Mariveles, Bataan Province. One tree gave 15 kilos of fruits, which by pressure yielded 800 cubic centimeters of oil. The residue ground up and distilled with steam yielded 73 cubic centimeters more. This oil distilled in steam contained no heptane, showing that probably all the latter is in the oil cavities immediately surrounding the seeds, and that the pulp of the fruit contains only resins and the higher boiling portions of the oil. It was also noted that the leaves, branches, bark, wood, and in fact, all parts of the tree are distinctly resiniferous and have the same pleasant, orange-like odor as the fruits. The united 873 cubic centimeters of crude oil were slowly distilled at ordinary pressure giving the following fractions:

	Fraction (degrees).	Grams.
(1)	98–110	15
(2)	110–130	13
(3)	130–150	18
(4)	150–160	520

Destructive distillation began above 160°, the temperature of the vapor being from 170° to 240°. The color of the resin oil became continuously darker as the distillation proceeded until near its close, when a light colored oil was collected and the temperature of the vapor fell coincident with a very hot liquid below. The raw oil thus obtained had a light brown color and quite a pleasant odor; specific gravity, $\frac{30^\circ}{4^\circ}=0.978$; $N\frac{30^\circ}{D}=1.4790$; acid number=263. The neutral oil is especially pleasant in odor, recalling that of menthol, although I failed to find this compound.

Thirty kilos of fruits from Baguio, Benguet (December, 1908), were ground and distilled with steam without preliminary treatment with the hydraulic press.

1,350 cubic centimeters of oil were obtained. This was redistilled over sodium and showed about the same relative percentage of heptane and hydropinene as the nuts collected from Mount Mariveles at the same season. (Second lot above.) The Benguet nut is considerably smaller and thinner than that from Mariveles.[34]

All the distillates up to 165° were now united and carefully fractionated ten times, the final result being as follows:

	Fraction (degrees).	Grams.
(1)	97–101	203
(2)	101–120	12
(3)	120–130	8
(4)	130–140	7
(5)	140–150	14
(6)	150–160	600
(7)	Residue, a very resinous oil.	

Fraction No. 1 was shaken out twice with concentrated sulphuric acid and then distilled over sodium, giving 197 grams of an oil, boiling point, 97° to 98°; specific gravity, $\frac{30^\circ}{4^\circ}=0.6752$; $N\frac{30^\circ}{D}=1.3840$; $A\frac{30^\circ}{4^\circ}=0$. The odor is very pleasant, being very much like diphenyl methane. This oil is undoubtedly normal heptane. 125 grams of heptane were treated with 200 grams of bromine in the sunlight. The influence of sunlight on the speed of bromination is very pronounced. It was noted by counting the number of drops of bromine decolorized per minute, that the reaction proceeded about six times as fast in direct sunlight as when the sun was behind a cloud. The principal product of the reaction under these conditions were *n*–heptyl bromide, boiling at 93° at 70 millimeters' pressure, 178° to 181° at ordinary pressure. It gives *n*–heptyl acetate when treated with fused sodium acetate dissolved in glacial acetic acid. This is a liquid of pleasant odor, boiling at 192°.

Fraction No. 6 was distilled three times over sodium and then gave an oil of the following properties: Boiling point, 158° to 160°; specific gravity, $\frac{30^\circ}{4^\circ}=0.8252$; $N\frac{30^\circ}{D}=1.4587$; $A\frac{30^\circ}{D}=29^\circ.6$. The hydrochloride prepared from this oil had the following properties: Boiling point, 114° to 116° at 34 millimeters; specific gravity, $\frac{30^\circ}{4^\circ}=0.9343$; $N\frac{30^\circ}{D}=1.4655$; $A\frac{30^\circ}{D}=+9^\circ$. The reaction of this chloride with magnesium according to Grignard was not very vigorous or complete and therefore the corresponding hydrobromide was prepared and 50 grams subjected to the Grignard reaction, which was quite violent. On treating the product of the reaction with water and dilute acids, a hydrocarbon of the following properties was obtained: Boiling point, 168° to 170°; specific gravity,

[34] In distilling resiniferous oils of the kind under discussion, it is often noted that an emulsion is formed before the liquid has reached the boiling point, the vapor and gas bubbles penetrate this emulsion with great difficulty; they have a fibrous structure, are full of gas bubbles and are so persistent as to be well worthy of note. One of these, while I was heating *Pittosporum* oil in a beaker, was so persistent, that on emptying the contents into a Hirsch funnel, the oil retained the form of the beaker, although on applying a vacuum, it filtered practically clear, with only traces of water and dirt left on the filter paper. These emulsions always disappear as soon as boiling becomes vigorous.

$\frac{30^\circ}{4^\circ}=0.8050$; $N\frac{30^\circ}{D}=1.4460$; $A\frac{30^\circ}{D}=+1.1$. This hydrocarbon is, therefore, hexahydro *p* cymol and the substance found in the oil from the *Pittosporum* fruits is a dihydroterpene $C_{10}H_{18}$.

I performed one experiment in which I subjected the dihydroterpene hydrobromide $C_{10}H_{19}Br$ to the Grignard reaction and heated the reaction product with benzaldehyde for one hour. On decomposing with water and dilute acids, I obtained, besides large quantities of the above hexahydro *p* cymol, a small amount of a crystalline substance melting at 136°, which on analysis proved to be benzoïn, the principal product of the reaction being the reduced hydrocarbon $C_{10}H_{20}$.

0.2032 gram substance gave 0.590 gram CO_2 and 0.1125 gram H_2O.

	Calculated for $C_{14}H_{12}O_2$ (per cent).	Found (per cent).
C	79.3	79.1
H	5.6	6.1

Therefore this reaction corresponds with that of dihydrolimonene magnesium chloride on benzaldehyde under the same conditions.[35]

A low-country species of *Pittosporum*, (*P. pentandrum* (*Blanco*) Merr.) was also examined. This tree is very abundant in the lowlands of all parts of the Islands. Special experiments have shown that it grows vigorously in cultivation. The fruits are quite small, and there is considerable labor involved in gathering them. One tree yielded 16 kilos of fruit which after grinding gave 210 cubic centimeters of an oil of pleasant odor by distillation with steam. The crude oil boiled from 153° to 165° and after being washed with alkalies and distilled over sodium, had the following properties: Boiling point, 155° to 160° (principally 157° to 160°); specific gravity, $\frac{30^\circ}{4^\circ}=0.8274$; $N\frac{30^\circ}{D}=1.4620$; $A\frac{30^\circ}{D}=40.40$.

These properties leave little doubt but that this oil consists principally of the same dihydroterpene that is found in the higher boiling portions of the oil of the ordinary petroleum nut.

VETIVER OIL.

Andropogon squarrosus L. f. (*A. muricatus* Retz.) is native to the Philippines and is found wild and very abundantly in all parts of the Archipelago. It is identical with the *khus-khus* or *khas-khas* of India. I have never seen screens and mats woven from roots in the Philippines as is common in India, but the roots are usually laid away with the clothing to impart to it a pleasant odor. This *Andropogon* is sold in all the larger public markets. The price for small lots is from 15 to 25 centavos, Philippine currency, per kilo. The natives term the roots *moras* or *raiz moras*, and claim that boiling them with vinegar preserves the odor. I was not able to verify this statement by experiments in the laboratory, as it seemed to me that acetic acid simply slightly intensified the apparent

[35] *This Journal, Sec. A.* (1908), 3, 59.

odor by its own volatility. The experiments conducted in the laboratory on native grass have not yet thoroughly cleared up all points connected with the cultivation and utilization of the roots for perfumery purposes. The yield of roots from various sources and especially the percentage of oil obtainable from them have been very variable. We have now planted on the laboratory grounds in Manila some experimental plots and hope to discover the best methods of handling this crop, as the grass promises to be quite profitable in the Philippines. The oil is valued at 100 to 200 pesos, Philippine currency (50 to 100 dollars, United States currency), per kilo according to quality. The greater part of the distillation at the present time is carried on in Europe from roots shipped principally from India, although some oil is distilled in Reúnion. The plant offers possibilities in the Philippines either for the distillation of the oil or for the export of the dried roots. I am not able to discover that there is at present any exportation of the vetiver roots.

Our experiments on vetiver are as follows:

(1) Thirty kilos of fresh vetiver roots were distilled for two working days (seven hours each) with steam, the condensed water being continually poured back over the roots, and the oil collected in a little petroleum ether to effect easier separation from the water, as the vetiver oil has almost the same specific gravity as water. The petroleum ether was distilled *in vacuo* and there were thus separated 327 grams of a light yellow oil (1.09 per cent) which had a very strong, pleasant odor and the following properties: Specific gravity, $\frac{30^\circ}{4^\circ}=0.9935$; $A\frac{30^\circ}{D}=+32.1$; $N\frac{30^\circ}{D}=1.5212$; saponification number=47.4.

The roots used in the above experiment were obtained from small gardens about Manila and were crushed between the rollers of a sugar mill before being distilled. Such a crushing of the roots seems to improve the yield of oil.

(2) Thirty-one kilos of fresh roots, uncrushed, on distillation as above gave 140 grams oil (0.3 per cent).

(3) Six kilos of dried roots, uncrushed, gave by extraction with ligroin 14 grams of an oil which had only a very slight vetiver odor.

(4) Eighty-one kilos of dry *moras* which had been stored in jute sacks for about three months after harvesting, were distilled with steam with continuous cohobation and yielded 370 grams of oil (0.456 per cent) of an intense odor and brown color. This oil had the following properties: Specific gravity, $\frac{30^\circ}{4^\circ}=0.9964$; $N\frac{30^\circ}{D}=1.5163$; $A\frac{30^\circ}{D}=+32.1$; saponification number=60.6.

It is to be noted that this oil with a higher saponification number has a much stronger odor than that obtained in experiment 1 given above (saponification number=47.4).

(5) A plot of well-fertilized ground containing 150 square meters was planted with vetiver grass. In six months time the plants had flowered and reached maturity; they were then removed, giving 270 kilos of roots, or at the rate of over 18,000 kilos per crop per hectare. However, it was found when these roots were transferred to the laboratory, that they had lost most of their odor, and they gave so small a yield of oil as not to make it worth while to distill them. Some of these plants had been pulled up from time to time and tested for their oil content; they seem to contain the oil up to the time of flowering.

These preliminary experiments seemed to indicate that the proper time for harvesting is about three months after planting, at which time, of course, the yield of roots is not nearly so heavy. The oil in the roots is a protection, and is withdrawn when the plant flowers and seeds. We have planted all of our vetiver by simply burying pieces of divided root tufts in the ground. We have as yet made no experiments on the propagation of the grass from the seed. It was found that the roots can very conveniently be harvested by washing away the soil with a stream of water, catching detached rootlets with a coarse screen. One hundred plants of the above lot, treated in this manner, gave 60 kilos of roots (wet) and 100 plants at Parañaque in a sandy beach soil, gave 23 kilos of roots. The latter were presumably three to four months old and contained a large percentage of oil.

THE COMPOSITION OF VETIVER OIL.

Genvresse and Langlois [36] found in vetiver oil a sesquiterpene, $C_{15}H_{24}$, which they termed vetivene, a sesquiterpene alcohol, $C_{15}H_{24}O$, vetivenol, and an acid $C_{15}H_{24}O_2$. They assign the vetiver odor to an ester of this acid and vetivenol. I am inclined to believe that there may be quite marked differences in the composition of the oil of vetiver due to differences in the age of the roots, methods of storing, distillation, etc., as I have noted that distillates from various lots of roots often had markedly different odors. One oil had very little of the distinctive vetiver odor and reminded me very strongly of gurjun balsam. Another on saponification with alcoholic potash gave large quantities of benzoic acid.

One hundred grams oil (Experiment No. 4) with a strong and pleasant vetiver odor were saponified for one hour on a steam bath with an excess of alcoholic potash. The product was poured into water and separated into neutral and acid products in the usual manner. There were obtained 19 grams of acids, the odor resembling that of fatty acids. The neutral oils retained a very strong odor of vetiver. Purification through the lead salt did not give a crystalline acid, therefore, the acids were distilled *in vacuo*, and after two such distillations gave a 40 per cent yield of a body boiling between 200° to 205° at 4 millimeters' pressure. This acid was a light yellow, viscous oil with a fatty odor like that of oleïc acid. With phenolphthaleïn as an indicator, 1.7850 grams acid required 7.0 cubic centimeters N sodium hydroxide for neutralization, the sodium salt being a noncrystalline, soapy mass; the acid itself had a refractive index, $N\frac{30^\circ}{D}$ =1.4850. This refractive index precludes the possibility of a sesquiterpene acid, as is suggested by Genvresse and Langlois. The analysis is as follows:

(1) 0.210 gram acid gave 0.5730 gram CO_2 and 0.1945 gram H_2O.
(2) 0.1870 gram acid gave 0.5125 gram CO_2 and 0.1650 gram H_2O.

	Calculated for $C_{14}H_{24}O_2$ (per cent).	Found (per cent).	Found (per cent).
C	75.	74.4	74.63
H	10.7	10.19	9.85
Na	9.3	9.0	....

[36] *Compt. rend. Acad. sci.* (1902), **135**, 1059; *Chem. Ztg.* (1902), **26**, 501.

Titration with potassium permanganate showed that 4.2 atoms of oxygen to one molecule of acid were used in oxidation. The zinc salt was prepared by adding a zinc chloride solution to the solution of the sodium salt. It is insoluble in all solvents. At first this salt precipitates as a gummy mass, which, however, on standing for twenty-four hours in the ice box becomes crystalline.

1.3290 grams substance gave 0.2110 gram ZnO.

	Calculated for $(C_{14}H_{23}O_2)_2Zn$ (per cent).	Found (per cent).
Zn	12.74	12.70

The zinc salt melts at a comparatively low temperature with decomposition to a brown liquid and burns very easily in the air. The lead, copper, silver, and calcium salts are all amorphous precipitates, insoluble in hot water or in alcohol.

The neutral oils were separated into the following three fractions by distillation at 12 to 15 millimeters.

	Fraction (degrees).	Grams.
(1)	125–133	17
(2)	137–140	25
(3)	140–145	22
Residue (semi-solid tar)		17

Fraction No. 1 had no vetiver odor and to judge from its properties is probably a sesquiterpene, identical with the vetivene of Genvresse and Langlois. Fractions (2) and (3) and especially the tarry residue, still had a persistent vetiver odor and the first two in their properties correspond to sesquiterpene alcohols. I expect to make more exhaustive studies on the composition and especially on the best methods of cultivating, storing, and distilling vetiver when more material is available. I consider it doubtful whether the odor of this oil is due to an ester. It is always noted that the odor becomes more marked when a little of the oil is placed in water, and saponified vetiver oils and resinous residues always have this same strong vetiver odor when placed in water. The native practices of both India and the Philippines of wetting the roots to make them exhale their odor are probably due to this fact.

BALAO RESIN.

Balao, panao, or *apitong,* is a soft, semi-solid resin coming from *Dipterocarpus vernicifluus* Blanco and *D. grandiflorus* Blanco. Clover has already made a preliminary report on this resin from this laboratory. The further studies on this subject are given below. The principal present use of *balao* is in the varnishing and caulking of native boats. The *balao* thus used gives a very brilliant, tough and durable coat and would seem to have properties that would make its general use for varnish manufacture desirable. The tree is rather widespread and in many localities quite abundant in the Philippines.

I am informed by Doctor Whitford and Mr. Curran, of the Bureau of Forestry, that there is no question but that very large quantities of these resins could be gathered if there were a commercial demand for them, and as they do not belong to the present class of varnish gums (fossil resins) the supply would be perpetual. In spite of the advantage which *balao* has in its exceedingly tough, durable, and hard coat, it has the very serious disadvantage of drying very slowly. Thus far I have not been able thoroughly to combine it with linsed oil, turpentine, or with other driers to make a quick-drying varnish. Another suggested use for the resin is for the treatment of gonorrhœa as a substitute for copaiba. A similar, possibly identical, resin is now being shipped from the Malay States for this purpose.

The distillation of *balao* presents some difficulty as there is a considerable quantity of water mixed with the resin, hence a violent foaming occurs on attempting distillation *in vacuo*. On running steam through the viscous resin to remove the volatile constituents, the difficulty is soon encountered that after heating for a short time the whole resin becomes very hard and solid, so that steam does not readily penetrate it. These difficulties were overcome by distillation *in vacuo* from an oil bath with the following arrangement:

Between the air pump and the receiver a three-way stop-cock is inserted. This is arranged to connect the distilling flask with the air pump or with the open air. As soon as the resin threatens to foam, a little air is let in through this stop-cock, and thus, by careful manipulation, it is possible to control the distillation until all the water has passed over, after which time there is no difficulty.

The record of the various experiments made on *balao* resin is as follows:

(1) I attempted to dissolve 270 grams of fresh *balao* resin in 500 cubic centimeters of ether, with the idea that in this manner the water could be removed and the resin easily distilled *in vacuo*. One hundred and ninety grams were dissolved and after drying with calcium chloride distilling off the ether, etc., were added to the filtered oil of experiment (2). The insoluble 80 grams was a hard, brittle, yellowish resin, which proved of value in making varnishes.

(2) One kilogram of *balao* was treated with 2 liters of ligroin (boiling point 60° to 80°). After heating for one hour on a reflux condenser, the solution was filtered. This is a very slow operation, as the paper is clogged by the gummy mass. Two hundred and twenty grams insoluble resin and a little dirt remained on the filter paper. After removing the water, shaking out with alkalies, drying and distilling off the ligroin, there remained 620 grams of the viscous, yellow oil. This was distilled *in vacuo*, and once redistllled *in vacuo* gave 190 grams of an almost colorless oil having the following properties: Boiling point at 10 millimeters' pressure, 120° to 125°; specific gravity, $\frac{30^\circ}{4^\circ}=0.9105$; $N\frac{30^\circ}{D}=1.5014$; $A\frac{30^\circ}{D}=85.8$.

This sesquiterpene is only partially soluble in 95 per cent alcohol. It is not completely miscible with glacial acetic acid. On adding to this mixture a drop of concentrated sulphuric acid, there is obtained a fine, red color, which gradually darkens.

The distillation residue is a hard, yellow, lustrous resin, soluble to the extent of about 75 per cent in alcohol or turpentine, the solutions giving hard, lustrous varnish coatings. This resin dissolves completely in two volumes of linseed oil and two of turpentine, giving a varnish which dries slowly (five days) to a tough, hard coating. The resin was further tested as to its solubility in the following solvents: petroleum ether hot or cold, very slight; cold acetone 75 per cent soluble, no more soluble on heating; almost completely soluble in cold xylol, chloroform, carbon tetrachloride and amyl acetate; in benzol it is but slightly soluble, hot or cold; it is 75 per cent soluble in ethyl acetate and 50 per cent soluble in cold chloral hydrate, the latter solvent taking it up with a red color. It is completely soluble on warming, the color being darker, approaching blue.

(3) Five hundred and seventy grams *balao* resin were carefully heated in a large evaporating dish over a free flame, the temperature being noted by means of a thermometer thrust into the resin. At 100° there was much foaming, due to water separation. The mass was kept at 100° for one hour, then gradually raised from 110° to 120°. Water continued to be given off and there was a very marked thickening of the mass, but no especial evidence of decomposition. In the next half hour, during which time the temperature had risen to 160°, the mass gradually became thicker and more solid, with constant evolution of water. At this stage 75 grams had been lost, and the acid number was 20.0 as compared to 18.6 for the original resins. The corresponding saponification numbers were 25.4 and 23.0. All these differences may readily be credited to the loss of water and show that this heating has no effect on these two factors. The solubility in alcohol seems to be somewhat increased over that of the unheated resin, but this may be due to the water loss. The temperature was finally raised and maintained at 200° to 220° for one hour. The resin melted and on cooling solidified to a hard, brittle, lustrous mass. The loss finally was 240 grams or 42 per cent.

(4) Three hundred grams *balao*, 700 cubic centimeters alcohol, and 50 grams potassium hydrate were heated to 100° for one hour with a reflux condenser. Almost complete solution had taken place upon saponification. The mass was poured into water and separated into neutral and acid portions. Fifty-two grams of solid, crystalline acids were separated from the alkaline extract on treating with hydrochloric acid. These acids were only partly soluble in ether, and this solvent therefore gives a means of separation. The neutral oils were shaken out with ether. At first all were soluble, but after the ether solution had stood for two days, 60 grams of a crystalline solid separated; this was filtered. The ether was then dried and evaporated, whereupon the residual oil distilled *in vacuo* gave 75 grams of sesquiterpene, boiling between 130° and 134° at 15 millimeters, nearly all passing over at 130°; specific gravity, $\frac{30^\circ}{4^\circ}=0.9111$; $N\frac{30^\circ}{D}$ 1.4969; $A\frac{30^\circ}{D}=+108.7$. There remained in the distilling flask 70 grams of hard, yellow resin with properties similar to those detailed under experiment 3.

(5) Acid and saponification numbers of two samples of *balao*.

	(1)	(2)
Acid number	13.0	10.0
Saponification number	18.5	34.16

(6) A sample of a very liquid *balao* was obtained and the solid constituents were separated from it by using a coarse, muslin cloth for a filter. A thick, viscous oil was obtained having approximately the consistency of castor oil. It had the following constants: $N\frac{30^\circ}{D}=1.5120$; $A\frac{30^\circ}{D}=+33^\circ.1$; acid number=20.8; saponification number=23.6.

This oil, treated with concentrated sulphuric acid, gives a brillant scarlet-red color. It is but partially soluble in a glacial acetic acid, and if a drop of concentrated sulphuric acid is added to this solution, a red color is obtained which in the course of a few minutes becomes darker and changes into an intense purple. With a drop of concentrated nitric acid, the oil only gradually gives this deep purple color, the acid beneath the oil being red.

(7) The product of five trees was caught in small boxes cut in the trees, similar to those used in the turpentine industry of the southern United States. This was done during four days and the total gathered amounted to 1,025 grams with an acid number of 13.4 and a saponification number of 20.9. This resin was white and of the usual consistency. It was thoroughly mixed and 50 grams heated from 200° to 220° in a metal bath with a reflux condenser for four hours. At first there was violent foaming, which soon ceased. The product was very liquid on removing from the hot bath, but on cooling changed to about the same consistency as that of the unheated resin. The hardening noted in other experiments when heat was employed was probably due to the removal of water. The solubility of this fresh resin in various solvents is about the same as that of the older, commercial resins. The product of one tree (40 centimeters in diameter) for five days (320 grams) was also collected. This was an exceedingly fluid resin which gathered in a very liquid state in longitudinal cracks in the heart of the tree. An attempt was made to centrifugate the solid particles from this resin, but there were evidently not sufficient differences in specific gravities to make this operation a success.

(8) *The destructive distillation of balao resin.*—Five hundred grams *balao* resin were distilled from a 1.5 liter Jena flask, a metal bath being used in the first part of the operation. There was slight foaming in the beginning, but after one-half hour, during which time the temperature of the metal bath had risen to 200°, the mass became very thick and gelatinous. Twenty grams of water and 5 grams of oil had distilled. It was now necessary to use a free flame. The whole mass melted, a considerable quantity of water was given off, and a fraction of oil (155 grams) boiling at 253° was obtained, the thermometer remaining practically constant. The next fraction (50 grams) came over very slowly, the thermometer registering 253° to 255°. The temperature of the vapor then began to fall and decomposition set in, as was evidenced by the blue color of the distillate, and the marked darkening of the resin in the flask, by gas evolution, etc. There were obtained 120 grams of a green oil, at a moderate heat, during the next two hours, the thermometer in the vapor showing a temperature of 220° to 230°. The heat was now markedly increased, a 7-inch Bunsen flame playing directly on the flask, and 110 grams of a greenish-brown oil distilled at 290° at 310°. Thirty grams of a black, solid tar remained in the flask. The total time of distillation was four hours. The amount of gas given off during the destructive distillation of *balao* resin is very small.

All fractions were redistilled as follows:

(*a*) The fractions obtained up to the time of decomposition were united, dried with calcium chloride, and distilled *in vacuo*, the boiling point being 128° to 131° at 13 millimeters' pressure, the greater part passing over at 129° and leaving a residue in the distilling flask of 12 grams, which was added to the fraction below. This is termed fraction number 1.

(*b*) The resin oils were redistilled at ordinary pressure, giving two fractions; these are fractions numbered 2 and 3.

(2) 180° to 225°, a light brown oil, 85 grams.

(3) 225° to 310°, a blue, fluorescent oil, 210 grams.

Various determinations were now made upon these three oils by Mr. Mariano Vivencio del Rosario of the Bureau of Science as follows:

No.	Specific gravity, $\frac{20^\circ}{4^\circ}$	Index number.	Saponification number.	Acid number.
1	0.9089	268.3	4.01	1.8
2	0.8882	192.1	10.7	23.0
3	0.9387	120.9	12.75	18.

The properties of the resin oil, fractions (2) and (3) united, were as follows: Specific gravity, 0.9215; index number, 144.6; saponification number, 12.07; acid number, 19.7.

These oils, when extracted with alkali, washed, dried, etc., give a light green, fluorescent oil of a rather pleasant odor.

(9) Many attempts were made to dissolve *balao* resin in linseed oil or turpentine, or to treat it with driers to give a quicker drying varnish.

Balao is completely and easily soluble in hot linseed oil, but on cooling the whole separates out, constituting a jelly which is not very soluble in turpentine. However, if *balao* is heated with linseed oil to 300° for six hours and then two volumes of turpentine added, about 75 per cent of the resin remains in solution and this solution, when filtered, gives a very satisfactory varnish. Additions of lead oxide, lead linoelate, manganese borate to *balao* resin, with subsequent boiling, did not seem to increase the drying properties. Terpineol, in which many unmelted resins dissolve, gave no better results.

THE SESQUITERPENE FROM BALAO RESIN.

I consider that, because of the narrow range of the boiling point of the fraction 128° to 131° at 13 millimeters, an individual sesquiterpene is contained in *balao* resin. Six hundred grams of this sesquiterpene were distilled three times *in vacuo* over sodium, the resulting oil being almost colorless, with the peculiar pleasant odor of the resin, reminding one slightly of oil of cedar. This oil had the following constants:

Boiling point at 8 millimeters, 118° to 119°; specific gravity, $\frac{30^\circ}{4^\circ}=0.9104$; $N\frac{30^\circ}{D}=1.4956$; $A\frac{30^\circ}{D}=+116.4$; ester and saponification numbers=O. Molecular refraction:

Calculated for $C_{15}H_{24}F_2$ (per cent).	Found (per cent).
66.15	65.9

This latter number shows that the sesquiterpene belongs to the bicyclic series, with two double bonds and one bridge bond.

The sesquiterpene, isolated in the manner described above, was now distilled at ordinary pressure; 150 grams of the oil passing over completely between 261° to

262°.4 (standard thermometer, wholly in the vapor). The distillate was yellow in color, being somewhat darker than the oil distilled *in vacuo*, but no odor, gas evolution, or other phenomena which would indicate any decomposition were noted. The constants found were: Specific gravity, $\frac{30°}{4°}=0.9104$; $N\frac{30°}{D}=1.4960$; $A\frac{30°}{D}=+116.5$; $A\frac{30°}{D}=+120.8$.

The action of bromine on the sesquiterpene was as follows: Some of the body of a constant boiling point was mixed with glacial acetic acid in which it is not very soluble. A violent reaction took place on adding bromine drop by drop, and the liquid turned an intense blue color, later passing into purple. As the sesquiterpene is completely and easily soluble in chloroform, the next experiment was made while using this solvent. The same results were obtained. On adding a very dilute, cold solution of bromine in chloroform to a solution of the terpene in chloroform in a freezing mixture, the first few drops were simply decolorized, but very soon the same color changes as have been mentioned above manifested themselves. The brominated sesquiterpene in every instance proved to be a hopeless tar.

A small amount of sesquiterpene gave no reaction either in the cold or at 100° when treated with sublimed aluminum chloride. The oil reacted instantly with warm, acidified potassium permanganate, reducing the permanganate, and giving a tar of a very pleasant odor from which no definite bodies could be isolated. The sesquiterpene when treated with concentrated hydrochloric acid at first gave a pink color which later deepened to an intense purple. Iodine numbers for this sesquiterpene were determined for me by Mr. Reibling and Mr. del Rosario of the Bureau of Science. Working according to the standard Hanus method they found 367, 372, 375, 384 (calculated Hanus number for 61=376). The iodine number which was found, depended upon the length of time during which the sesquiterpene remained in contact with the iodine solutions. If these solutions were left standing for twenty-four hours or more, iodine numbers much higher than the above were obtained, namely, 564, 583, etc. These results are probably due to the peculiar, unsaturated, and easily oxidizable structure of the sesquiterpenes.

Some of the sesquiterpene isolated as described above and which had been allowed to stand in a glass-stoppered bottle in the light for one and one-half years was redistilled over sodium *in vacuo*. It gave the following constants: Boiling point at 15 millimeters, 130° to 131°; specific gravity, $\frac{30°}{4°}=0.9100$; $N\frac{30°}{D}=1.4950$; $A\frac{30°}{D}=101.2$.

This body was dissolved in an equal weight of dry ligroin and saturated with dry hydrochloric acid. Two molecules of hydrochloric acid for one molecule of the sesquiterpene were added and the solution became purple. No solid hydrochloride could be obtained and the addition product could not be distilled *in vacuo* without decomposition. An attempt was therefore made to subject the crude product to the Grignard reaction in the hope that di- and tetra-hydro sesquiterpenes, at present an unknown series of bodies, might be obtained. The hydrochloride had a slight action on magnesium, but as the reaction did not go to completion it was impossible to isolate the compounds wished for. The attempts to prepare these reduced sesquiterpenes, which may throw some light on the very dark field of their chemistry, will be repeated with cadinene hydrobromide, as we have in the Philippines a large supply of this sesquiterpene obtainable from the oil of *supa*.

THE DISTILLATION OF BLUMEA BALSAMIFERA DC.

Blumea balsamifera DC. grows very abundantly in many parts of the Philippines. I have made a few experiments for the purpose of determining whether this plant can profitably be cultivated and utilized. From 0.1 to 0.4 per cent of a yellow oil with a camphor-like odor is obtained on distilling the leaves. This is almost pure *l*–borneol. As this substance is so easily oxidized to camphor, the oil from *Blumea balsamifera* should be valued at from one-half to three-fourths the price of camphor. The growth of this plant in the Philippines is exceedingly vigorous and the leaves could be cut four times a year. According to some experiments made in Indo-China,[37] it is possible to obtain 50,000 kilos of leaves per hectare, per year, which would give a possible borneol yield of from 50 to 200 kilos per hectare. As labor is not exceedingly cheap in the Philippines, it is a question whether the cultivation and distillation of these plants could be handled at a profit. This would need to be worked out.

THE DISTILLATION OF LANTAVNA CAMARA L.

Lantavna camara L., a sweet-scented weed, is exceedingly abundant in the Philippines. It grows so abundantly and so luxuriantly that if the oil is of any value, its cultivation is certainly a commercial possibility.

Seventy kilos of the leaves distilled with steam gave 60 cubic centimeters of a light yellow oil; 100 kilos gave 245 cubic centimeters, and 110 kilos gave 78 cubic centimeters of oil.

These results show that the yield of oil evidently varies considerably, the differences depending upon the season, age of the leaves, etc. The oil has a specific gravity of $\frac{30^\circ}{4^\circ} = 0.9132$; $N\frac{30^\circ}{D} = 1.4913$; $A\frac{30^\circ}{D} = +11.5$. Its odor reminds me somewhat of sage. Fifty grams distilled *in vacuo* gave two fractions as follows:

(1) Twenty-two grams boiling between 125° to 130° at 12 millimeters; $N\frac{30^\circ}{D} = 1.4892$.

(2) Twenty-four grams boiling between 130° and 140° at 11 millimeters; $N\frac{30^\circ}{D} = 1.4970$.

We shall send samples to Europe for valuation, and if it proves to be of any commercial value we will study the question further.

OIL OF YLANG-YLANG.

In a previous paper in this series,[38] I published constants on first and second grade, pure ylang-ylang oils of known origin. Various regularities were noted which justified me in stating that first grade ylang-ylang

[37] *Bull. Économ.* (1907), n. s. **9**, 202.

[38] *This Journal, Sec. A.* (1908), **3**, 65.

oils were characterized by a low refractive index, low optical activity, and high ester numbers. I have continued the investigation on this season's distillates of this oil and find exactly the same series of regularities. Acetyl numbers have also been made on these oils, and it will be noted that first-grade ylang-ylang oils are characterized by high acetyl numbers as compared with the second-grade oils. The actual determination of these numbers was made by the method of Zerewitinoff [39] and the results calculated to the usual definition of acetyl number, namely, saponification number of 1 gram of oil after acetylation. The numbers obtained by this method are from 15 to 20 per cent higher than those given by the standard method, due no doubt to the well-known behavior of alcohols like linalool and geraniol toward acetic anhydride.

TABLE III.—*First-grade ylang-ylang oils.*

No.	$N\frac{30°}{D}$	$A\frac{30°}{D}$	Specific gravity, $\frac{30°}{4°}$	Ester number.	Acetyl number.
		Degrees.			
20	1.4944	—24.3	0.943	119	203
24d	1.4863	—32.5	0.915	100	177
48	1.4880	—42.5	0.910	90	154
49	1.4935	—35.2	0.930	108	187
53	1.4920	—31.0	0.92	106	180
27	1.4872	—40.0	0.918	109	188
28	1.4877	—44.8	0.914	106	183
29	1.4882	—45.6	0.913	102	196
30	1.4897	—43.1	0.922	107	189
31	1.4868	—44.3	0.916	107	192
32	1.4870	—44.6	0.917	106	181
33	1.4892	—50.2	0.915	102	182
34	1.4880	—51.8	0.908	92	147
35	1.4898	—43.0	0.931	129	214
51	1.4860	—22.0	0.934	126	202
52	1.4860	—31.0	0.929	105	182
55	1.4923	—50.2	0.919	97	177
56	1.4921	—50.3	0.919	97	174
57	1.4924	—50.2	0.918	98	179
58	1.4921	—50.3	0.919	96	172
59	1.4921	—50.0	0.917	96	175
60	1.4924	—50.2	0.918	98	178
61	1.4922	—50.1	0.918	98	178
62	1.4922	—50.0	0.917	97	176
63	1.4923	—50.0	0.919	97	175
64	1.4921	—50.3	0.918	97	176
1	1.4885	—40.0	0.917	102	182
2	1.4880	—40.0	0.910	92	161
3	1.4880	—36.5	0.924	118	201
4	1.4860	—34.0	0.922	120	209
7	1.4910	—43.0	0.932	100	178

Samples 55 to 64 inclusive represent ten distillations made in the same day, using three stills and the same lot of mixed flowers.

[39] *Ber. d. deutschen chem. Ges.* (1901), **40**, 2023.

TABLE IV.—*Second-grade ylang-ylang oils.*

No.	$N\frac{30^\circ}{D}$	$A\frac{30^\circ}{D}$	Specific gravity, $\frac{30^\circ}{4^\circ}$	Ester number.	Acetyl number.
		Degrees.			
21.	1.4933	—46.2	0.915	85	132
A	1.4928	—40.4	0.912	86	130
M	1.4923	—38.5	0.914	86	138
L	1.4913	—42.2	0.910	86	127
26	1.4923	—39.8	0.915	88	141
39	1.5014	—79.3	0.910	83	112
40	1.5011	—70.9	0.916	84	108
41	1.5004	—70.4	0.914	83	109
42	1.5010	—74.0	0.912	74	107
43	1.5012	—78.8	0.909	74	104
44	1.5012	—73.2	0.912	85	109
45	1.4922	—39.2	0.912	87	120
46	1.4910	—41.0	0.905	85	124
47	1.4915	—41.0	0.913	85	131
36	1.4990	—71.2	0.905	71	96
37	1.5002	—77.2	0.906	72	101
38	1.5008	—71.9	0.912	74	103
50	1.4910	—43.0	0.910	84	131
54	1.4920	—41.8	0.910	84	127
5	1.5030	—58.7	0.923	80	115
6	1.5005	—49.0	0.925	87	118
8	1.5021	—56.0	0.925	75	110

I have also undertaken the extraction of the perfume oil from ylang-ylang flowers. Many of the constituents of essential oils are very delicate substances and distillation with steam decomposes these compounds to a considerable extent, so that a steam-distilled oil but rarely has exactly the same odor as the flowers from which it was obtained. Extraction with cold solvents and the removal of the solvent *in vacuo,* the temperature never being allowed to rise above 40°, gives oils which have exactly the same aroma as the flowers. This process has the further commercial advantage that such extracted flower oils can not be imitated synthetically, as the change in aroma is undoubtedly due to traces of very easily decomposable compounds which it will be difficult, if not impossible, ever to isolate and identify. The extracted oil need fear no competition with synthetic oils. Alcohol, ether, chloroform, and petroleum ether have been used as solvents for ylang-ylang oil, and the last named has given the best results. Naturally, a very high grade of petroleum ether, which leaves no bad smelling residue when distilled up to 40° in a vacuum of 40 millimeters, must be used as the solvent for the essential oil. Operating in this manner, we have obtained oil yields of from 0.7 to 1.0 per cent. The oil is of a very dark color and contains a considerable amount of resin in solution. When in bulk, the odor is not particularly pleasant or very strong, but when the extract is greatly diluted the pleasant aroma of the flowers becomes very apparent. The physical constants of one sample of this oil were as follows: Specific gravity, $\frac{30°}{4°}=0.940$; $N\frac{30°}{D}=1.4920$; ester number=135; acetyl number=208.

The oil is too dark to permit readings of its optical rotation to be practicable. These constants are seen to agree quite well with those of a very high grade distilled oil, and as was stated above, the different odor is probably due to traces of delicate compounds present in the extracted oil, which are destroyed during the process of distillation. It is rather curious to note that when this extracted oil is shaken out with water, a considerable amount of resin separates, carrying the distinctive flower aroma, and the separated oil then has an odor resembling that of methyl–*p*–kresol.

These extracted oils should sell for a considerably higher price than the best distilled oils, which fact, taken in consideration with the increased yield and the impossibility of competition from synthetic oils, offers a very attractive new industry to the Philippines.

OTHER PRODUCTS.

The leaves of an unknown species of *Fagara* collected in the northern provinces were examined and found to contain a small percentage of an oil which contained limonene and also probably a limonene derivative which may also be obtained by the action of a solution of dilute, alkaline, copper sulphate on limonene. The compound gives a crystalline derivative with phenylhydrazine and its nature will be taken up in a subsequent publication.

One of the mints, *Hyptis suaveolens* Poir., known by the Tagalog name of *sub-cabayog*, was also examined.

Two hundred kilos of this weed distilled with steam yielded only 27 grams of a greenish oil, with a powerful menthol odor. Investigation proved that menthol was the principal constituent of this oil, but the yield is much too small to render the plant of any value for purposes of distillation.

The leaves of *Clausena anisum-olens* (Blanco) Merr., a tree which is rather abundant in some parts of the Philippines, have an odor which is strongly like that of anise. Alcoholic extracts of these leaves also have a very strong anise-like odor. It is possible that this plant can be used locally in preparing *"anisados,"* which are favorite alcoholic beverages among the natives. It is interesting in this connection to note the statement of Busse,[40] who, speaking of the medicinal and economic plants of Dutch East Africa, states that *Clausena anisata* Willd. does not smell

[40] *Ber. d. deutschen pharm. Ges.* (1904), 14, 215.

like anise, but like heliotrope. This is not true for the Philippine species of this plant.

There are two varieties of flowers known as *champaca* in the Philippines, the yellow and the white, *Michelia champaca* and *M. longifolia* Bl. Of these the yellow has much the finer odor and it is considered by experts to be by far the finest perfume in the Philippines, the scent being at the same time very soft, strong, and lasting. Small parcels of *champaca* oil, principally distilled from the white variety, have been sold in Europe, the supply coming mostly from Java. The Filipinos are very fond of the flowers, they being made into wreaths and sold in small lots at the rate of a peso to a peso and a half per kilo. One attempt at steam distillation of an oil from the flowers was not successful. The yield of oil was very small and did not have an odor greatly resembling that of the flowers. Enfluerage with paraffine oil has been successfully applied. The paraffine oil is allowed to stand over the flowers for twenty-four hours, drawn off, filtered and made up to the original volume before being applied to fresh flowers. By ten such extractions a very fine, strong odor is imparted to the paraffine which is now suitable as a base for perfumes, or the champaca oil may be extracted from the paraffine with strong alcohol. The loss in paraffine is large, so that we shall endeavor to extract the flowers with petroleum ether, alcohol, ether and other volatile solvents. Very few flowers were available this year because of the many typhoons during the flowering season, which lasts from September to November. The tree is readily propagated from the seeds and begins to bear in three years. The quantity of flowers which can be obtained from one tree is much less than from the ylang-ylang, but the price of champaca extracts is enormously higher than those from the latter.

We have also attempted to obtain a perfume oil from the flowers of *Plumeria acutifolia* Poir., which is used as an ornamental tree in the cemeteries throughout the Islands. The fragrance of the flowers is faint, but characteristic, and the flower is supposed to be the source of the perfume known as "frangipani." I distilled 40 kilos of flowers with steam, but obtained no oil, nor even an aqueous distillate of pleasant odor. Many extraction experiments with different solvents have shown that the perfume is very easily destroyed by heat so that the temperature used in handling these flowers must never rise above 40°. Extraction with low-boiling petroleum ether and distillation of the petroleum ether *in vacuo* gives a gummy oil with a satisfactory odor. The best results which we have obtained thus far are by enfluerage with paraffine oil, the operation being carried out as detailed above under champaca. The season, weather conditions, and time of day seem to have a very pronounced effect on the amount of perfume in these flowers, and we have not yet worked out all these factors.

We have distilled 100 kilos of the roots of *Curcuma zedoaria* Rosc., which is very abundant in many localities near Manila. Sixty-five grams of oil (0.665 per cent) were obtained and also 40 grams of a volatile, beautifully crystalline solid.

The oil has a dark, greenish-brown color and a pleasant, slightly camphoraceous odor. It is probably optically inactive; certainly its optical activity does not exceed $+1°.5$. The oil is so dark as to preclude more accurate measurement. Specific gravity, $\frac{30°}{4°}=0.933$; $N\frac{30°}{D}=1.4920$.

It is readily soluble in two or more volumes of 80 per cent alcohol. On distilling the lowest boiling portions of the oil *in vacuo,* it loses its camphoraceous odor (probably due to cineol) and the scent then becomes quite flower-like. Although oil of zedoary is one of the oldest known essential oils, very little has been discovered concerning its composition. A study of the chemical composition of this oil will be taken up later. It is to be noted that the specific gravity of the oil I obtained does not agree with the figures recorded in the literature for oil of zedoary.

THE OXIDATION OF PHENOL: THE EFFECT OF SOME FORMS OF LIGHT AND OF ACTIVE OXYGEN UPON PHENOL AND ANISOLE.

By H. D. Gibbs.

(From the Laboratory for the Investigation of Foods and Drugs, Bureau of Science, Manila, P. I.)

I have shown [1] that neither pure phenol, moist crystals, nor a solution of the crystals in water are affected by the intense sunlight of this locality when exposed in sealed glass tubes in atmospheres of nitrogen, hydrogen, or carbon dioxide.

Kohn and Fryer [2] have exposed both pure phenol crystals and moist phenol *in vacuo* and found the light to have no effect. From these experiments they, and Richardson,[3] conclude that the reactions responsible for the red coloration of phenol are due to hydrogen peroxide oxidation and that the presence of water, oxygen, and sunlight are all necessary factors, the absence of any one of which will prevent the reaction.

These writers, as I have shown,[4] are correct in their opinion that the cause of the red coloration is oxidation and I have isolated the products to be expected from such a reaction, namely, quinone and catechol. Another substance which is probably formed during the reaction is quinol and the presence of the condensation product phenoquinone is extremely probable.

Kohn and Fryer state [5] "since the coloration is always accompanied by the absorption of moisture, the presence of moisture is most probably intimately associated with the formation of the color" and [6] "in the absence of moisture no coloration takes place."

Since writing the first article [7] "The Compounds which Cause the Red Color in Phenol," this phase of the question has been investigated and I find that these statements are not in accord with the facts. It is not surprising that Kohn and Fryer were led into this error, for the character of the sunlight available to them and the atmospheric conditions in their

[1] *This Journal, Sec. A,* (1908), **3**, 361.
[2] *Journ. Soc. Chem. Ind.* (1893), **12**, 111.
[3] *Ibid,* (1893), **12**, 415.
[4] *Loc. cit.*
[5] *Loc. cit.* 110.
[6] *Loc. cit.,* 111.
[7] *Loc. cit.*

locality are hardly comparable with those in which I have worked in the Tropics.

Richardson [8] says: "Dr. Kohn also tells me that a degree of darkening in phenol, such as was obtained by me after three days' exposure in Clifton, England, could only be produced after many weeks under the conditions under which he has exposed it in Liverpool," and Kohn himself remarks [9] that in his own experiments the exposures have been made more under the conditions under which the usual reddening of phenol occurs, the samples being exposed in the south windows of a well lighted room.

I am led to believe that active oxygen in any of its forms will react with pure, dry phenol and consequently produce the coloration. Kohn and Fryer [10] think that the oxidation of phenol goes on in the absence of light and they make the following statement:

"In respect to the action of light a series of experiments showed that the coloration is produced in the dark, although slowly, and therefore the light acts as an accelerator of the change only—an action of which there are many other instances. * * *"

They made exposures of dry phenol in dry air to the light conditions in their locality and found no coloration in seven months. I have, incidental to other work, exposed dry phenol in dry, pure oxygen to the diffused light of this laboratory for several weeks, and moist phenol to moist, atmospheric air in the dark at room temperature for two months without any appreciable coloration becoming visible. Nevertheless, it can not be considered proved that there is no reaction between oxygen and phenol in the dark. In fact it is probable, from considerations which will be advanced later, that a slow reaction takes place.

Hydrogen peroxide reacts readily and I will show, in the experimental part of this paper, that dry ozone is very reactive, either with the pure, dry crystals or with melted phenol. The intimate association of water with the coloration, which Kohn and Fryer observed, is thus explained not as a compound necessary to the reaction, but as one of the products of the reactions:

$$C_6H_5OH+O=C_6H_4(OH)_2,$$
$$C_6H_4(OH)_2+O=C_6H_4O_2+H_2O, \text{ or}$$
$$C_6H_5OH+2O=C_6H_4O_2+H_2O.$$

There is no doubt, however, but that the rate of oxidation is more rapid in the presence of moisture.

Chapman, Chadwick, and Ramsbottom [11] found that the presence of moisture in the reaction between carbon monoxide and oxygen in the presence of ultra-

[8] *Loc. cit.*, 415.
[9] *Loc. cit.*, 416.
[10] *Loc. cit.*, 111.
[11] *Journ. Chem. Soc. London* (1907), **97**, 943.

violet light increases the rate of the formation of carbon dioxide and that while dry carbon dioxide is decomposed by the light, in the presence of moisture no decomposition could be detected. They conclude that in a photo-chemical reaction, the catalyst (moisture) exerts a marked influence in determining the mode of distribution of the energy amongst the molecules of the reacting substances.

EXPERIMENTAL.

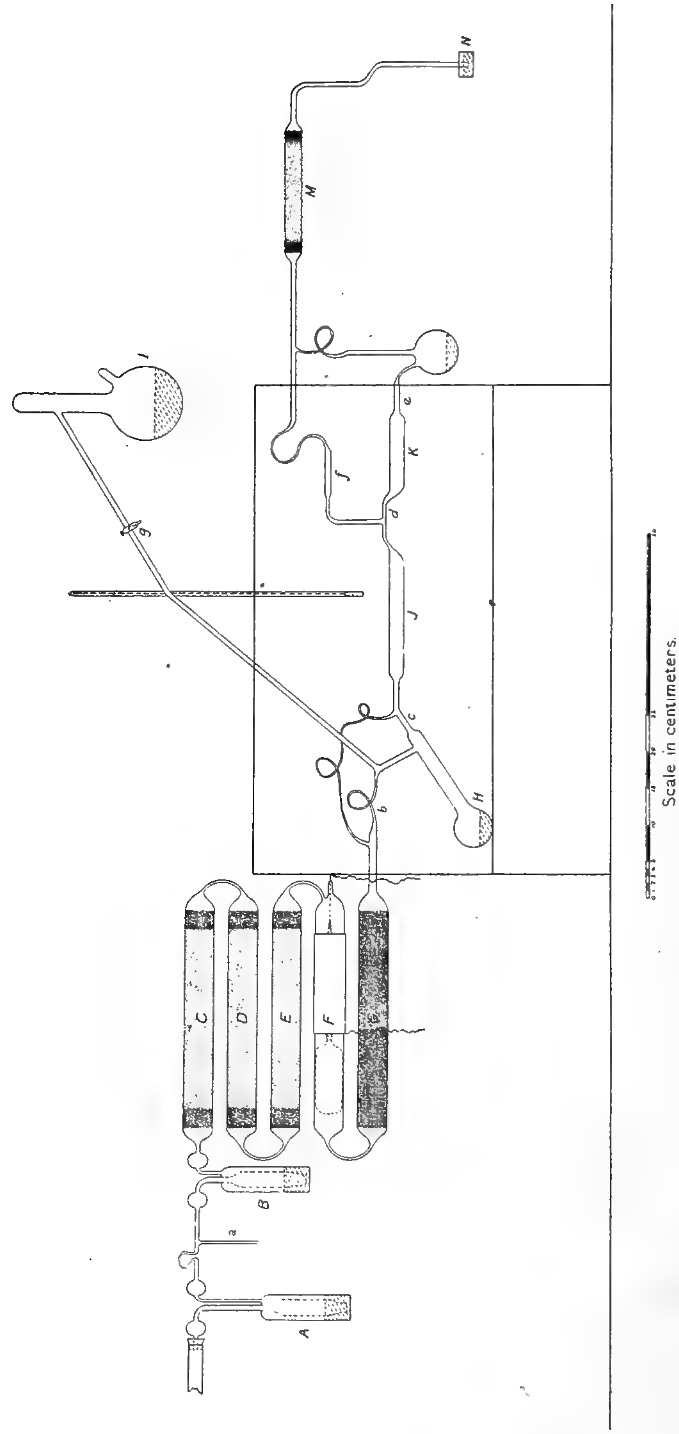
Crystals of purest phenol were placed in a bulb tube and heated in an atmosphere of dry hydrogen until about 75 per cent volatilized. After cooling in the current of hydrogen, this gas was replaced by dry, atmospheric air which had been passed through a purifying chain. The tube was then carefully sealed and placed in the sunlight, at a temperature of about 30°. The crystals colored slowly with liquefaction, until the entire mass had changed into a liquid of a deep red color. The coloration was first noticeable in two hours and liquefaction was complete after about five days, depending upon the quantity of phenol and oxygen present, the size of the tube, the quality of the glass, and some other factors. The experiment and results described were duplicated several times.

This work was then repeated with the utmost care and with an apparatus especially designed to eliminate all known sources of error. It permitted the double distillation of phenol over sodium in an atmosphere of dry, pure hydrogen and the condensation of any desired fraction in two tubes which could be sealed out of the apparatus independently of each other, the replacement of the hydrogen with purified, dry atmospheric air or oxygen, and the treatment of one or both of the tubes with ozonized oxygen in the dark. During all of these operations there was no possibility for the entrance of moisture, for all of that portion of the apparatus between the extremities of the drying tubes at both ends of the chain was composed of glass vessels sealed in a continuous chain.

DESCRIPTION OF APPARATUS. (FIG. 1.)

The gases employed, hydrogen, atmospheric air, and oxygen, were purified by passing through concentrated sulphuric acid, two tubes of calcium chloride, one tube of soda lime, a combustion tube filled with purified asbestos heated to redness, and then into the chain of apparatus shown in fig. 1. Here the gases successively passed through a saturated solution of caustic potash, *A*, concentrated sulphuric acid, *B*, three tubes of phosphorus pentoxide held in place by plugs of glass wool, *C*, *D*, and *E*, an ozonizer of the Siemen's[12] form, *F*, and a tube of tightly packed glass wool, *G*. The next portion of the apparatus consists of an arrangement of tubes and distilling flasks, inclosed in an asbestos oven, for the handling of the phenol, and the tube of phosphorus pentoxide *M*, with its end dipping under mercury in the dish *N* to exclude moisture. All of the apparatus from *A* to *N* was connected by glass seals.

[12] *Ann. d. Phys.* (1857), **102**, 120.



A
B
a
C
D
E
F
G
H
I
J
K
M
N
b
c
d
e
f
g
Scale in centimeters.

DRYING THE APPARATUS AND THE PHENOL.

After the complete chain was closed by glass seals, with the exception of the two extremities and the stopcock *g*, the combustion tube was heated and a slow current of hydrogen passed through for six hours. The portions of the apparatus inclosed in the asbestos oven, shown in fig. 1 by the heavy lines, and also the tubes *F* and *G* were heated to 140° for four hours after which the hydrogen current was stopped and the apparatus allowed to stand for ten days.

A pure sample of about 400 cubic centimeters of colorless phenol was employed as a starting material. It was distilled over a small piece of metallic sodium [13] and the middle fraction collected in a receiver arranged to exclude the light. After cooling, the flask was gently shaken and the crystals which immediately formed represented only about one-half of the total mass, owing to the sudden rise in temperature due to the crystallization of the supercooled liquid. The melted portion was at once drained from the crystals. These were again distilled and the middle fraction collected in the flask *I* through the side tube. A small stick of metallic sodium was dropped in, the side tube sealed, and a slow hydrogen current turned on. The purified sample was again distilled, the first fraction passing out through the tail of the stopcock *g* and the middle fraction condensed in the flask *H* without stopping the distillation, by quickly turning the stopcock. The flask *I* was then removed by sealing the outlet tube below the stopcock *g*.

The asbestos oven was heated to from 160° to 180° in the steady current of hydrogen for two hours, the phenol partly vaporizing and collecting in the receiver *L*. A small flame was then placed under the flask *H* and the phenol boiled until about one-third had passed through the tubes *J* and *K* and collected in *H*. The source of heat was removed from the oven and the phenol condensed in the tubes *J* and *K* until they were about one-third filled. The whole apparatus was cooled in the current of hydrogen and the distilling flask sealed out of the chain by closing the tubes at *b* and *c*. The residue in the distilling flask was colorless.

In order to change the gas in the apparatus and avoid the phenol coming in contact with oxygen which had not been heated (to eliminate the possibility of the presence of ozone) the outlet *a* was opened and the hydrogen in the combustion-furnace displaced by air. The combustion-furnace was again heated, the outlet *a* sealed, and the hydrogen throughout the apparatus displaced by air. The tube *K* was removed by careful fusion at the points *d* and *e*.

The phenol in this tube (*K*) colored gradually when it was placed in the direct sunlight until the oxygen was practically all in combination. On breaking one of the points under water, the amount of oxygen which had combined was shown by the amount of water sucked in. Other tubes sealed in the same way were found to color more or less rapidly depending largely upon the temperature. When cooled by contact with broken ice, the coloration was only visible after several days' exposure to a bright sun. When the temperature was nearly that of the melting point of phenol, the color appeared in from fifteen minutes to

[13] The sodium employed was in the form of sticks inclosed in small glass tubing into which it has been introduced by melting *in vacuo*. Sections of the tube of the desired length were broken and immediately dropped into the distilling flask. By this means sodium of a comparatively pure quality, free from moisture and hydroxide, was obtained.

one hour, probably because minute particles had been melted. Several tubes after exposure were tested for the presence of carbon dioxide by dipping the point under a clear solution of barium hydroxide and allowing a small quantity of the solution to be sucked in. Small quantities of carbon dioxide were indicated in every case. About 2 grams of pure phenol sealed, in a dry, purified atmosphere containing a little more oxygen than atmospheric air, in a 200 cubic centimeter flask with two outlet tubes, was exposed to the direct sunlight for a month and then tested for carbon dioxide by aspirating the gases through a barium hydroxide solution. All necessary precautions to avoid the introduction of the carbon dioxide of the atmosphere were taken. The tips of the outlet tubes of the flasks were not broken until the rubber tube connections were in place, a clear solution of barium hydroxide contained in a *U* tube attached, and soda lime tubes and a wash bottle containing a concentrated solution of potassium hydroxide, to prevent the entrance of carbon dioxide, connected. A considerable amount of carbon dioxide was indicated by the heavy precipitate of barium carbonate.

After the tube *K* had been sealed off, the atmosphere in the apparatus was replaced by pure oxygen, the tube *J* being wrapped in black paper to exclude the light. No coloration of the phenol could be observed. The tube *J* containing the phenol crystals was then packed in broken ice and the oxygen current ozonized by connecting the terminals of the ozonizer *F* with an induction coil. The reaction between the ozone and the cold phenol crystals was at first very slow, no appreciable coloration being visible for several hours. However, when it had begun, the action proceeded with increasing velocity, no ozone escaping from the reaction tube containing the phenol after the reaction was well under way. However, before that time a small quantity of supercooled, liquid phenol farther along in the apparatus, at the point *f*, colored instantly upon the contact with the ozone, but none of the latter escaped at *N*, as was proved by repeated tests. In both cases the first color was bright yellow; this color gradually extended throughout the mass and changed from yellow to pink and finally to a dark, reddish-brown with gradual liquefaction of the crystals.

Another experiment was carried out in the same way, except that the phenol in the tube *J* was not cooled with ice and was in the form of a supercooled liquid. In this instance the phenol colored with great rapidity and no ozone escaped to the tube *f*. The liquid phenol in *f*, in this experiment, was not protected from the diffused daylight of the room, and nevertheless remained colorless after exposure to the rapid current of oxygen throughout the entire experiment which lasted for fourteen days.[14] On bubbling the oxygen escaping at *N* through a potassium

[14] The phenol was subjected to the action of the oxygen current for this length of time for the reason that the ozonizer was rather feeble and produced only a small degree of ozonization.

iodide-starch solution, no coloration was produced, showing that the ozone was entirely removed by reaction with the phenol. Carbon dioxide is given off in considerable quantities during the reaction.

The tube *J* was finally opened and a study of the reaction products made. The reddish-brown liquid was shaken with water, the insoluble portion separated and the aqueous solution extracted repeatedly with chloroform and ether. These extracts were found to contain considerable quantities of unchanged phenol, small amounts of quinone and catechol, and considerable amounts of quinol.

The aqueous solution contained an acid which was volatile with steam, reduced ammoniacal silver solution and mercuric chloride, was precipitated by calcium hydroxide, and on boiling precipitated calcium oxalate. It gave an orange-yellow precipitate with phenylhydrazine [15] in the cold. This precipitate on purification and recrystallization formed yellow crystals. Even though an insufficient quantity of the phenylhydrazine compound was obtained for an analysis, it is reasonably safe to assert that the acid in aqueous solution was glyoxylic acid.

Several experiments were completed in the same manner with the difference that the issuing gases were passed through $\frac{N}{5}$ solutions of barium hydroxide. The following was the result:

	Grams.
Carbon dioxide evolved	0.11
Weight of the mixture in the tube *J* when the evolution of carbon dioxide had practically ceased	3.00
Acidity of aqueous extract was equivalent to 18 cubic centimeters $\frac{N}{10}$ = glyoxylic acid (CHO.COOH) equivalent to 4.4 per cent of the residue.	0.13
Chloroform extract	0.64
Ether extract	0.23

The chloroform and ether extracts were dried in a vacuum desiccator with the loss of considerable of the products. The principal loss in weight was due to phenol vaporized.

Two grams of another residue, on distillation with steam gave an acid distillate equivalent to 16 cubic centimeters $\frac{N}{10}$ alkali which, calculated as glyoxylic acid, equals 5.9 per cent.

THE ACTION OF OZONE UPON PHENOL.

Otto [16] observed that ozone reacts with phenol producing a red color. He studied the reaction at 16° and 50° and isolated no reaction products.

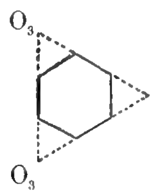
Dry ozone is, in general, not reactive. It is more reactive when traces of moisture are present.[17] Pure, dry, ozonized oxygen will react

[15] Fischer, E., *Ber. d. deutschen chem. Ges.* (1884), **17**, 577.

[16] *Ann. chim. et phys.*, Paris (1898), III, **13**, 136.

[17] Uhrig, Richarz, *Phys. Ztschr.* (1905), **6**, 1.

at once with pure, moisture-free phenol in the liquid state and more slowly when the phenol is in the form of crystals. The reactions which take place are largely influenced by the temperature. At the room temperature, 30°, the first action is the production of quinone, and possibly quinol, as indicated by the coloration. As the reaction proceeds an ozonide is undoubtedly produced. This is evidenced by the copious evolution of carbon dioxide and the formation of glyoxylic acid, a reaction analogous to the breaking down of the triozonide of benzene,



$$O_3+3H_2O=2CHO.CHO+2CO_2+4H_2O,$$

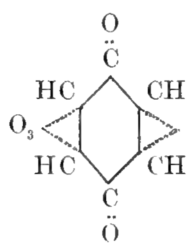
as demonstrated by Harries and Weiss.[18]

When ozone acts upon dry phenol, the water which seems to be necessary to the breaking down of the ozonide, and which also accelerates the reaction, is produced during the formation of quinone as follows:

$$C_6H_5.OH+2O=C_6H_4O_2+H_2O$$

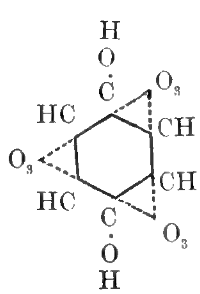
When ozone reacts upon moist phenol, the same reaction products are produced, quinol resulting in larger quantities than quinone.

Whether it is the diozonide of quinone or the triozonide of quinol which breaks down according to the reactions—



$$O_3+2H_2O_2=2HOOC.CHO+2CO_2+2H_2O$$

or



$$=2HOOC.CHO+2CO_2+H_2O$$

[18] *Ber. d. deutschen chem. Ges.* (1904), **37**, 3431.

has not been determined. When dry ozone comes in contact with dry phenol, cooled in an ice bath, the velocity of the reaction is very much reduced; the products, however, appear to be the same. Carbon dioxide is evolved and no ozonide can be isolated. No attempts have been made to work at lower temperatures and employ solvents for the phenol, with the view of isolating an ozonide.

THE ACTION OF NASCENT OXYGEN, LIBERATED AT THE ANODE, UPON PHENOL.

By the action of the alternating current upon aqueous solutions of phenol in the presence of magnesium sulphate and magnesium hydrogen carbonate, Drechsel[19] has obtained catechol, quinol, phenolsulphonic acid, γ diphenol, formic acid, oxalic acid, succinic acid and a number of other products. The action of the alternating current in aqueous alkaline solutions has also been studied.

Bartoli and Papasogli[20] have studied the products of the action of the direct current upon alkaline solutions of phenol.

It is to be expected that the oxidation of alkaline solutions of phenol will produce more complicated reaction products than when an acid solution is employed, for the reason that quinone is so easily oxidized to complicated products in presence of alkalies.

EXPERIMENTAL.

A concentrated aqueous solution of phenol, acidified with sulphuric acid to facilitate the passage of the electric current, was divided between two vessels connected by a syphon, and electrolyzed with a direct current passing between platinum electrodes placed one in each vessel.

While the evolution of hydrogen was quite brisk from the cathode, very little oxygen escaped from the anode. The solution surrounding the anode quickly assumed a yellow color deepening to a red, while that surrounding the cathode remained colorless. The anode became coated with a thick layer of a yellowish-red substance which was removed from time to time by washing the electrode in alcohol. This compound is insoluble in water, soluble in alcohol and in phenol, imparting to both solutions a brilliant red color. It is in all probability one of the condensation products to which the coloration of phenol is to be attributed.

The solution around the anode was found to contain considerable quantities of quinone. No complete investigation of the reactions involved was attempted.

THE QUESTION OF THE CHEMICAL ACTIVITY OF OXYGEN GAS IONS.

Experimental data seems to point to the fact that gas ions are not reactive in the chemical sense.

Gockel[21] found that the ionization of ozonized oxygen made by passing oxygen over moist phosphorus was not destroyed by passing the gases through various

[19] *Journ. f. prakt. Chem.* (1884), 2, 29, 229; and (1888), 2, 38, 67.
[20] *Compt. rend. Acad. sci.* (1882), 94, 1339; *Gazz. chim. ital.* (1884), 14, 90.
[21] *Phys. Ztschr.* (1903), 4, 602.

solutions, water, potassium hydroxide, dilute and concentrated sulphuric acid, potassium permanganate, pyrogallol, potassium iodide, and oil of turpentine, even though the ozone was in some cases completely removed.

Bredig and Pemsel[22] observed that the rate of the oxidation of sodium sulphite is not accelerated when the air, before passing into the solution, is exposed to the action of ultra-violet or Röntgen rays, uranium or phosphorus. Ewan[23] after studying the slow oxidation of phosphorus, sulphur and aceteldehyde, concludes that in the process only a small portion of the oxygen which is dissociated into its atoms takes part in the oxidation. Van't Hoff[24] in commenting upon the work of Ewan says that the oxidation may be due to oxygen atoms or oxygen ions and that it is not due to ozone. Eder[25] balances the evidence by saying that in the present state of our knowledge it is by no means excluded that oxidation is accelerated by contact of the oxidizable substance with the oxygen which has been ionized by exposure to light and that ozone formation and ionization are accompanying phenomena.

From the experiments performed with the apparatus shown in fig. 1, it is to be concluded that another instance has been added to those above cited, pointing to the inactivity of the oxygen ions in the process of oxidation. By means of this apparatus pure, dry ozonized oxygen was brought into contact with pure, dry phenol in the dark. The tube *G*, containing a length of 18 centimeters of tightly packed glass wool removed the gas ions[26] produced by the brush discharge in the tube *F*, so that it is to be presumed that oxygen in the condition of O_2 and O_3 (and perhaps some atoms due to an equilibrium $O_2 \rightleftharpoons 2O$) only pass into the tube *J* containing the phenol. In some experiments the glass-wool filter was omitted from the chain and in others it was in place as shown in fig. 1. In both cases the reaction with phenol in the liquid state, supercooled or not, proceeded at once upon contact with the ozone, no ozone escaping reaction with the phenol, while with phenol which was entirely crystalline the reaction was very much diminished in speed. No variations were noted between the rate or character of the reaction due to the presence or absence of the ion filter in the apparatus chain.

While it is to be concluded from these experiments that ozone is a form of oxygen reactive with phenol, with or without the presence of the gas ions, it is not proved, from the method of experimentation, that the gas ions exert no influence.

[22] Dammer, Handbuch d. anorg. Chem. (1903), **4**, 122; Eder, Photochemie, Halle, a/S. (1906), 87; *Jahresb. d. Chem.* (1899), **1**, 380.

[23] *Chem. News.* (1894), **70**, 90.

[24] *Ztschr. f. phys. Chem.* (1895), **16**, 411.

[25] Photochemie, Halle a/S. (1906), 87.

[26] With respect to the removal of the ions formed by the action of Röntgen rays see Thomson and Rutherford, *Phil. Mag. & Journ. Sci.* (1896), **42**, 392. With respect to ions formed in other ways see Conduction of Electricity through Gases, 1906, 11. On page 39 Thomson states: "From these numbers we conclude that the ions produced by Röntgen rays, by radio-active substances and by ultra-violet light are identical, a conclusion which we shall find confirmed by several other courses of reasoning."

INFLUENCE OF THE GLASS OF THE CONTAINING VESSEL ON THE RATE OF COLORATION.

Different varieties of glass have been found to show different absorption values to short wave lengths. Atmospheric air is more opaque to the most chemically active ultra-violet rays than fluorspar, rock salt, or quartz.[27]

Phenol exposed to the action of the sun's rays is colored more rapidly under quartz glass than under ordinary glass. A sample of pure phenol was divided into two equal portions in watch glasses, one covered by a clear glass dish and the other by a quartz dish of almost exactly the same thickness, and placed side by side in the sun. The sample protected by the quartz glass distinctly showed more coloration in two hours. After several days the coloration of the two samples was found to have deepened in about the same ratio.

Two small, thin glass bulbs of equal size inclosing equal quantities of phenol, were placed in the sun, one protected by a soda-glass dish and one by a quartz dish. The coloration was noticeably more rapid under the quartz than under the soda glass. Layers of equal thickness showed the difference in color to be marked when viewed through a color comparator.

THE PRODUCTION OF OZONE IN THE SUNLIGHT.

Atmospheric air and oxygen are ozonized by ultra-violet rays.

Lenard[28] has shown that under their influence gases become conducting and in the case of oxygen, ozone is formed. These effects were brought about in air by the short wave lengths to which the atmosphere is comparatively opaque. Lenard's[29] observations that coal gas or an atmosphere charged with coal gas is even more opaque to the short wave lengths than pure air has been confirmed by J. J. Thomson.[30] Regner[31] has found the wave lengths below 200 $\mu\mu$ to be ozone producing, while those above 257 $\mu\mu$ have the opposite effect. Since Meyer[32] observed that the ozone absorption spectrum shows a maximum at wave length 257 $\mu\mu$, it is to be expected that these waves will be most active in the process of deozonization. The oxygen absorption spectrum[33] begins about the wave length 193 $\mu\mu$ and extends farther into the ultra-violet and Lenard[34] found that the region of greatest ozone production lies between the wave lengths 140 to 190 $\mu\mu$.

Since only the absorbed rays produce chemical reactivity it is evident that, as the character of the vibrations changes from the shorter to the longer wave lengths, the ozonization process is changed to one of

[27] Lenard, *Ann. d. Phys.* (1900), **306**, 486.
[28] *Ann. d. Phys.* (1900), **70**, 486.
[29] *Phil. Mag.* (1897), **43**, 254.
[30] *Proc. Cambridge Phil. Soc.* (1908), **14**, 419.
[31] *Ann. d. Phys.* (1906), **325**, 1033.
[32] *Ibid.* (1903), **12**, 849.
[33] Kreusler, *Ann. d. Phys.* (1901), **6**, 418.
[34] *Loc. cit.*

deozonization, the change in wave length producing this effect being about 60 $\mu\mu$; that is, from 193 to 257 $\mu\mu$. The sun's rays being a mixture of wave lengths constantly changing in character as they pass through the earth's atmosphere, the shorter being absorbed, and, as suggested by Fisher and Braehmer,[35] with the formation of ozone, it is reasonable to suppose that the ozonization process gradually changes to one of deozonization as the earth's surface is approached and that greater quantities of ozone are not found near the surface, not so much through the destruction of ozone by oxidation, as Fisher and Braehmer have advanced, as through the influence of the longer wave lengths,[36] the temperature also being an important factor. From the experiments of Regener it may be assumed that there is an equilibrium between O_2 and O_3, at every temperature, and that the concentrations of the molecular oxygen and the ozone depend, other conditions being equal, upon the concentrations or intensities of the various absorbed wave lengths in the rays to which the gas mixture is exposed. Moreover Briner and Durand [37] have found that the temperature is an important factor in this equilibrium. Oxygen, under the influence of the silent discharge, reaches an equilibrium with 11 per cent ozone formation at —78°, while at —194° the conversion to ozone is practically quantitative.

Elster and Geitel found that amalgams of sodium or potassium inclosed in glass vessels loose a negative charge in the daylight. J. J. Thomson,[38] referring to their work, stated that "The glass vessel would stop any small quantity of ultra-violet light which might be left in the light after its passage through the atmosphere." In this reference he must have had in mind the shorter wave lengths, for it can not be doubted but that wave lengths shorter than 300 $\mu\mu$ reach the surface of the earth. Edmond Becquerel,[39] sixty-six years ago, with a crude apparatus and a flint-glass prism, succeeded in photographing the sun's spectrum to about

[35] *Ber. d. deutschen chem. Ges.* (1905), **38**, 2639.

[36] Ozone in the upper atmosphere will be swept to the surface by air currents. The variation in the amounts found in the surface atmosphere may be thus accounted for.

Peyrou (*Compt. rend. Acad. sci.* (1894), **119**, 1206) could find ozone in the atmosphere of Paris only when there were high winds. He, however, rather attributes the results to the circulation of ozone formed over growing crops.

De Thierry (*Ibid.* (1897), **124**, 460) has observed that the quantity of ozone in the atmosphere increases with the altitude. At Chamonix, altitude of 1,050 meters, the amount found was 3.5 milligrams, while at Grands-Mulets, Mont Blanc, altitude 3,020 meters, 9.4 milligrams per 100 cubic centimeters were found.

Hartley (*Journ. Chem. Soc. London* (1881), **39**, 127) states, "The foregoing experiments and considerations have led me to the following conclusions: First, that ozone is a normal constituent of the higher atmosphere. Second, that it is in higher proportion there than near the earth's surface."

[37] *Compt. rend. Acad. sci.* (1907), **145**, 1272.

[38] Conduction of Electricity through Gases, Cambridge Univ. Press (1906), 251.

[39] *Ann. d. chim. et phys.* (1843), III, **9**, 298.

the wave length 328 $\mu\mu$. Photographs made with improved apparatus show the Fraunhofer line *U* which has the wave length 294.8 $\mu\mu$. Since the limit of visual sensibility of the human eye is about 400 $\mu\mu$ (Nutting [40] says 330 $\mu\mu$) the above statement of Thomson can not be considered as being strictly accurate.

It is evident that ultra-violet light will penetrate to the interior of a glass vessel exposed to the sun's rays, the quality of the glass being an important factor. Regener[41] states that glass absorbs the ultra-violet rays below the wave length 300 $\mu\mu$. Fisher and Braehmer [41] have observed that the coloration of manganese glass is produced slowly in the sunlight, more rapidly in high altitudes than in the lowlands, and in a few hours on exposure to the rays of the quartz-mercury lamp, and further that this effect is due in the latter case neither to the cathode nor Röntgen ray, but to the ultra-violet light.[42]

From these considerations one would expect that, under the most favorable conditions, the production of ozone in the atmosphere at sea level would be at a minimum (in the absence of other catalysts than sunlight), while if the atmosphere or oxygen were inclosed in a glass vessel, possibly only traces or none whatever would be produced as a result of the action of the sun's rays and that if an equilibrium between ozone and molecular oxygen is established it will lie at the point where the ozone concentration is extremely minute.[43]

While it is possible that ozone may be produced by radioactivity, since radioactivity is present in the atmosphere and M. and Mme. Curie[44] have found that radioactive barium produces ozone in the air and Richarzy and Schenk[45] have shown that oxygen is ozonized with feebly radioactive radium bromide, it does not seem probable that an equilibrium between the two oxygen states will be seriously affected by this influence, or that it requires serious consideration among the causes which produce the oxidation of phenol.

EXPERIMENTAL.

Two soda-glass tubes, 60 centimeters long and 16 millimeters inside diameter, the glass less than 1 millimeter in thickness, were thoroughly dried and sealed, inclosing an atmosphere of pure, dry oxygen, free from ozone and gas ions and placed in the direct sunlight. The moisture was removed from the tubes by sealing them on to the drying chain (see fig. 1) previously described, at the point *b* and the chain was closed to moisture by a phosphorus pentoxide tube sealed on at the right extremity. All of that portion of the apparatus inclosed between the phosphorus pentoxide tubes was heated to 110° for six hours in a

[40] Bull. Bureau of Standards 1908, **5**, 265.

[41] *Loc. cit.*

[42] Fisher, *Ber. d. deutschen chem. Ges.* (1905), **38**, 946.

[43] Ewell (*Electrochem. & Met. Ind.* (1909), **7**, 23) states that the equilibrium between oxygen and ozone at ordinary temperatures is almost infinitesimal.

[44] *Compt. rend. Acad. Sci.* (1899), **129**, 823.

[45] *Journ. Chem. Soc.* London (1904), Abs. **2**, 399; *Sitzungsber. Akad. d. Wiss.*, Berlin (1904), **13**, 490.

current of oxygen. The ozone was removed from the oxygen by the combustion furnace and the gas ions were destroyed by the tube of tightly packed glass wool *G.*[46] After cooling in the oxygen current and standing eighteen hours, the operation was repeated and the tube sealed out of the chain.

A second tube of the same dimensions was treated in the same way, except that before sealing it was opened just in front of the phosphorus pentoxide tube, the oxygen current running at a fairly rapid rate, and a small piece of cleaned and ignited silver foil inserted. The seal was then made several centimeters back from the opening to avoid the introduction of moisture from the flame of the blowpipe. One end of the tube was wrapped with tin foil for a distance of 5 centimeters and the pieces of silver put into this darkened pocket so that the direct rays of the sun would not strike it.

Silver foil discolors in the presence of ozone;[47] the test, however, is not as delicate as some others.

After four and ten days' exposure, respectively, the tubes were removed from the direct sunlight at 1 p. m. to obtain the maximum sun effect and immediately tested for ozone. The first tube was cooled to produce a slightly reduced pressure in the interior, so that on breaking the tip beneath the surface of a sensitive potassium iodide and starch solution about 2 cubic centimeters were drawn in. This solution was passed repeatedly from end to end of the tube and showed no visible coloration on standing in the dark, after twenty-four hours. The second tube was tested by breaking the tips from both ends and washing out the gas, through the small opening, by means of a stream of pure oxygen. The issuing gas played against a piece of sensitive potassium iodide-starch paper without producing any noticeable discoloration. The piece of silver foil also was without indication of ozone. If active oxygen was formed in the sunlight under the conditions described, the amount was so minute that the delicate tests employed were decidedly negative.

THE EFFECT OF OZONE, AND OXYGEN AND SUNLIGHT UPON THE METHYL ETHER OF PHENOL, ANISOLE.

Anisole is not colored by a rapid current of ozonized oxygen bubbling through it for two days at 30°, or by exposure to direct sunlight in the presence of moisture and oxygen for two months, the temperature occasionally rising above 40°.

No special attempts were made to purify the anisole. A sample which had been in this laboratory for some time was distilled once and the middle fraction employed in the experiments. It remained practically colorless throughout the experiments. The fixation of the labile hydrogen atom of phenol prevents oxidation under the conditions of the experiment.

[46] Thomson and Rutherford, *Phil. Mag.* (1896), 42, 392.

[47] Thiele, *Ztschr. f. öff. Chem.* (1906), 12, 11.

THE ACTIVITY OF THE PHENOL MOLECULE.

The measurements of the absorption-spectrum of phenol made by Hartley [48] show a broad absorption band with a maximum at $\lambda=272\ \mu\mu$. The breadth of this band depends upon the concentration. With 1 milligram molecule in 100 cubic centimeters of alcohol the extremities of the band are $\lambda=291.6$ to $243.1\ \mu\mu$ and with 1 milligram molecule in 500 cubic centimeters they are $\lambda=283.5$ to $261.5\ \mu\mu$.

Anisole shows the same absorption band, with the difference that it divides into two bands near the head. This variation shows a marked difference between the constitution of the two compounds which has been traced by Baly and Collie [49] to a certain amount of tautomerism in phenol. The absorption band heading at about $\lambda=277\ \mu\mu$ is characteristic of the labile hydrogen atom. Baly and Eubank state,[50] "These results leave no doubt but that phenol, under these experimental conditions, has not the same structure as anisole, and that the difference is due to the wandering of the labile phenolic hydrogen atom."

The active wave lengths are thus seen to be very close to the limit of the sun's rays which escape absorption in the atmosphere and which are capable of penetrating glass. The fact that the coloration of phenol has been found to be more rapid under quartz than under other kinds of glass is evidence upon this point. The failure of Kohn and Fryer [51] to obtain any coloration of pure phenol is evidently due to the atmospheric conditions in Liverpool. In Manila, where this investigation has been carried on, the atmosphere is free from smoke and very clear at certain seasons of the year. The altitude of the sun is such that the ultra-violet absorption of the atmosphere is less than in Liverpool, even if the atmospheres in the localities were equally clear. Hartley [52] says,

> "I have been led to attribute the limited extent of the solar spectrum, as photographed in London, to the selective absorption of rays by the tarry matters in the smoke of the town's atmosphere, especially since my experience of the extraordinary absorptive power of benzene derivatives."

That the phenol molecule is activated under the conditions of the observations described, appears to be a more reasonable explanation of the phenomenon than that the oxygen molecule is activated by available wave lengths which do not approach the region of the oxygen absorption

[48] *Journ. Chem. Soc. London* (1902), **81**, 929.
[49] *Ibid.* (1905), **87**, 1339.
[50] *Ibid.*, 1348.
[51] *Loc. cit.*
[52] *Journ. Chem. Soc. London* (1881), **39**, 111.

spectrum.[53] Bancroft[54] in expounding the second law of Grotthuss[55] says:

"If the active light is light which is absorbed by the substance to be oxidized and not by the oxygen, then the substance to be oxidized has been made active by the light and the oxygen is the depolarizer. If the active light is absorbed by oxygen and not by the substance to be oxidized, then this latter is the depolarizer and the oxygen is made active by light."

Eder[56] with regard to this phase of the question states that a compound which is acted upon by light absorbs only those vibrations of the light with which its atoms vibrate, or are capable of vibrating, in synchrony. In this way the absorption of the light is connected with the intra-molecular constitution of the compound. The amplitude of the vibrating atoms composing a molecule of a substance sensitive to light may be increased by the light waves vibrating in coincidence, and when a certain limit is exceeded, a breaking of the molecular bonds ensues; that is, photo-chemical decomposition takes place. This effect is well exemplified by certain color substances employed in photography to increase the optical sensibility of the silver salts.[57] Bancroft says,[58] concerning the action of optical sensitizers on photographic plates.

"The theory of Grotthuss enables us to make a definite statement in regard to sensitizers, and one that differs to a certain extent from any of the previous ones. A sensitizer must be a depolarizer, directly or indirectly. It must be a reducing agent in the broad sense of the term or it must be changed into one by the action of light. In either case, the sensitizer is decomposed by the action of light on the sensitized plate;" and "Eder's theory of molecular vibration can not account for Abney's experiment with cyanine plates to which the silver bromide was added after the exposure to light."[59]

The possibility that ozone is formed during the combination of phenol with oxygen is not excluded. From the fact that small amounts of carbon dioxide have been found in the tubes of pure phenol and purified atmospheric air after exposure in the sunlight until the major portion of the oxygen had disappeared, it seems to be quite possible that the sunlight reaction produces in a measure the same products as the reaction between ozone and phenol in the absence of light. It is also possible that a peroxide, other than hydrogen peroxide, is formed during the reaction.

[53] In the case of moist phenol, where there is hydrogen peroxide formation, other considerations enter.

[54] *Journ. Phys. Chem.* (1908), **12**, 258.

[55] *Ibid.*, 212. "The action of a ray of light is analogous to that of a voltaic cell (Grotthuss)".

[56] Photochemie, Halle a/S (1906), 43.

[57] *Ibid.*, 45.

[58] *Loc. cit.* 360.

[59] *Ibid.*, 376.

THE EFFECT OF TEMPERATURE UPON THE ACTIVITY OF THE PHENOL MOLECULE.

Kohn and Fryer[60] have observed that the phenol residues in the distilling flasks are always colored. I have many times observed the same phenomenon on distilling phenol when access to the atmospheric air or oxygen was possible. When the phenol was distilled in an atmosphere of hydrogen with the apparatus shown in fig. 1, the residues were always absolutely colorless when viewed by the eye. No precautions are necessary to exclude light and the phenol in the hydrogen atmosphere will remain colorless indefinitely in the sunlight.

EXPERIMENTAL.

About 50 grams of pure phenol were introduced into a distilling flask which was arranged with a tube reaching to the bottom, sealed in at the top of the neck. The phenol from the time of its purification was protected from the light and from contact with substances which might introduce impurities and the distilling flask was likewise protected from the diffused daylight of the room by asbestos wrappings. No corks or stoppers were used in the distilling flask, glass seals only being employed. The sample was distilled with a current of purified, dry, atmospheric air slowly bubbling through the tube reaching to the bottom of the flask. The air was purified by passing through the purifying chain fig. 1, previously described, with the combustion furnace heated.

The distillation was stopped when about 10 cubic centimeters of phenol remained in the distilling flask. The phenol had been at the boiling temperature twenty minutes, and during this time had assumed a light reddish-yellow color, about the shade usually produced by a few hours' exposure, in contact with atmospheric air, to the sun at a temperature of about 40°. On changing the air current to oxygen and heating to the boiling point the rate of coloration was much more rapid, a brilliant red being produced in a few minutes.

A tube of pure, dry phenol, prepared by the method of distillation in hydrogen in the apparatus described, shown by fig. 1, and sealed in contact with purified atmospheric air, was protected from the action of light by heavy wrappings of tin foil, and placed in a steam bath at 100° in the

[60] *Loc. cit.*, 108, state, "The sample was therefore carefully distilled six times successively from a glass retort and the distillate collected in a glass receiver. The first portion of the distillate was always rejected, and a small residue left in the retort in each distillation. The residue left in the retort always possessed a dark pink tinge, which darkened rapidly on exposure, even in blue glass bottles"; and on page 110, "The combined results of the previous series of experiments show that distillation from glass vessels is really an effectual means for completely purifying phenol. For our further experiments we therefore distilled 'absolute' phenol under the conditions already described, and in order to be well on the safe side fifteen successive distillations were made. The final product, which was quite colorless, melted at 41° C. * * * During the distillations the residue in each case turned pink, and on standing become red."

dark. The steam bath was heated for seven hours a day during six days of the week. The tin-foil covering was carefully removed once a week for the shortest possible length of time, to allow examination of the phenol. At the end of the second week a faint reddish yellow was observed. This color deepened constantly as time proceeded.

The rate of combination of the phenol molecule with oxygen, and consequently the formation of the color will undoubtedly be augmented with a gas mixture containing a higher percentage of oxygen than atmospheric air.

It is evident from these experiments, that for the production of the purest phenol, the distillation should not be conducted with access to oxygen. While the temperature of the phenol is elevated it should come in contact only with an indifferent gas. It is also probable that the combination with oxygen goes on at all temperatures down to the absolute zero, the temperature being an important factor of the rate.

INFLUENCE OF THE ALTITUDE OF THE SUN UPON THE RATE OF COLORATION.

I believe that I have noticed a difference in the rate of coloration of phenol at different seasons of the year. When the sun is directly overhead, which occurs twice a year in this latitude, there is apparently a more rapid production of the red color than when it is in the far south in December and January. This observation is attended by so many factors that it is difficult at this time to make any positive statement. A more complete series of observations and measurements extending over a long period of time will be necessary before any definite results can be obtained.

It is obvious that the rays pass through a thinner layer of atmosphere in reaching the surface of the earth when the sun is in the zenith and therefore the ultra-violet absorption will vary at different seasons of the year, and since the shorter wave lengths undergo refraction to a lesser extent than the longer, a greater proportion of the shorter waves reach the earth's surface when the sun is directly overhead.

It is possible that these considerations produce different light effects in the Tropics, where the sun is sometimes in the zenith, than in the temperate and arctic zones where it never reaches the same condition.[61]

The admirable observations of Cornu have shown that the limit of the sun's spectrum is variable, according to the state of the atmosphere and the altitude of the sun[62] and that the longest ultra-violet spectrum was obtained near noon at the highest elevations.[63]

[61] The attempt to photograph the sun spectrum to shorter wave lengths than any recorded will shortly be made in this locality by the writer.

[62] *Compt. rend. Acad. sci.* (1879), **88**, 1101.

[63] *Ibid.* (1879), **89**, 808.

SUMMARY.

1. Pure phenol remains colorless in the sunlight when in contact with the indifferent gases, hydrogen, nitrogen and carbon dioxide.

2. Pure phenol will become colored in the presence of oxygen.

In the dark the rate is not appreciable at room temperatures. It increases with rise of temperature, can be measured at 100°, and at the boiling point of phenol is fairly rapid.

In the sunlight the rate of coloration is rapid and increases directly with the temperature.

3. The cause of the color is oxidation.

The principal products of the oxidation are quinol, quinone, and catechol. Some carbon dioxide has been found.

The principal colored compounds are probably quinone condensation products. The formation of the intense red condensation product phenoquinone is probable.

4. Active oxygen will unite with phenol with considerable ease and rapidity.

Ozone is very reactive. Quinol, quinone, catechol, glyoxylic acid, and carbon dioxide have been identified among the products of the action with ozone. No ozonide has been isolated.

Oxygen liberated at the anode reacts with phenol. Quinone is one of the reaction products.

5. The experiments argue against the chemical activity of the oxygen gas ions.

6. The glass through which the sunlight acts upon phenol in the presence of oxygen has an influence upon the rate of reaction. Glasses having the most complete ultra-violet absorption retard the reaction in the greatest degree.

7. Ozone could not be detected in pure, dry molecular oxygen sealed in a glass tube and exposed to the sun.

8. The altitude of the sun, the thickness of the atmosphere through which it acts, and the atmospheric conditions undoubtedly influence the rate of the coloration of phenol.

9. The methyl ether of phenol, anisole, is not colored by ozone or oxygen and sunlight.

The fixation of the labile hydrogen of phenol decreases the susceptibility of the compound to oxydizing influences.

10. The reactivity of the phenol molecule is augmented by the absorbed wave lengths at about $\lambda=291$ to $243\ \mu\mu$, and as far as has been observed the same effect is produced by higher temperatures. The oxidation and consequent coloration of phenol goes on under both influences.

11. The purest phenol can only be distilled out of contact with oxygen. Hydrogen has been employed in this work.

ON A RAPID CLINICAL METHOD FOR DETERMINING THE AMMONIA COËFFICIENT OF URINES.

RAYMOND F. BACON.

(*From the Chemical Laboratory, Bureau of Science.*)

The ammonia coëfficient of a urine is a number corresponding to the percentage of the total nitrogen which is present as ammonia or ammonium salts. The normal urine of adult human beings has an ammonia coëfficient of 4.1 to 4.64 per cent. This amount may increase in various pathologic conditions until half of the nitrogen in the urine is excreted as ammonia and ammonium salts. Such a condition indicates very serious disturbances in the metabolism of the patient.

The present methods of determining ammonia in the urine are quite tedious; they require a rather long process and considerable apparatus. The usual method employed is the distillation of the urine with a mild alkali (magnesia, sodium carbonate, etc.), the evolved ammonia being absorbed in standard acid and the amount determined by simple titration. The total nitrogen is estimated by the Kjeldahl method or less accurately from a determination of the urea in the urine by decomposition with an alkaline hypobromite. A certain amount of urea is always decomposed by the alkali in the distillation method; this entails the appplication of a correction to the results as obtained by the above process. The value of this correction is usually determined, after the ammonia has been distilled in the manner given above, by adding sufficient water to the liquid to bring it up to the original volume, and redistilling under the same conditions and for the same length of time. If the distillation is carried out *in vacuo* to avoid the decomposition of urea by alkalies, great trouble is often experienced because of the foaming of the urine. It is absolutely impossible to distill some albuminous urines *in vacuo* because of the foaming of the alkaline liquids. The method which I propose is sufficiently accurate for clinical purposes, requires no elaborate apparatus, the actual manipulation requires about three minutes and the whole determination is finished in about thirty minutes. I propose to determine the ratio of ammonia to urea plus ammonia; this, for clinical purposes, represents a sufficiently close approximation to the true ammonia coëfficient. The method does not result in a high degree of accuracy in this determination, yet I consider that this disadvantage is more than overbalanced by its simplicity.

The present method of determining the ammonia coëfficient in the urine is quite beyond the ordinary practitioner. A high ammonia index of the urine has been used in cases of pernicious vomiting of pregnancy as a safe diagnostic indication that the pregnancy should be terminated. It has been shown very clearly that in many cases a delay of a comparatively few hours in operating involved fatal results. When a patient's life is at stake, it is highly important to have a quick method for making this determination which can be carried out by the physician in his own laboratory. It is also probable that there may be wide variations in the ammonia index of the urine in many pathologic conditions. At the present time this determination is but rarely made on urines, consequently but little is known concerning the number of disturbances in the human organism which may cause a large part of the nitrogen to be eliminated as ammonium salts instead of as urea.

I have sometimes obtained ammonia indices varying as much as 10 per cent from the calculated, in several hundred determinations which I have made to test the method outlined in this paper, using known quantities of urea and ammonium chloride: thus with a true ammonia index of 4 there may be obtained 3.6 to 4.4 per cent. This is a very large error in an analytical determination, but nevertheless at the present time, for diagnostic purposes, an ammonia index of 22 would probably have the same significance as one of 24. When more accurate determinations become necessary this method must be improved.

The proposed method is based upon two well-known reactions. When urea is treated with Millon's reagent (mercuric nitrate in nitric acid solution), it is decomposed to give nitrogen and carbon dioxide and this same reagent has no effect on ammonia or ammonium salts.

As is well known, hypobromites in alkaline solution decompose urea into carbon dioxide and nitrogen, the carbon dioxide being absorded; they also decompose ammonia, liberating nitrogen. The reactions may be represented by the following equations:

In acid solution with mercuric nitrate.—

$$CO(NH_2)_2+3O \longrightarrow CO_2+N_2+2H_2O$$

In alkaline solution with hypobromites.

$$CO(NH_2)_2+3O \longrightarrow CO_2+N_2+2H_2O.$$

$$2NH_3+3O \longrightarrow N_2+3H_2O.$$

$$CO(NH_2)_2+3NaOBr+2NaOH \longrightarrow 3NaBr+Na_2CO_3+N_2+3H_2O$$

$$2NH_3+3NaOBr \longrightarrow N_2+3NaBr+3H_2O.$$

The gas evolved by reason of the action of urea on an alkaline hypobromite solution is nitrogen. Both nitrogen and carbon dioxide are given off by the action of urea on the acid mercuric nitrate solution and as they are evolved in equal volumes, half of the gas obtained is

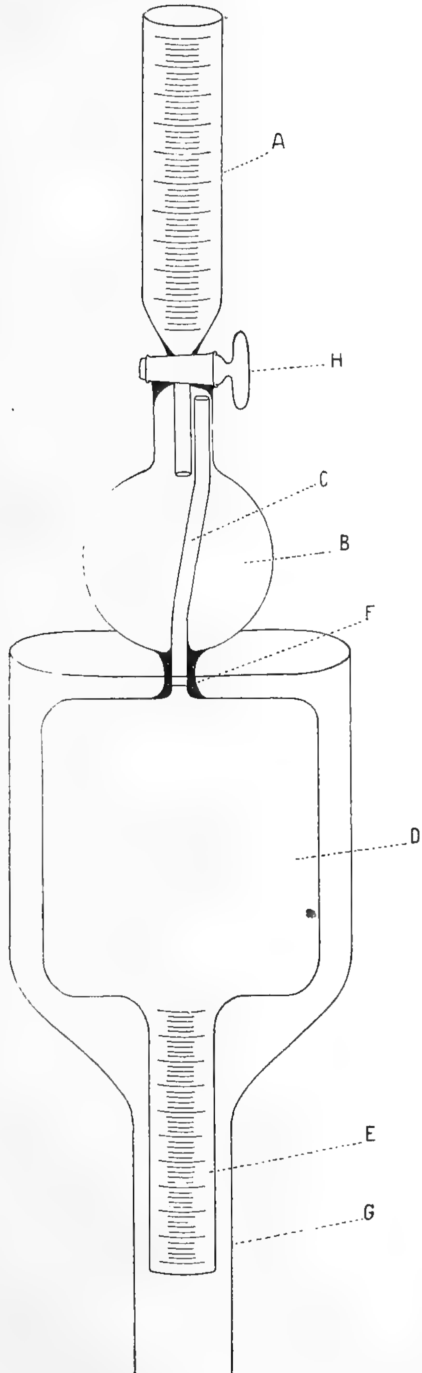


FIG. 1.

nitrogen. Ammonia, as stated above, has no effect on this reagent, whereas with the hypobromite solution the ammonia is also oxidized to nitrogen. Consequently, by oxidizing a solution containing ammonia and urea in two separate pieces of apparatus and noting the amount of gas obtained after the action of each reagent, it becomes a simple matter of calculation to ascertain the respective quantities of urea and ammonia in the original solution. I have devised the following simple form of apparatus for carrying out these determinations. (See fig. 1.)

Two pieces of apparatus are used. *A* is a tube holding 10 cubic centimeters, graduated in 0.1. *B* is a glass bulb having a capacity of 20 cubic centimeters. The tube *C* of about 1-millimeter bore leads from the top of the latter to the graduated eudiometer below. To avoid making the apparatus inconveniently long I have inserted a gas chamber just below the zero mark *F* of the eudiometer; this in the apparatus used with the hypobromite solution has a capacity of 30 cubic centimeters and in the one used with the mercuric nitrate solution one of 60 cubic centimeters. The remainder of the eudiometer *E* is graduated in 0.1 up to 100 cubic centimeters. To measure the gases under the same conditions of pressure, a jacket tube, *G*, of the form shown in the illustration is provided. For the determination in alkaline solution this is filled with water, but for that in acid solution glycerine, mercury, or some other liquid which does not absorb carbon dioxide must be used. Details of the manipulation are as follows:

The mercuric nitrate reagent is prepared by dissolving 10 cubic centimeters of mercury in 130 cubic centimeters of strong nitric acid (specific gravity, 1.4). When solution is complete, 140 cubic centimeters of water are added and, if necessary, the whole is filtered. The reagent keeps well. 10 cubic centimeters of this solution (preferably hot) are run into the bulb *B* of the proper apparatus, the level of the liquid is brought to the zero of the ureometer by raising or lowering the apparatus, and the stop-cock *H* is closed. Then 5 cubic centimeters of the urine (or a sufficient amount of urine to evolve a quantity of gas which will fall on the graduated part of the ureometer) is placed in *A*, and the ureometer is raised until its lower level is just below the surface of the liquid in the jacket *G*. The urine is then run in slowly by opening the stop-cock *H* until only a few drops remain in *A*. Two or three cubic centimeters of water are added to *A* to wash in these last few drops of urine and this is also run into the bulb *B*, care being taken, of course, not to admit any air into *B*. The gas evolution soon begins and may be assisted by shaking the apparatus gently. When the evolution of gas has ceased and the latter has attained the room temperature, the ureometer is lowered until the liquid level is the same inside and outside the eudiometer tube and the gas volume is read. The manipulation with the hypobromite is just the same as with the mercuric nitrate solution, and the urine is added to each solution within a few minutes, so that the gas volumes in both pieces of apparatus may be read off at the same time, both then being under the same conditions of temperature and pressure, no correction is necessary for these factors, as the ammonia index is a percentage coëfficient. The hypobromite reagent is conveniently prepared by adding 1 cubic centimeter of bromine to 10 cubic centimeters of a 20 per cent solution of sodium hydroxide.

In making the calculation of the ammonia coëfficient from the volumes of gas obtained, it is evident that this would be exceedingly simple if the reactions were quantitative. Unfortunately, this is not the case. One gram of urea treated with the mercuric nitrate reagent gives 724 cubic centimeters of the gases, carbon dioxide and nitrogen, instead of the calculated 744 cubic centimeters, an error of 2.67 per cent. One gram of urea with the alkaline hypobromite solution gives only 354.3 cubic centimeters of nitrogen instead of the calculated 372.7 cubic centimeters. I have obtained from one gram of ammonium chloride 208 cubic centimeters of the gas, instead of the calculated 211 cubic centimeters. All these volumes were measured under standard conditions of temperature and pressure, although for the purpose of the determination of the ammonia coëfficient of urine it is not necessary to reduce the volume of the gas to standard conditions. It is only required that the gases in the two ureometers should have the same temperature and be under the same pressure, as the actual quantities of urea and ammonia are not required, but only their ratio. To avoid calculation in the future, I have prepared a table giving the ammonia coëfficient corresponding to various volumes of gases. The number of cubic centimeters of urine plus wash water is subtracted from the observed volume of gas and the ammonia index is then read off directly from the table. The table is calculated by dividing the number of cubic centimeters of gas obtained from the mercuric nitrate solution by 2.05. This number is then subtracted from the number of cubic centimeters of gas liberated from the hypobromite solution, and the ratio of this remainder to the total cubic centimeters of gas from the hypobromite, represents the ammonia coëfficient, as expressed by a formula:

$$A = \frac{\left(H - \frac{M}{2.05}\right) \times 100}{H}$$

Where A is the ammonia coëfficient.

M = number of cubic centimeters of gas from the mercuric nitrate solution.

H = number of cubic centimeters of gas from the hypobromite solution.

TABLE I.—*For calculating the ammonia index of urines.*

Number cubic centimeters gas with mercuric nitrate solution.	Number of cubic centimeters of gas with hypobromite solution.																										
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
60	2.6	5.8	8.7	11.5	14.1	16.5	18.8	21.0	23.1	25.1	27.0	28.7	30.4	32.0	33.6	35.1											60
61		4.19	7.18	10.0	12.6	15.1	17.5	19.7	21.8	23.8	25.7	27.5	29.2	30.9	32.5	34.0	35.4										61
62		2.6	5.6	8.5	11.1	13.7	16.1	18.3	20.5	22.5	24.5	26.3	28.1	29.7	31.4	32.9	34.3										62
63			4.0	6.9	9.7	12.2	14.7	17.0	19.2	21.2	23.2	25.1	26.8	28.6	30.2	31.7	33.2	34.6									63
64				5.4	8.2	10.8	13.3	15.7	17.9	20.0	22.0	23.9	25.7	27.4	29.1	30.6	32.2	33.6	35.0	36.3							64
65				3.9	6.7	9.7	11.9	13.9	16.6	18.7	20.7	22.6	24.5	26.2	27.9	29.5	31.1	32.5	33.9	35.2							65
66					5.3	8.0	10.6	13.0	15.1	17.4	19.5	21.5	23.4	25.1	26.8	28.4	30.0	31.8	32.6	34.2							66
67						6.8	9.4	11.9	14.2	16.4	18.5	20.5	22.4	24.1	25.9	27.6	29.1	30.6	32.0	33.5	34.8						67
68						5.4	8.0	10.5	12.9	15.1	17.2	19.3	21.2	23.0	24.7	26.4	28.0	29.5	31.0	32.4	33.7	35.0					68
69						4.2	6.6	9.2	11.6	13.8	16.0	18.0	20.0	21.9	23.6	25.4	27.0	28.5	30.0	31.4	32.7	34.0					69
70							5.3	7.8	10.2	12.6	14.8	16.8	18.8	20.7	22.5	24.2	25.9	27.5	29.0	30.4	31.8	33.1	34.4				70
71							3.9	6.5	9.0	11.3	13.5	16.6	17.6	19.5	21.4	23.1	24.7	26.4	27.9	29.4	30.7	32.1	33.5				71
72								5.1	7.6	10.0	12.2	14.4	16.6	18.4	20.2	22	23.6	25.2	26.9	28.4	29.7	31.1					72
73								3.8	6.3	8.7	11.0	13.2	15.2	17.2	19.1	20.9	22.6	24.2	25.8	27.4	28.7	30.1					73
74									5.0	7.4	9.7	11.9	14.0	16.0	17.9	19.8	21.5	23.1	24.7	26.3	27.7	29.2	30.5				74
75									3.9	5.1	8.7	11.0	13.1	15.1	17.0	18.9	20.6	22.3	24.0	25.5	27.0	28.5	29.9				75
76										5.1	7.5	9.7	11.9	13.9	15.9	17.8	19.5	21.2	22.9	24.5	26.0	27.4	28.8	30.1			76
77											6.2	8.5	10.7	12.8	14.8	16.7	18.5	20.2	21.8	23.4	25.0	26.5	27.9	29.2	30.5		77
78											5.	7.3	9.5	11.6	13.6	15.5	17.4	19.2	20.8	22.4	24.0	25.5	26.9	28.3	29.6	30.9	78
79												6.1	8.3	10.4	12.5	14.4	16.3	18.1	19.8	21.5	23.0	24.5	26.0	27.4	28.7	31.0	79
80												4.9	7.1	9.3	11.4	13.3	15.2	17.0	18.7	20.4	22.0	23.5	25.0	26.4	27.7	30.3	80

To render this table reasonably compact I have calculated it only for entire cubic centimeters. In the most frequently occurring cases, where fractions of a cubic centimeter of gas are involved, the ammonia coëfficient may be very easily interpolated, from the numbers given in this table.

I also present a table (II) calculated from that of Vanino [1] whereby the actual quantity of urea in a urine may be ascertained from the number of cubic centimeters of gas evolved by the mercuric nitrate solution. To obtain the amount of urea, the number of cubic centimeters of gas obtained is multiplied by the number given in the table corresponding to the temperature and pressure of the gas, thus: if 76.4 cubic centimeters' of gas were found at 25° and 734 millimeters' barometric pressure, the urea amounts to $76.4 \times 1.181 = 0.091$ gram urea.

[1] *Ztschr. f. anal. Chem.* (1895), 34, 56.

TABLE II.—*Weight in milligrams of urea corresponding to 1 cubic centimeter gas mixture* (CO_2, N_2).

Barometer in mm.	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	Barometer in mm.
720	1.217	1.212	1.205	1.200	1.195	1.189	1.182	1.177	1.170	1.165	1.158	1.152	1.146	1.140	1.134	1.128	720
722	1.221	1.215	1.210	1.203	1.198	1.192	1.185	1.180	1.173	1.168	1.161	1.155	1.149	1.143	1.137	1.131	722
724	1.224	1.219	1.213	1.206	1.201	1.195	1.189	1.183	1.177	1.171	1.165	1.159	1.153	1.147	1,141	1.135	724
726	1.227	1.222	1.216	1.210	1.204	1.199	1.193	1.186	1.180	1.175	1.168	1.162	1.156	1.150	1.144	1.138	726
728	1.230	1.225	1.220	1.214	1.208	1.202	1.196	1.190	1.183	1.178	1.171	1.165	1.159	1.153	1.147	1.141	728
730	1.234	1.228	1.223	1.218	1.211	1.205	1.200	1.193	1.188	1.181	1.175	1.169	1.163	1.157	1.151	1.145	730
732	1.237	1.232	1.226	1.221	1.214	1.209	1.203	1.196	1.191	1.184	1.178	1.172	1.166	1.160	1.154	1.148	732
734	1.242	1.235	1.230	1.224	1.218	1.212	1.206	1.200	1.194	1.188	1.181	1.175	1.169	1.163	1.157	1.151	734
736	1.245	1.240	1.233	1.227	1.222	1.215	1.210	1.203	1.198	1.191	1.185	1.179	1.173	1.167	1.160	1.155	736
738	1.248	1.243	1.236	1.231	1.225	1.218	1.213	1.206	1.201	1.194	1.188	1.182	1.176	1.170	1.164	1.158	738
740	1.252	1.246	1.240	1.234	1.228	1.222	1.216	1.210	1.204	1.198	1.191	1.185	1.179	1.173	1.167	1.161	740
742	1.255	1.250	1.244	1.238	1.232	1.226	1.220	1.213	1.207	1.201	1.196	1.190	1.184	1.178	1.171	1.166	742
744	1.258	1.253	1.247	1.241	1.235	1.230	1.223	1.217	1.211	1.204	1.199	1.193	1.187	1.181	1.174	1.169	744
746	1.261	1.256	1.250	1.245	1.238	1.232	1.226	1.221	1.214	1.207	1.202	1.196	1.190	1.184	1.177	1.172	746
748	1.266	1.260	1.254	1.248	1.242	1.236	1.230	1.224	1.217	1.211	1.205	1.199	1.193	1.187	1.180	1.175	748
750	1.269	1.263	1.257	1.252	1.245	1.239	1.233	1.227	1.221	1.214	1.209	1.203	1.197	1.191	1.184	1.179	750
752	1.272	1.267	1.260	1.255	1.248	1.243	1.236	1.230	1.224	1.217	1.212	1.206	1.200	1.194	1.187	1.182	752
754	1.276	1.270	1.264	1.258	1.252	1.246	1.239	1.234	1.227	1.221	1.215	1.209	1.203	1.197	1.190	1.185	754
756	1.279	1.274	1.267	1.262	1.255	1.249	1.243	1.237	1.231	1.224	1.218	1.212	1.206	1.200	1.193	1.188	756
758	1.282	1.277	1.271	1.265	1.259	1.253	1.246	1.240	1.234	1.228	1.222	1.216	1.210	1.204	1.197	1.192	758
760	1.286	1.280	1.275	1.268	1.263	1.256	1.249	1.244	1.237	1.232	1.225	1.219	1.213	1.207	1.200	1.195	760
762	1.289	1.283	1.278	1.272	1.266	1.259	1.252	1.247	1.241	1.235	1.229	1.223	1.217	1.211	1.204	1.199	762
764	1.293	1.287	1.285	1.275	1.269	1.263	1.256	1.250	1.244	1.238	1.132	1.226	1.220	1.214	1.207	1.202	764

I have made over two hundred determinations to test the accuracy of this method of estimating the ammonia coëfficient, for the greater part using known quantities of urea and ammonium chloride. A series of these results is given below in Table III. In the determination of the ammonia coëfficient in the urines listed, the figure given under the heading "Calculated" represents the value obtained by determining total nitrogen by the Kjeldahl method and the ammoniacal nitrogen by distillation with powdered magnesia according to the standard method.

TABLE III.

Taken.	Number of cc. of gas with mercuric nitrate reagent.	Number of cc. of gas with alkaline hypobromite.	Ammonia coefficient found.	Calculated.
0.08 gram urea in 5 cc. of water; 0.008 gram NH_4Cl in 5 cc. of water	65.0	33.7	5.9	5.6
0.08 gram urea in 5 cc. of water; 0.016 gram NH_4Cl in 5 cc. of water	61.0	33.5	10.4	10.6
0.1 gram urea in 5 cc. of water; 0.05 gram NH_4Cl in 5 cc. of water	75.0	47.5	21.6	23.5
0.1 gram urea in 5 cc. of water; 0 025 gram NH_4Cl in 5 cc. of water	77.0	43.0	12.8	12.4
0.1 gram urea in 5 cc. of water; 0.03 gram NH_4Cl in 5 cc. of water	77.5	44.8	14.7	14.2
0.1 gram urea in 5 cc. of water; 0.04 gram NH_4Cl in 5 cc. of water	77.2	45.9	18.1	18.3
0.1 gram urea in 5 cc. of water; 0.01 gram NH_4Cl in 5 cc. of water	78.1	40.3	5.45	5.6
0.1 gram urea in 5 cc. of water; 0.01 gram NH_4Cl in 5 cc. of water	76.2	39.1	5.0	5.6
0.1 gram urea in 5 cc. of water; 0.05 gram NH_4Cl in 5 cc. of water	76.0	47.8	22.1	23.5
0.1 gram urea in 5 cc. of water; 0.06 gram NH_4Cl in 5 cc. of water	76.8	50.0	25.0	24.9
0.1 gram urea in 5 cc. of water; 0.07 gram NH_4Cl in 5 cc. of water	76.8	52.8	29.0	28.1
0.1 gram urea in 5 cc. of water; 0.08 gram NH_4Cl in 5 cc. of water	77.2	54.0	30.4	31.0
0.1 gram urea in 5 cc. of water; 0.09 gram NH_4Cl in 5 cc. of water	77.0	57.0	33.6	33.4
0.1 gram urea in 5 cc. of water; 0.1 gram NH_4Cl in 5 cc. of water	77.5	59.6	35.8	35.2
0.1 gram urea in 5 cc. of water; 0.1 gram NH_4Cl in 5 cc. of water	77.5	60.0	36.4	35.2
0 1 gram urea in 5 cc. of water; 0.1 gram NH_4Cl in 5 cc. of water	76.1	59.4	37.5	35.2
Fresh normal urine 5 cc	38.0	17.8	4.3	4.1
Urine very much decomposed, 5 cc	20.3	17.9	44.4	45.9
Fresh normal urine 5 cc	64.2	32.8	4.5	4.1
Do	69.4	35.4	4.5	4.1
Urine 24 hours' old, 5 cc	57.2	30.3	7.6	7.2
Urine 72 hours' old, 5 cc	52.4	32.1	20.6	19.9

TABLE III—Continued.

Taken.	Number of cc. of gas with mercuric nitrate reagent.	Number of cc. of gas with alkaline hypobromite.	Ammonia coefficient found.	Calculated.
Urine, pregnancy case	31.4	16.6	7.8	7.2
Urine pregnancy case, duplicate determination. Urine 3 hours older, no new Kjeldahl made on this one	32.9	17.4	8.0	7.2
Urine, fresh normal	65.0	33.3	5.1	4.6
Urine, fresh normal, duplicate	65.5	33.6	4.8	4.6
Urine about 1 week old	34.6	23.1	26.8	26.0
Urine about 24 hours' old	51.0	26.7	6.7	6.3

Now that a very simple and quick method has been worked out, I expect to determine the ammonia index of a great number of urines from persons suffering with various diseases. The results will be published later.

EDITORIAL

THE TENSILE STRENGTH OF MACHINE- AND HAND-STRIPPED ABACA FIBER.[1]

Promoters of hemp-stripping machines have from time to time maintained that the hand-stripped fiber is not as strong as the machine-stripped hemp. It is of considerable importance to the Manila hemp industry to substantiate these claims, as there seems to be little doubt but that in a few years a large part of the abacá leaves will be stripped by machines, and if the machine-stripped hemp is stronger than the hand-stripped variety, the whole Manila hemp industry will be very materially benefited. The present active competition which Manila hemp must meet with the sisal and maguey fibers is largely due to the fact that these latter are machine-stripped, and consequently more uniform and stronger than retted or hand-stripped fibers of the same species.

I have made tests on the comparative tensile strength of machine- and hand-stripped abacá fibers. In the first series of tests, stalks from the same plantation of the same age were selected at random, one-half were stripped on the machine and one-half by hand. The latter represented the best grade of hand-stripping, with a smooth-edged knife, and the resulting hemp was much cleaner than that usually found in the market. While the above method of selection would not be rigid without a very large number of tests, still the results obtained so markedly and uniformly point in the same direction that little doubt is left as to the relative strength of the fibers. In making the tests, ten fibers at one time were twisted together and the number of kilos necessary to break them measured with a Riehle testing machine. Fifty lots of ten fibers each of hand- and machine-stripped hemp of the same length were then weighed to obtain the average weight of the fibers, so that any differences in breaking strain could not be ascribed to different sizes of the fibers used. An arbitrary strength factor X was then calculated, representing the breaking strength divided by the weight of the fibers. The results of the first series of tests are presented in Table I.

[1] These tests were made possible through the kind coöperation of Mr. M. A. Clarke, the machine used being that of the Manila Hemp Machine Company.

TABLE I.

Class of fiber.	Breaking strength in kilos.	Class of fiber.	Breaking strength in kilos.
Mindoro machine-stripped	21.4	Davao machine-stripped	31.4
Do	23.8	do	33.6
Do	24.0	do	31.0
Do	22.6	do	34.5
Do	[a]34.0	Mindoro hand-stripped	14.5
Do	24.1	do	18.6
Do	25.0	do	16.3
Do	21.8	do	14.1
Do	24.5	do	[a]20.4
Do	26.9	do	14.5
Do	22.3	do	15.4
Do	27.6	do	14.1
Do	28.1	do	12.7
Davao machine-stripped	32.6	do	17.7
Do	34.0	do	13.2
Do	35.5	do	14.1
Do	40.5	do	15.4

[a] Picked samples.

The averages for the first series of tests are as follows:

Class.	Number of determinations.	Breaking strength in kilos.	Average weight of 10 fibers in grams.	Strength factor, X.
Mindoro machine	13	25.3	0.0509	50
Mindoro hand	13	15.4	0.0510	30
Davao machine	9	35.4	0.0716	48

In the second series of tests each leaf was split into two parts, one-half was stripped by machine and the other half by hand. This lot of hemp was from Albay Province. The numbers opposite each other represent the same leaf, and hence are comparable. The results are presented in Table II.

TABLE II.

Breaking strength in kilos.		Breaking strength in kilos.	
Machine-stripped.	Hand-stripped.	Machine-stripped.	Hand-stripped.
26.8	11.4	17.8	11.8
19.9	14.0	19.5	10.9
23.4	14.4	21.8	18.2
22.3	10.9	20.9	7.2
21.0	11.4	27.3	11.8
23.1	10.9	16.8	11.4
26.4	13.2	16.8	11.8
19.1	8.6	[a]21.0	[a]12.2
16.8	11.8		
15.0	8.6		

[a] Averages.

The average weight of the two classes of fibers in this last series was the same, so that their relative tensile strength is correctly given by the average breaking strain.

Many other determinations with the same results have been made. There is little doubt but that the machine-stripped fiber is very considerable stronger than the hand-stripped variety. To give a reason for this difference is another matter. Examination under the microscope showed that both classes of fibers were quite clean and revealed no differences between them. It is my opinion that the difference is due to the continuous, steady pull of the fiber under the machine's knife as compared to the intermittent jerky pull which is necessary in hand stripping. The jerks of the hand-stripper strain the fibers so as very markedly to lower their tensile strength. Confirmatory evidence for this theory is given by the fact that hand-stripped hemp shows very many broken fibers, so that a bundle of this class of abacá consists of a series of shorter and longer fibers, while the machine-stripped abacá has practically no fibers broken and all are of the same length. The advent of the hemp-stripping machine should very materially advance the quality of Manila hemp.

RAYMOND F. BACON.

THE EXCRETA OF THE PYTHON.

The Biological Laboratory of this Bureau has one young python, the excreta of which I have examined. This python is now about 18 months old. It is 2.4 meters long and is already so strong that it is very difficult for one man to handle it. This snake eats on an average once in eight days, the meal consisting of one large guinea pig or two rats. It may perhaps be of interest to note that none of the pythons in captivity in Manila must be forced to eat, as is often the case in colder climates.

The excretum is passed two days after feeding as a white, slightly moist solid, accompanied by a considerable quantity of water, which carries most of the mineral constituents in solution. Ten grams of the solid portion of the excreta, dried *in vacuo,* lost 10.3 per cent water. Ten grams of dried excreta distilled with sodium hydrate gave 0.87 gram of ammonia and 8.9 grams uric acid. The calculated amount of ammonia for 8.9 grams uric acid, to form ammonium acid urate is 0.899. The solid excreta of the python are, therefore, almost pure ammonium acid urate.

RAYMOND F. BACON.

A RUBBER VINE.

The woody, climbing vine *Parameria philippenensis* Radlk, is very abundant in the Philippines. The bark of this vine contains a rubber-like gum, which, however, does not flow sufficiently upon tapping to obtain it in that manner. There is such a large quantity of this vine in the Islands of Mindoro and Cebu that at various times companies have been formed to exploit this product commercially as a rubber-yielding plant. At the present time, the bark, which in Tagalog is called *tagulaoay,* is macerated with coconut oil or some other fatty oil, and the resulting thick solution of the gum is used by the natives in treating wounds, the solution acting like surgeon's plaster. It is claimed that by its use infection is absolutely prevented. This was the only disinfectant carried by the Filipino insurgent armies and was used entirely to prevent infections of wounds during the Philippine insurrection. Whether or not it has any value for these purposes can not at present be stated. Analyses of the bark show that it contains from 4 to 5 per cent of this rubber-like gum. Several experiments were made on methods looking toward its extraction on a large scale. The bark of the vine is easily ground to a coarse powder, from which gasoline extracts practically all the rubber. A sticky, greenish, resinous mass was obtained on distilling the gasoline. It was not in this manner possible to obtain a rubber which was not decidedly tacky. Carbon bisulphide gave better results, the rubber being strong and not sticky. The freshly extracted rubber is yellow, but it soon turns black in the air and becomes somewhat tacky. Our experiments seem to show that the commercial utilization of the *Parameria* vine as a source of rubber is very doubtful. Much more can be expected from the rubber gum from the various species of *Ficus,* which is one of the most abundant trees in the Islands. We will soon take up a study of these *Ficus* rubbers.

RAYMOND F. BACON.

NOTE ON THE ACTION OF SODIUM ALCOHOLATES ON ALCOHOLS.

Guerbet[1] has recently published results which demonstrate that when sodium benzylate is heated with members of the lower series of fatty alcohols from 200° to 220°, the hydrogen in the alcohol is substituted by a benzyl group. Thus, with ethyl alcohol he obtained the alcohol $C_6H_5 . CH_2 . CH_2 . CH_2 . OH$, etc. When he substituted aromatic al-

[1] *Compt. rend. Acad. sci.* (1908), **146**, 1405.

cohols for the aliphatic he obtained hydrocarbons. Thus, for example, with benzyl alcohol and sodium benzylate, he did not obtain phenyl benzyl carbinol, but stilben, diphenyl, and toluol. The publication of these results induces me to call attention to some experiments made in connection with my studies on sodium benzhydrol and sodium benzylate.[2] I have found by many experiments in which I heated sodium benzhydrol with methyl and ethyl alcohol to between 250° and 300° in sealed tubes that it was not possible to substitute hydrogen in these alcohols under the given conditions. There were obtained with ethyl alcohol and sodium benzhydrol, instead of the expected diphenyl propyl alcohol the following: Benzol; diphenyl methane; sodium benzoate; tetraphenyl ethylene and ethane; ethylene; ethyl ether, and acetaldehyde condensation products; in other words, simply the decomposition products, at this temperature, of sodium benzhydrol and of sodium ethylate. It would also seem theoretically improbable that $\gamma\gamma$ diphenyl propyl alcohol could be formed at this temperature, for the very similarly constituted benzhydrol very readily decomposes at 300°. The results of Guerbet are self-evident from the work of Nef on sodium alcoholates, and from my work on sodium benzhydrol and sodium benzylate. The methylene hypothesis of Nef, assuming an equilibrium between di- and tetra-valent carbon, is not only a very satisfactory explanation for the chemical behavior of alkyl halides and of metallic alcoholates, but makes it possible to predict with a considerable degree of accuracy the reaction between these compounds under various conditions. Fromm[3] obtained symmetrical tetraphenyl butane as one of the products of the dissociation by heat of benzyl sulphide. According to the theory of Nef, this must have been formed by the addition of phenyl methylene to dibenzil, the latter resulting from the union of two phenyl methylene particles and the subsequent reduction of the stilben, thus formed, these reactions are represented by equations as follows:

$$(1) \quad (C_6H_5CH_2)_2S \longrightarrow C_6H_6CH< + H_2S$$

$$(2) \quad 2C_6H_5 . CH< \longrightarrow C_6H_5 . CH : CH . C_6H_5$$

$$(3) \quad C_6H_5CH : CHC_6H_5 + H_2S \longrightarrow C_6H_5 . CH_2 . CH_2 . C_6H_5 + S$$

$$(4) \quad 2C_6H_5 . CH< + C_6H_5 . CH_2 . CH_2 . C_6H_5 \longrightarrow \begin{array}{ccc} C_6H_5 . CH_2 & & H_2C . C_6H_5 \\ | & & | \\ C_6H_5 . C & \text{———} & C . C_6H_5 \\ H & & H \end{array}$$

To confirm this method of the formation of symmetrical tetraphenyl butane I chose the benzyl ester of an acid which on decomposition would yield products which could reduce the stilben first formed in the reaction,

[2] *Am. Chem. Journ.* (1905), **33**, 68.
[3] *Ber. d. deutschen chem. Ges.* (1903), **36**, 534.

as special experiments showed that the heat dissociation of benzyl benzoate yielded principally tetraphenyl ethylene, and no symmetrical tetraphenil butane. To this end I heated two molecular quantities of benzyl chloride with one molecular amount of anhydrous potassium oxalate in a sealed tube from 160° to 200° for four hours. I obtained thus a 28 per cent yield of symmetrical tetraphenyl butane melting at 255°. This is the best method thus far suggested for preparing this hydrocarbon.

RAYMOND F. BACON.

REVIEW.

Soils and Fertilizers. By Harry Snyder, B. S. Third edition. Cloth. Pp. xv+350. Price, $1.25 net. New York: The Macmillan Company, 1908.

This book is primarily intended as a text and manual for agricultural instruction. It presents in a brief but comprehensive form the physical and chemical principles of the science. Only one chapter is devoted to the physical properties of soils; this seems rather too brief in view of their relative importance. The chapters on chemical composition of soils, fertilizers, soil preparation, and crop rotation are especially complete and should prove valuable not only to the student in the classroom, but to the practical agriculturist as well.

Much of the subject matter discussed, particularly the questions of soil nitrogen and humus, is based upon the author's extensive work in this field of investigation, hence the facts are presented in a very convincing manner.

The most important features of the work from the students' standpoint are the chapters on laboratory practice and the review questions.

The only reference throughout the book to the effect of climatic conditions on soil fertility is to the checking of nitrification by cold and strong sunlight, with the consequent general tendency to less soil nitrogen in southern latitudes. As the book is not written to meet the demands of tropical conditions, this can not be considered as an adverse criticism.

The book is especially well illustrated throughout.

G. F. R.

ORDER No.

Bureau of Science—Annual Reports.

201. Fifth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1906.
202. Sixth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1907.
203. Seventh Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1908.

Philippine Museum.

(Now Section of Ornithology.)

* *No. 1, 1903.*—On Birds from Luzon, Mindoro, Masbate, Ticao, Cuyo, Culion, Cagayan Sulu and Palawan. By Richard C. McGregor.
* *No. 2, 1903.*—List of Bird Skins Offered in Exchange.
43. *No. 3, 1904.*—Birds from Benguet Province, Luzon, and from the Islands of Lubang, Mindoro, Cuyo, and Cagayancillo. By Richard C. McGregor.
* *No. 4, 1904.*—The Birds of Calayan and Fuga, Babuyan Group. By Richard C. McGregor.

Mining Bureau.

(Now Division of Mines.)

45. *1890.*—Descripción física, geológica y minera en bosquejo de la Isla de Panay por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
* *1890.*—Memoria descriptiva de los manantiales minero-medicinales de la Isla de Luzón, estudiados por la comisión compuesta de los Señores D. José Centeno, Ingeniero de Minas y Vocal Presidente, D. Anacleto del Rosario y Sales, Vocal Farmacéutico, y D. José de Vera y Gómez, Vocal Médico.
47. *1893.*—Estudio descriptivo de algunos manantiales minerales de Filipinas ejecutado por la comisión formada por D. Enrique Abella y Casariego, Inspector General de Minas, D. José de Vera y Gómez, Médico, y D. Anacleto del Rosario y Sales, Farmacéutico; precedido de un prólogo escrito por el Excmo. Sr. D. Angel de Avilés, Director General de Administración Civil.
48. *1893.*—Terremotos experimentados en la Isla de Luzón durante los meses de Marzo y Abril de 1892, especialmente desastrosos en Pangasinán, Unión y Benguet. Estudio ejecutado por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
49. *1901.*—The Coal Measures of the Philippines. Charles H. Burritt.
50. *1902.*—Abstract of the Mining Laws (in force in the Philippines, 1902). Charles H. Burritt.
51. *1902., Bulletin No. 1.*—Platinum and Associated Rare Metals in Placer Formations, H. D. McCaskey, B. S.
52. *1903.*—Report of the Chief of the Mining Bureau of the Philippine Islands. Charles H. Burritt.
53. *1903, Bulletin No. 2.*—Complete List of Spanish Mining Claims Recorded in the Mining Bureau. Charles H. Burritt.
54. *1903, Bulletin No. 3.*—Report on a Geological Reconnoissance of the Iron Region of Angat, Bulacan. H. D. McCaskey, B. S.
55. *1904.*—Fifth Annual Report of the Mining Bureau. H. D. McCaskey.
56. *1905.*—Sixth Annual Report of the Chief of the Mining Bureau. H. D. McCaskey.
57. *1905, Bulletin No. 4.*—A Preliminary Reconnoissance of the Mancayan-Suyoc Mineral Region, Lepanto, P. I. A. J. Eveland, Geologist.
58. *1905, Bulletin No. 5.*—The Coal Deposits of Batan Island. Warren D. Smith, B. S., M. A., Geologist.

Division of Mines.

301. *1908.*—The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products during the year 1907, issued by Warren D. Smith, Chief of the Division of Mines.

Ethnological Survey.

(Now Division of Ethnology.)

401. *Vol. I, 1905.*—The Bontoc Igorot, by Albert Ernest Jenks. Paper, ₱2; half morocco, ₱3.
402. *Vol. II, Part 1, 1904.*—Negritos of Zambales, by William Allen Reed. Paper, ₱0.50; half morocco, ₱1.50.
403. *Vol. II, Part 2 and Part 3, 1905.*—The Nabaloi Dialect, by Otto Scheerer. The Bataks of Palawan, by Edward Y. Miller. (Bound also in one volume with Part 1, Negritos of Zambales.) Paper, ₱0.50; half morocco, ₱1.50. Combined, half morocco, ₱3.
404. *Vol. III, 1904.*—Relaciones Agustinianas de las razas del Norte de Luzón, by Perez. Paper, ₱0.75; half morocco, ₱2.
405. *Vol. IV, Part 1, 1905.*—Studies in Moro History, Law, and Religion, by Najeeb M. Saleeby. Paper, ₱0.50; half morocco, ₱1.50.

Division of Ethnology.

406. *Vol. IV, Part 2, 1908.*—History of Sulu, by Najeeb M. Saleeby. Paper, ₱1.50.
407. *Vol. V, Part 1 and Part 2, 1908.*—The Batán Dialect as a Member of the Philippine Group of Languages, by Otto Scheerer. "F" and "V" in Philippine Languages, by C. E. Conant. Paper, ₱1.60.
408. *Vol. V, Part 3.*—A Vocabulary of the Igorot Language as spoken by the Bontok Igorots, by the Rev. Walter Clayton Clapp. Igorot-English, English-Igorot. Paper, ₱1.50.
409. Directions for Ethnographic Observations and Collections, 1908. *For free distribution.*

NOTE.

Those of the above-listed publications which are for sale may be obtained from the Director of Printing, Manila, P. I. Publications for free distribution, listed above, may be had by writing to the Business Manager, Philippine Journal of Science, Manila, P. I. Please give order number.

---

* Out of print.

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.
Authors receive 100 copies of their papers free.
The numbers of each section will appear as rapidly as material is available. Each section will be separately paged and indexed.
Subscriptions may be sent to the DIRECTOR OF PRINTING, Manila, P. I. Correspondence should be addressed to the Business Manager, Philippine Journal of Science, Manila, P. I.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
Messrs. WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
Messrs. MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
Messrs. KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
Messrs. A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

A limited number of unbound copies of previous volumes are available which may be secured from the Director of Printing at the following rates: Volume I, 1906 (not divided into sections), $5, United States currency; Supplement to Volume I, $2.50, United States currency; Volume I (without supplement), $3, United States currency; all later volumes at current subscription prices.

VOL. IV MAY, 1909 No. 3

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., PH. D.

CO-EDITOR,

RICHARD P. STRONG, PH. B., M. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, PH. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, PH. D.; ALVIN J. COX, PH. D.
RAYMOND F. BACON, PH. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS, B. S.; R. C. MCGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. GENERAL SCIENCE

BUREAU OF SCIENCE
MANILA

MANILA
BUREAU OF PRINTING
1909

PREVIOUS PUBLICATIONS.

ORDER No.

Bureau of Government Laboratories.

* *No. 1, 1902, to No. 14, 1904.*

15. *No. 15, 1904, Biological and Serum Laboratories.*—Report on Bacillus Violacevus Manilæ: A Pathogenic Micro-Organism. By Paul G. Woolley, M. D.

* *No. 16, 1904, Biological Laboratory.*—Protective Inoculation against Asiatic Cholera: An Experimental Study. By Richard P. Strong, M. D.

17. *No. 17, 1904.*—New or Noteworthy Philippine Plants, II. By Elmer D. Merrill, Botanist.

* *No. 18, 1904, Biological Laboratory.*—I. Amebas: Their Cultivation and Etiologic Significance. By W. E. Musgrave, M. D., and Moses T. Clegg. II. The Treatment of Intestinal Amœbiasis (Amœbic Dysentery) in the Tropics. By W. E. Musgrave, M. D.

19. *No. 19, 1904, Biological Laboratory.*—Some Observations on the Biology of the Cholera Spirillum. By W. B. Wherry, M. D.

20. *No. 20, 1904.*—*Biological Laboratory:* I. Does Latent or Dormant Plague Exist Where the Disease is Endemic? By Maximilian Herzog, M. D., and Charles B. Hare. *Serum Laboratory:* II. Broncho-Pneumonia of Cattle: Its Association with B. Bovisepticus. By Paul G. Woolley, M. D., and Walter Sorrell, D. V. S. III. Pinto (Paño Blanco). By Paul G. Woolley, M. D. *Chemical Laboratory:* IV. Notes on Analysis of the Water from the Manila Water Supply. By Charles L. Bliss, M. S. *Serum Laboratory:* V. Frambœsia: Its Occurrence in Natives in the Philippine Islands. By Paul G. Woolley, M. D.

21. *No. 21, 1904, Biological Laboratory.*—Some Questions Relating to the Virulence of Micro-Organisms with Particular Reference to Their Immunizing Powers. By Richard P. Strong, M. D.

22. *No. 22, 1904, Bureau of Government Laboratories.*—I. A Description of the New Buildings of the Bureau of Government Laboratories. By Paul C. Freer, M. D., Ph. D. II. A Catalogue of the Library of the Bureau of Government Laboratories. By Mary Polk, Librarian.

* *No. 23, 1904, Biological Laboratory.*—Plague: Bacteriology, Morbid Anatomy, and Histopathology (Including a Consideration of Insects as Plague Carriers). By Maximilian Herzog, M. D.

24. *No. 24, 1904, Biological Laboratory.*—Glanders: Its Diagnosis and Prevention (Together with a Report on Two Cases of Human Glanders Occurring in Manila and Some Notes on the Bacteriology and Polymorphism of Bacterium Mallei). By William B. Wherry, M. D.

25. *No. 25, 1904.*—Birds from the Islands of Romblon, Sibuyan, and Cresta de Gallo. By Richard C. McGregor. (*For first four bulletins of the ornithological series, see Philippine Museum below.*)

26. *No. 26, 1904, Biological Laboratory.*—The Clinical and Pathological Significance of Balantidium Coli. By Richard P. Strong, M. D.

27. *No. 27, 1904.*—A Review of the Identification of the Species Described in Blanco's Flora de Filipinas. By Elmer D. Merrill, Botanist.

28. *No. 28, 1904.*—I. The Polypodiaceæ of the Philippine Islands. II. Edible Philippine Fungi. By Edwin B. Copeland, Ph. D.

29. *No. 29, 1904.*—I. New or Noteworthy Philippine Plants, III. II. The Source of Manila Elemi. By Elmer D. Merrill, Botanist.

30. *No. 30, 1905, Chemical Laboratory.*—I. Autocatalytic Decomposition of Silver Oxide. II. Hydration in Solution. By Gilbert N. Lewis, Ph. D.

31. *No. 31, 1905, Biological Laboratory.*—I. Notes on a Case of Hæmatochyluria (Together with Some Observations on the Morphology of the Embryo Nematode, Filaria Nocturna). By William B. Wherry, M. D., and John R. McDill, M. D., Manila, P. I. II. A Search into the Nitrate and Nitrite Content of Witte's "Peptone," with Special Reference to Its Influence on the Demonstration of the Indol and Cholera-Red Reactions. By William B. Wherry M. D.

32. *No. 32, 1905.*—*Biological Laboratory:* I. Intestinal Hæmorrhage as a Fatal Complication in Amœbic Dysentery and Its Association with Liver Abscess. By Richard P. Strong, M. D. II. The Action of Various Chemical Substances upon Cultures of Amœbæ. By J. B. Thomas, M. D., Baguio, Benguet. *Biological and Serum Laboratories:* III. The Pathology of Intestinal Amœbiasis. By Paul G. Woolley, M. D., and W. E. Musgrave, M. D.

33. *No. 33, 1905, Biological Laboratory.*—Further Observations on Fibrin Thrombosis in the Glomerular and in Other Renal Vessels in Bubonic Plague. By Maximilian Herzog, M. D.

* *No. 34, 1905.*—I. Birds from Mindoro and Small Adjacent Islands. II. Notes on Three Rare Luzon Birds. By Richard C. McGregor.

35. *No. 35, 1905.*—I. New or Noteworthy Philippine Plants, IV. II. Notes on Cuming's Philippine Plants in the Herbarium of the Bureau of Government Laboratories. III. Hackel, "Notes on Philippine Grasses." IV. Ridley, "Scitamineæ Philippinenses. V. Clarke, "Philippine Acanthaceæ." By Elmer D. Merrill, Botanist.

36. *No. 36, 1905.*—A Hand-List of the Birds of the Philippine Islands. By Richard C. McGregor and Dean C. Worcester.

* Report of the Superintendent of Government Laboratories for the Year Ending August 31, 1902. (Appendix M of Third Annual Report of the Philippine Commission.)

* Report of the Superintendent of Government Laboratories in the Philippine Islands for the Year Ending September 1, 1903. (Appendix G of the Fourth Annual Report of the Philippine Commission.)

39. Third Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1904.

40. Fourth Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1905.

Bureau of Science—Publications.

101. Price and Exchange List of Philippine Bird Skins in the Collection of the Bureau of Science, Manila, P. I. (Effective January 1, 1908.)

102. *No. 1, 1909.*—A Check-List of Philippine Fishes. By David Starr Jordan and Robert Earl Richardson. *In press.*

103. *No. 2, 1909.*—A Manual of Philippine Birds. By Richard C. McGregor, Parts I and II. A systematic index to the orders, families, and genera. Paper, ₱8 for the two parts.

---

* Out of print.

(Concluded on third page of cover.)

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV MAY, 1909 No. 3

CALORIMETRY, AND THE DETERMINATION OF THE CALORIFIC VALUE OF PHILIPPINE AND OTHER COALS FROM THE RESULTS OF PROXIMATE ANALYSIS.

By ALVIN J. COX.

(From the Laboratory of Inorganic and Physical Chemistry, Bureau of Science, Manila, P. I.)

Many engineers are accustomed to judge of the steaming quality of coal from its specified heating value [1] rather than from the analysis of the fuel. To determine this a steaming test is not satisfactory, because different furnaces give different values and the personal equation of firing and manipulation enter to a large degree into the results. Steaming tests are useful only for comparative purposes and then only when they are carried out in identical apparatus and under like conditions.

The only absolutely reliable means of determining the heating value of a coal is by the use of a standard calorimeter which records accurately.

There are many kinds of calorimeters [2] of varying accuracy, some of which show discrepancies of as much as 15 per cent and are seldom if ever used. In general, the large apparatus is to be condemned, because it is impossible to detect the errors which creep in and to make allowance for them. This is not the place to describe the difficulties and defects connected with these calorimeters. In all cases the

[1] The heating value of a coal is expressed in calories. A calorie is the amount of heat necessary to raise the temperature of 1 gram of water 1° C. The "pound calorie" is sometimes used by English writers; it is the amount of heat necessary to raise the temperature of 1 pound of water 1° C. The figures would be the same in either case, for when the heating value of a coal is given in calories it means that 1 gram of coal will heat the given number of grams of water 1° C. or that 1 pound of coal will heat the given number of pounds of water 1° C. One British thermal unit is the heat necessary to raise 1 pound of water 1° F., therefore, 1 calorie=9/5 B. T. U.
the end of this article.

[2] A bibliography of the literature of calorimeters, arranged alphabetically, is given at the end of this article.

burning takes place in pure oxygen. In all older calorimeters this occurs slowly under atmospheric pressure, while in a number of the more recent ones the explosion method is used; that is, the combustion occurs under a pressure of fifteen to twenty-five atmospheres. Another method used in some of the calorimeters is to effect combustion with combined oxygen. The explosion method is the one used in the Berthelot[3] bomb and has the advantage over most of the other forms of apparatus in that perfect combustion is attained.[4] In 1892, Mahler[5] employed an enameled bomb and obtained results as satisfactory as with the platinum bomb of Berthelot, while the cost of the apparatus is much less. In 1849, Hempel[6] introduced the idea of pressing the wire into the coal briquette for electrical incineration and in 1897 Kröker[7] added to the bomb a head which was fitted with two gas-tight valves, which greatly facilitates the determination of the products of combustion. These points are all included in the Berthelot-Mahler[8] bomb calorimeter which

[3] See bibliography.

[4] Fries, J. A. (*Journ. Am. Chem. Soc.* (1909), **31**, 272), using an Atwood bomb (which is a modification of that of Berthelot) with a modified top has shown that the determination of carbon by means of it "is absolutely reliable and gives very accurate results."

[5] Mahler, P. *Ztschr. f. angew. Chem.* (1892), **5**, 491; (1898), **11**, 865.

[6] Hempel, W. *Ibid.* (1892), **5**, 389; Langbein, H. *Ibid.* (1896), **9**, 488.

[7] Kröker. *Ibid.* (1898), **11**, 865.

[8] Calorimeter nach Berthelot-Mahler mit geänderter Einrichtung der Verbrennungsbombe (nach dem System von Dr. K. Kröker). Verfertiger, Julius Peters, Berlin, N. W., Thurmstr. 4. This is an apparatus in which the combustibles are burned in compressed oxygen in a vessel, called a "bomb," surrounded by a large quantity of water, and the products of combustion cooled by the water until the temperature is reduced to that of the water. Any water formed by the combustion is condensed, and its latent heat is also given up to the calorimeter. Corrections are made on the end temperature for the water value of the apparatus, for radiation and for the heat of formation of the products of combustion, including the water formed, and the difference determined between this result and the initial temperature. The increase in temperature is a measure of the heat-producing power of the coal. The calorific value is the product of the units of water by the degrees raised; that is, the heat produced by the burning of a unit weight of coal under these conditions.

The most troublesome source of error in careful calorimetric work is the loss or gain of heat by the calorimeter from its surroundings. Unavoidable irregularities in the conditions make this correction variable and its determination somewhat uncertain. Many methods of making it have been proposed. In the experiments given in this paper this loss, which is mostly due to radiation, was in the majority of cases taken into consideration according to the Regnault-Stohmann-Pfaundler formula (Stohmann, *Journ. f. prakt. Chem.* (1889), N. F. **39**, 517 *et seq.*), that is:

$$\text{The correction} = \frac{v - v'}{\tau' - \tau} \cdot \left(\frac{t_2 - t_1}{9} + \frac{t_1 + t_n}{2} + \sum_{1}^{n-1} (t) - n\tau \right) - (n-1)\, v \text{ where,}$$

v = the mean temperature difference of the preliminary period.

τ = the mean of the temperature readings of the preliminary period.

$t_1, t_2 \ldots t_n$ = the temperature readings of the combustion period.

v' = the mean temperature difference of the period after combustion.

τ' = the mean of the temperature readings of the period after combustion.

n = the number of the temperature readings of the combustion period.

was used in my tests. This apparatus is generally accepted as being the most accurate.[9] While accurate, it is nevertheless expensive and requires an elaborate equipment and a skill in manipulation which prevents as wide a usage as it deserves. A great many attempts have been made to find a substitute for this apparatus as is shown by the references given at the end of this paper; however, few of these other types give the calorific value more accurately than the result as calculated from easily obtained data. When the necessary apparatus for the direct determination of the heating power is not at hand, it is an important feature to have some means of approximately estimating the calorific value and it is one object of this paper to indicate a method for the calculation of this value for Philippine coal from the results of the proximate analysis. It is hoped that this calculation will fulfill the essential requirements for commercial purposes.

Owing to the recent revival of interest in Philippine coal, we now make many more analyses than formerly. It is not always convenient to undertake calorific determinations of all of these, but I have direct data in sufficient quantity to correlate a formula which will give a result approximately equal to that obtained with the calorimeter.

Many attempts have been made to develop a reliable formula for calculating the heating power from analytical data. That first proposed was by Dulong for the calculation of the heat of combustion from the results of ultimate analysis, and is as follows:

$$\text{Calorific power} = \frac{1}{100}\left[8080C + 34500\left(H - \frac{O}{8}\right)\right]$$

Others who have contributed to the development of this line of work by furnishing data, suggesting formulæ or modifications of that given above are Gmelin, v. Jüptner, Cornut, Ser, Kern,[10] Scheurer-Kestner, Meunier-Dollfus, Mahler, Bunte, etc. The calorific work done by Scheurer-Kestner and Meunier-

[8 continued] The results obtained by this formula agree very well with those from the empirical formula, which is a correction in calories of two-thirds of the difference between the highest temperature and that of the room, multiplied by four times the duration of the combustion in minutes; this correction was used in some cases. The temperature difference was determined by the use of a Beckmann thermometer.

Detailed directions for the manipulation of a bomb calorimeter in heat determinations, for the determination of the water value of the apparatus, the calculation of the results, etc., may be found, in the publications of Stohman, F., Kleber, Cl., and Langbein, H. *Journ. f. prakt. Chem.* (1889), N. F. **39**, 503; Atwood, W. O. and Snell, J. F. *Journ. Am. Chem. Soc.* (1903), **25**, 659, and also in many text-books.

[9] Braume, J. S. S., and Cowan, W. A. *Journ. Soc. Chem. Ind.* (1903), **22**, 1232 and Gray, Tho. and Robertson, J. G. *Ibid.* (1904), **23**, 704 have made comparative studies of different types of calorimeters and agree that reliable results can be obtained only with some form of bomb calorimeter.

[10] Liebig's process for the estimation of carbon and hydrogen in coals is discussed and the calorific value is calculated by use of the formula 8080C+34, 460H. Kern, S. *Chem. News* (1876), **34**, 233.

Dollfus (1868–1875)[11] has long been considered the most reliable ever accomplished on European coal and has done much to further the determination of the heating power of coal and the substantiation of Dulong's formula. Beginning in 1885[12] these authors continued their earlier investigations and made a number of determinations in order to fix a fair average for all coals. They found the heating power of many coals to be greater than that calculated from the elements; the Russian coal gave results which were very much nearer, in fact, fell slightly below the calculated value; therefore, indicating that the calculated value was a fair approximation to the truth. Mahler[13] has also done much careful work on European coal. He modified Dulong's formula by using the value 8140 for the heating power of carbon as determined by Berthelot and Petit[14] instead of 8080 as determined by Favre and Silbermann[15] and also so as to take into account the nitrogen content as follows:

$$\text{Calorific value}=\frac{1}{100}\left[8140C+34500\left(H-\frac{(O+N)-1}{8}\right)\right]$$
$$=\frac{1}{100}\left[8140C+34500H-4312.5\left((O+N)-1\right)\right]$$

Mahler emphasized the fact that Dulong's formula generally gave results which were below the actual, corroborating the observations of Scheurer-Kestner and Meunier-Dollfus, and proposed the adoption of the formula modified to read:

$$\text{Calorific value}=\frac{8140C-34500H-3000\,(O-N)}{100}$$

The application of this to a large number of coals gave variations of about the same magnitude from the actual value as that of Dulong, but in the opposite direction.

Dulong's formula has stood the test through many years of discussion and suggested substitutions. The formula has no scientific value, but in 1891, Bunte,[16] as the result of a series of investigations in Munich, showed it to be sufficiently accurate for all practical purposes; and in 1899 the report of the Committee on Coal Analysis[17] appointed by the American Chemical Society gave it in the following form as the most reliable formula for the calculation of the heating effect of a coal burned to liquid water:

$$\text{“Calorific power}=8080C+34{,}460\left(H-\tfrac{1}{8}O\right)+2250S\text{”}$$

[11] Scheurer-Kestner, A., and Meunier C. *Compt. rend. Acad. sci.* (1868), **66,** 1220; **67,** 659, 1002; (1869), **68,** 608; **69,** 412; (1871), **73,** 1061: (1873), **77,** 1385; *Ann. chim. et phys.* (1874), V, **2,** 325; *Bull. Soc. chim. Paris* (1874), n. s. II, **21,** 402. Scheurer-Kestner, A. *Compt. rend. Acad. sci.* (1868), **66,** 1047.

[12] Scheurer-Kestner, A., and Meunier-Dollfus, C. *Compt. rend. Acad. sci.* (1885), **100,** 908; *Ann. chim. et phys.* (1886), VI, **8,** 267.

[13] Mahler, P. *Bull. Soc. encourag. ind. nat.* (1892), **91,** 358.

[14] *Ann. chim. et phys.* (1889), VI, **18,** 80.

[15] *Ibid.* (1852), III, **34,** 403.

[16] *Journ. f. Gasbeleuchtung* (1891), **34,** 21 and 41.

[17] *Journ. Am. Chem. Soc.* (1899), **21,** 1130.

The literature is full of material showing an agreement within 2 or 3 per cent between results obtained by direct determination and those calculated from elementary analyses.[18] Lord and Haas[19] have shown from their work that the results on American coals "if calculated from the ultimate analysis, might be expected to lie within two per cent of the calorific value" and the work of the Coal Testing Plant[20] at St. Louis has shown a similarily close agreement. However, all of these formulæ have the disadvantage that elementary analysis is too tedious for ordinary technical work. At the time these were originally proposed, it was much easier to make an elementary analysis, in point of time at least, than to make a determination of the heating power. To-day it is simpler to determine at once calorimetrically the heating power of the material than to carry out an elementary analysis.

The prediction of the heating power of a coal from the results of a proximate analysis was suggested by Kent[21] in 1892.

He writes, "Mahler's results group themselves very closely around the average curve of the diagram, indicating therefore that there is a law of relation between the composition of the coal as determined by proximate analysis and the heating value. Knowing, therefore, the percentage of fixed carbon in the dry coal free from ash, we may in the case of all coals containing over 58 per cent of fixed carbon, predict their heating value within a limit of error of about 3 per cent."

A formula for the derivation of the calorific power from the proximate analysis was first proposed by Goutal[22] in 1896. Later De Paepe[23] applied it to a wider range of coals and suggested some modifications for the values first proposed. Since then Goutal has extended his investigations to more than six hundred anthracitic and bituminous coals and finds[24] that the calorific value can be calculated with sufficient accuracy for industrial purposes.

Such a formula is only an approximation. It would be impossible to derive an absolutely correct formula from analyses made by an entirely empirical method, of a substance so complex and varied as coal. However, it has often been recorded[25] that the results obtained by calculation

[18] Alix, J., and Bay, I. *Compt. rend. Acad. sci.* (1904), **139**, 215 have pointed out that nearly all coals contain more or less calcium carbonate, and in the ultimate analysis the carbon dioxide from this is also calculated to carbon. This may be a source of variation.

[19] Trans. *Am. Inst. Min. Eng.* (1897), **17**, 268.

[20] *Prof. Papers* **48**, *U. S. Geol. Surv.* (1906), **1**, 174.

[21] Kent, W. *Mineral Ind.* (1892), **1**, 105.

[22] *Ann. chim. anal.* (1896), **1**, 169; *Rev. d. chim. ind.*, (1896), **7**, 65.

[23] De Paepe, D. *Bull. Ass. belge* (1898), **12**, 279.

[24] Goutal. *Compt. rend. Acad. sci.* (1902), **135**, 477; *Ann. chim. anal.* (1903), **8**, 279; *Analyst* (1903), **28**, 128.

[25] Noyes, W. A., McTaggart, J. R., and Craver, H. W. *Journ. Am. Chem. Soc.* (1895), **17**, 843; Gill, A. H. *Gas and Fuel Analyses for Engineers*, N. Y. (1902), 90; Hempel, W. *Ztschr. f. angew. Chem.* (1892), **5**, 389.

vary by less than 2 per cent on either side, from those given by the calorimeter.

Other methods have been proposed for the determination of the heating power of coal without the use of the calorimeter. These methods are never more than approximations.

The oldest of these is that of Berthier,[26] the determination being made by intimately mixing 1 gram of powered coal and 50 grams of litharge together in a clay crucible and covering with a layer of salt. The mixture is heated in a crucible furnace, with a gradually increasing heat until fusion is complete; this requires about fifteen minutes. The crucible is removed, poured, and when cold the buttom is cleaned and weighed. Pure carbon should reduce 34 times its own weight of lead; hydrogen 103 times its own weight. One part of pure carbon can raise the temperature of 8,080 [27] parts of water 1°. If the fuel is assumed as carbon, its value in heat-units may be estimated by multiplying $\frac{8080}{34}$ by the weight of the lead buttom obtained in the assay. As hydrogen is always present in the coal, this method necessarily gives low results.[28] Stölzel [29] observed that between the results obtained by this method and those calculated from the ultimate analysis there was an almost constant difference; those by Berthier's method being about one-ninth too low. Von John and Fullon [30] made a series of comparisons of the results of Berthier's process with those calculated from analysis on European coals. The former were almost uniformily lower than the latter, in some cases 900 calories. In 1895, Noyes, McTaggart, and Craver [31] compared the results obtained by Berthier's method, on various coals in the calorimeter and by calculation from the ultimate analysis. They corroborate the statements made in previous work that Berthier's method gives low results. "Theoretically, 1 gram of lead should correspond to a heating effect in the coal of 234 calories. The results calculated with this factor are, however, about 12 per cent too low. The average of the results obtained, give an empirical factor of 268.3 calories per gram of lead." The results given were calculated with this empirical formula and agree with those determined by the calorimeter as well as those calculated by Dulong's formula. Munroe [32] proposed a "modification of Berthier's process for the valuation of a coal." This has all of the constant error of the conventional process and in general is a more complicated manipula-

[26] *Polytech. Journ.*, (Dingler) (1835), **58**, 391.

[27] Favre, P. A., and Silbermann, J. T. *Ann. chim. et phys.* (1852), III, **34**, 403.

[28] Langbein, H. *Chem. Ztg.* (1906), **30**, 1116, has pointed out that this method will not even give accurate results for coke.

[29] Stölzel, C. *Polytech. Journ.*, (Dingler) (1857), **146**, 138; *Jahresbr. chem. Technol.* (1858), **3**, 499.

[30] Von John, C., and Fullon, H. B. *Jahresbr. d. Reichsanst.* (1892), 155; *Ztschr. f. angew. Chem.* (1893), **6**, 285.

[31] Noyes, W. A., McTaggart, J. R., and Craver, H. W. *Journ. Am. Chem. Soc.* (1895), **17**, 847; *Analyst* (1896), **21**, 22.

[32] Munroe, C. E. *Am. Chem. Journ.* (1880–81), **2**, 277.

tion. In like manner Lebaigne[33] proposed to grind together 0.2 gram of finely powered coal with 2 grams of pure potassium nitrate. In order to lessen the action of the nitrate on the coal, 5 grams of sodium sulphate are mixed in and the whole slowly melted in a silver crucible. When the mass becomes white, then the heat is gradually increased until it is thoroughly fused. The mass is dissolved in water and titrated with sulphuric acid. In order accurately to determine the heating power of a coal by Berthier's method it would be necessary to determine the relation between the carbon and hydrogen, that is, their percentages by an elementary analysis. It is not surprising that the method has fallen into disuse. However, the process might be of use locally. The coal of a vein or sometimes of an entire region is very similar and a constant empirical factor might be determined which would give good results.

Goutal's formula as originally proposed applies only to coals capable of being analyzed by the official method and was not extended to coals where the percentage of fixed carbon in the pure coal is as low as 50 per cent. Some time ago I attempted to extend the formula of Goutal to Philippine coal.[34] It was thought at that time that the coals of this Archipelago were of the same class as many of the bituminous coals of America. However, sufficient data were not then at hand to demonstrate this fact; more recent work has shown them to be of slightly lower grade, the volatile combustible matter to be of slightly lower calorific value and large discrepancies occur in their analyses when made by the official method.[35] It is a well-known fact that the quantity and character of the volatile products of a coal are influenced by the conditions of distillation; by the official method of analysis the rise of temperature in the coal is very rapid and more of the coal is volatilized than by the smoking-off method and for this reason if for no other the volatile combustible matter of Philippine coals would appear different from others of the same grade. The calorific value of the fixed carbon of Philippine coal is also slightly lower than that of coking coals. That of pure coke, free from ash, is often greater than that of pure carbon because of the hydrogen from the pitch (hydrocarbon) which characterizes a coking coal, a part of which is always left as the cementing material in the coke. As a rule, the heating value does not differ materially from that of pure anthracite coal. Goutal gives the average for pure anthracite coal as 8250 calories.[36] The heating power of a sample of coke is given as follows:

[33] *Répert. d. Pharmac.* (1880) No. 6; *Jahresbr. d. chem. Technol.* (1882), **27**, 990.

[34] Cox, A. J. *This Journal*, (1906), **1**, 877.

[35] *Idem, Sec. A.* (1907), **2**, 41; *Sec. A.* (1908), **3**, 301.

[36] *Compt. rend. Acad. sci.* (1902), **135**, 479. A similar number is given by The Coal and Metal Miners' Pocket Book, Scranton, Pa. (1902), 168.

Proximate analysis of the coal.

[The figures give percentages.]

Source of the coal.	Method of analysis.	Water.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.
Australia	Official[37]	2.53	36.12	48.99	12.36	0.09
Do	do	2.53	36.07	48.96	12.44	

Analysis of the coke.

[The figures give percentages.]

No.	Source of the coal.	Method of analysis.	Combustible matter.[a]	Ash.	Sulphur.
1	Australia	Official	79.85	20.15	Trace.
2	do	do	79.74	20.26	

[a] By difference.

Calorific value of the coke in calories:

1	2
6550	6562

Calculated calorific value of the pure coke (free from ash):

1	2
8209	8224

The latter results corroborate those of Goutal and substantiate his formula for coking coals, that—

$P=82C+aV$ where,
P=the heating power in calories.
C=percentage of fixed carbon as determined by analysis.
V=percentage of volatile combustible, as determined by analysis.
a=function of the ratio between the volatile combustible and the total combustible matter in the coal, that is:

$$\frac{\text{per cent of volatile combustible matter}}{100-(\text{per cent moisture}+\text{per cent ash})}$$

In my previous publication, as was stated, the values for a were given tentatively, as sufficient data were not available thoroughly to test the accuracy of the formula when applied to coals of these Islands. Attention was called to the fact that greater discrepancies between calculated and determined values were noted in the analyses of Philippine coals than in the ones from which the numbers were calculated. A satisfactory explanation was not then at hand, but it is now believed that these were due to the inapplicability of the methods of analysis existing at that time, as will be shown below. The numbers were calculated from American

[37] Accurate. *Cf. This Journal, Sec.* A. (1907), 2, 52.

bituminous and subbituminous coals and are applicable only to coals of that class. They are as follows:

When the percentage of volatile combustible as compared with total combustible matter is equal to—	Then a is equal to—
25	102
27.5	97
30	92
32.5	87
35	82
37.5	77
40	72
42.5	67
45	63
47.5	59
50	58
52.5	....
55	56

Australian coal is strictly of the class of the American bituminous coal and the use of the formula with the values of a as given above is applicable to it, as is shown by the following table where the determined and calculated results are tabulated side by side:

TABLE I.[38]

No.	Source.	Water.	Volatile combustible.	Fixed carbon.	Ash.	Total sulphur.	$\frac{100 \text{ V. C.}}{\text{V.C.}+\text{F. C.}}$	Calories.	
								Calorimeter.	Calculated.
1	Westwaldsend (1905)	2.59	32.85	52.97	11.59		38.3	6,637	6,775
2	Westwaldsend (1906)	2.60	34.84	52.57	9.99	0.01	39.9	6,976	6,825
3	do	2.44	34.77	45.18	11.61	0.61	43.6	6,128	6,000
4	Westwaldsend (1907)	2.80	34.23	50.94	12.03	0.09	40.2	6,614	6,600
5	Westwaldsend (1908) [a]	1.74	36.64	52.43	9.19	0.15	41.1	6,983	6,875
6	Westwaldsend (1907) [b]	2.56	32.97	51.68	12.79	0.12	38.9	6,472	6,650
7	Westwaldsend (1908)	2.80	31.24	54.35	11.61		36.5	6,835	6,920
8	New Westwaldsend (1907).	2.56	35.28	52.46	9.70	0.31	40.2	6,906	6,825
9	Illawarra near Sydney	1.26	25.26	63.49	9.99		28.5	7,624	7,600
10	Lichzow Valley (1908)	2.11	32.47	52.62	12.80	0.58	38.2	6,987	6,770

[a] Selected lump. [b] Double screened and picked twice.

We would anticipate that the Goutal formula using the values of a given above, is applicable to Australian coal, since the latter is of the same class as the 150 American coals from which the values were calculated.

I have devised a chart (fig. 1) which is generally applicable to coals of this class, by means of which the same results may be obtained and the formula and laborious process of calculating entirely dispensed with.

[38] Analyses made by the official method (*Journ. Am. Chem. Soc.* (1899), 21, 1116).

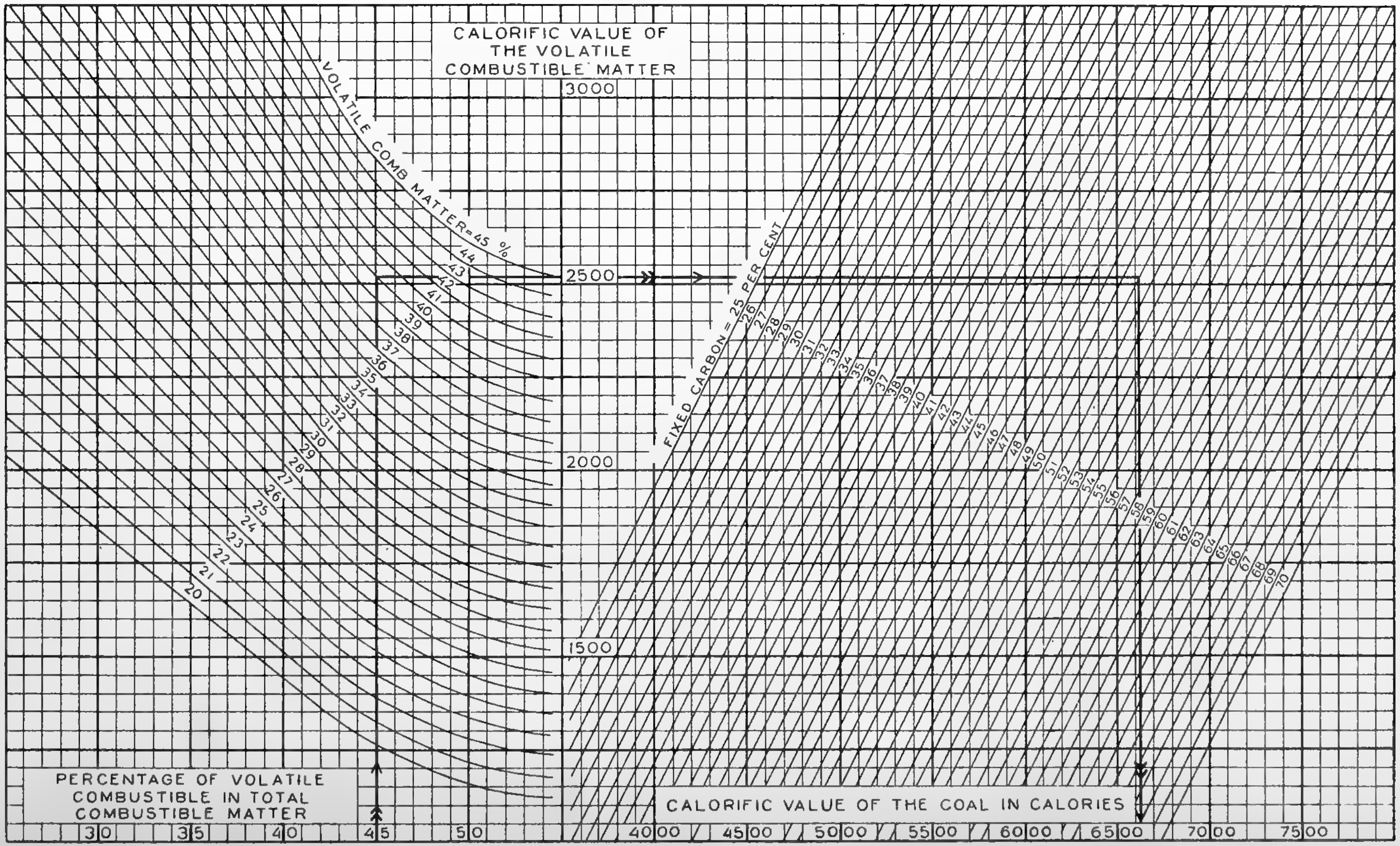


Fig. 1.—Chart for finding the calorific value of bituminous and sub-bituminous coals from their proximate analyses, when analysis by the official method is applicable.

This chart has been drawn on the basis of the Goutal formula with my values for *"a"* given on page 179, and from it the approximate calorific value of the coal may be found, when the proximate analysis as made by the official method is known. The procedure is as follows:

Find from the analysis the percentage of volatile combustible matter in the pure coal $\left(\frac{100 \text{ V. C. M.}}{\text{V. C. M.} + \text{F. C.}}\right)$. Locate this value on the chart and follow the ordinate (vertical line), until it intersects the curve representing the volatile combustible matter which agrees with the percentage determined in the analysis; continue from this point along the abscissa (horizontal line), until the curve representing the percentage of fixed carbon of the analysis is reached; continue downward on the ordinate to the base line where the calorific value of the coal may be directly read. Example:

Analysis of the coal.

Constituent.	Per cent.
Water	5.75
Volatile combustible matter	40.00
Fixed carbon	50.00
Ash	4.25
Total	100.00

$\frac{100 \text{ V. C. M.}}{\text{V. C. M.} + \text{F. C.}}=45$, the percentage of volatile combustible matter in the pure coal. Locate 45 on the chart and follow the ordinate as indicated by the arrow until it intersects the curve representing 40 per cent of volatile combustible matter; continue from this point along the abscissa until the curve representing 50 per cent of fixed carbon is reached; continue downward on the ordinate to the base line where the calorific value of the coal may be read as 6,620 calories.

Goutal assumed the calorific value of the fixed carbon of all coal to be 8,200 calories,[39] or the share that fixed carbon contributes to the calorific value of coal as eighty-two times the per cent of fixed carbon in the sample. This was substantiated by the determination of the calorific value given above for an Australian coal, but it does not

[39] Streit, H. *Dissert. Univ. Zürich* (1906); *Chem. Abs.* (1908), **2**, 1040 has shown that the heat of combustion of ash- and moisture-free coke obtained by one and the same method from different coals is the same but differs if different methods are employed. Crucible coke produced by the French (Goutal) method is least degasified, by the American method most; that by the Bochum method occupies an intermediate position. In general the heat of combustion of pure cokes is as follows:

	Calories.
Crucible coke:	
Goutal	8,230
Bochum	8,160
American	8,100
Gas coke	8,000
Oven coke	7,950

hold good for Philippine noncoking coals as is shown by the following results:

Proximate analyses of the coals.

[The figures give percentages.]

Source of the coal.	Method of analysis.	Water.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.
Cebú, near Carmen	Smoking-off [40]	14.61	35.58	48.16	1.65	0.12
Do	do	14.71	35.43	48.29	1.57	
Polillo	do	5.88	39.18	48.90	6.04	
Do	do	5.90	39.39	48.75	5.96	

Analyses of the residues from which the volatile matter has been expelled.[41]

[The figures give percentages.]

Source of the coal.	Combustible matter.[a]	Ash.	Sulphur.
Cebu, near Carmen	96.69	3.31	Trace.
Do	96.85	3.15	
Polillo	89.01	10.99	
Do	89.11	10.89	

[a] By difference.

Calorific value.

[The figures give calories.]

Source of the coal.	Of the residue from which the volatile matter has been expelled.			Of the pure fixed carbon.		
	1.	2.	3.	1.	2.	3.
Cebu, near Carmen	7,826	7,830	7,815	8,087	8,091	8,076
Polillo	7,233	7,239	7,249	8,122	8,128	8,140

The fixed carbon from a powdered sample of most of the known coal of these Islands is somewhat similar to wood sawdust charcoal. It is very granular and it seldom manifests any tendency to sinter together.[42] The average of the six closely agreeing determinations given above of the calorific value of the pure fixed carbon is 8,107 calories. This is

[40] Accurate; large mechanical loss by official method.

[41] These samples were obtained by expelling the moisture and volatile combustible matter as outlined in *This Journal*, Sec. A (1907), **2**, 44, cooled in a desiccator and weighed directly from the crucible by difference, so that there was no opportunity for the absorption of moisture.

[42] Recently 2 coking coals have been discovered.

an exceedingly close agreement with the generally accepted number of Berthelot,[43] of Petit[44] or of Favre and Silberman[45] of 8,140, 8,103, and 8,080 calories, respectively, for pure carbon. The Philippine coals are known to be very low in heavy hydro-carbon compounds[46] and naturally the fixed carbon would likewise be low, since it would be the more easily degasified. The above results indicate that they are entirely devoid of hydrocarbons that have high heats of combustion, or else that the pure fixed carbon is pure carbon. Therefore, at present it is impossible to establish a generally applicable formula for calculating the heat of combustion of all types of coals from the results of proximate analysis and instead of using eighty-two times the per cent of fixed carbon for its calorific value, for our coals, we must use eighty-one.

Bement says "moisture is the most variable"[47] factor in Illinois coal and "it is a fact that the coal from a general locality has been analyzed over and over again, with always a more or less different result when presented in only the moist coal composition, so that after all of the multiplicity of work, a final conclusion or full understanding is still unattained."[48]

It is probable that the great variability in the moisture is accountable for the different results. I have shown[49] that when coal is analyzed according to the official method, a variation of one and a half per cent in the volatile combustible matter, respectively fixed carbon, is produced if the percentage of loosely held water is varied five per cent; moreover, in the analysis of Philippine coal the official method gives large mechanical losses. The smoking off method which was devised and substituted for the official method gives no mechanical loss and also by its use no variation in the fuel ratio is produced when the content of loosely held water is varied. In the light of this research it seems proper to attribute the great discrepancies which were noted in Bement's paper, to error in the method of analysis rather than to inherent properties of the coal.

There are other errors in the proximate analysis of coal which, though recognized, are not often capable of calculation as they represent the sum of a number of variable chemical changes. It was pointed out above that the presence of carbonates in coal introduces the error of high carbon in the ultimate analysis. This is also true of the proximate analysis. Carbonates which give off carbon dioxide, gypsum and silicates which give up their combined water, and pyrites which is converted to iron oxide, when the coal is burned to ash, are all sources of error.

[43] Berthelot, *loc. cit.*

[44] Petit, *loc. cit.*

[45] Favre, P. A., and Silbermann, J. T. *Ann. chim. et phys.* (1852), III, **34**, 403.

[46] Cox, A. J. *This Journal* (1906), **1**, 877.

[47] Bement, A. *Ill. Geol. Surv.* (1906), Bull. **3**, 23.

[48] Bement, A. *Journ. Am. Chem. Soc.* (1906), **28**, 637.

[49] Cox, A. J. *This Journal, Sec. A* (1907), **2**, 60.

W. Brinsmaid [50] has shown that in an Illinois coal each one per cent of ash as weighed equals 1.13 per cent of ash in the coal. 1.13 per cent error on a coal found to contain 10 per cent of ash, is not inconsiderable. As a small offset to this error, the combustion of the sulphur develops some heat, but this is an extremely small factor in Philippine coals.

Great unity in results are obtained with Philippine coals when the smoking-off method of analysis is used.

The proximate analyses and calorific values of most of the known Philippine coals are given in Table II.

[50] *Journ. Ind. and Chem. Eng.* (1909), 1, 67.

TABLE II.—*Proximate analyses and calorific values of Philippine coals.*

No.	Source.[a]	Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Color of ash.	Total sulphur.	Fuel ratio.[b]	$\frac{100 \text{ V. C. M.}}{\text{V. C. M.} + \text{F. C.}}$	Calories. Calorimeter.	Calories. Calculated.	Variation of the calculated from the determined calories.
1	Batan Island, eastern end	20.81 20.70	36.92 —	35.57 —	6.70 —	—	1.54	0.963	50.9	4792	4860	+ 68
2	do	20.82 20.40	37.10 37.38	36.76 36.94	5.32 5.28	—	1.59	0.992	50.1	4772	4976	+204
3	do	12.50 12.53	35.68 35.69	37.12 36.94	14.70 14.84	Cream to brown	0.83	1.038	49.1	4578	4912	+334
4	Batan Island, north side of eastern end	13.39 13.16	39.06 39.14	39.00 39.27	8.55 8.43	—	1.93	1.003	49.9	5221	5266	+ 45
5	Batan Island, south side of eastern end	20.69 20.65	36.43 36.44	37.88 37.87	5.00 5.04	—	0.79	1.039	49.0	4790	5021	+231
6	do	19.79 19.79	36.95 37.06	37.81 37.89	5.45 5.26	—	1.14	1.023	49.4	4862	5049	+187
7	Batan Island, Betts (1905)	15.41 15.42	39.46 39.46	41.02 41.00	4.11 4.12	—	0.22	1.039	49.0	4873	5437	+564
8	Batan Island, Betts (April, 1907)[c]	18.09 17.97	36.24 36.82	38.44 38.28	7.23 6.93	—	0.84	1.050	48.8	4647	5165	+518
9	Batan Island, Betts (May, 1907)[c]	18.54 18.69	36.72 36.27	34.76 34.97	9.98 10.07	—	—	0.955	51.1	4560	4736	+176
10	Batan Island, Betts (June, 1907)[c]	21.11 21.15	36.72 —	37.36 —	4.81 5.04	—	—	1.017	49.6	4820	4994	+174

[a] These names are arranged alphabetically except those beginning with P, which are placed after those beginning with B for convenience of classification.

[b] $\frac{\text{Fixed carbon.}}{\text{Volatile combustible.}}$

[c] Analyzed for me by Mr. H. S. Walker of this laboratory.

TABLE II.—*Proximate analyses and calorific values of Philippine coals*—Continued.

No.	Source.[a]	Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Color of ash.	Total sulphur.	Fuel ratio.[b]	$\frac{100 \text{ V. C. M.}}{\text{V. C. M. F. C.}}$	Calories. Calorimeter.	Calories. Calculated.	Variation of the calculated from the determined calories.
11	Batan Island, Military Reservation[c]	6.52	38.84	49.12	5.52		0.15	1.259	44.3	6264	6062	—202
		6.42	39.13	48.98	5.47							
12	do	5.76	37.15	53.63	3.46		0.13	1.435	41.1	6542	6344	—198
		5.43	37.55	53.57	3.45							
13	do	5.76	41.21	50.55	2.48		0.16	1.225	44.9	6685	6307	—378
		5.62	41.34	50.58	2.46							
14	Batan Island, Military Reservation, (coal seam No. 5)	7.42	37.15	52.96	2.47	Yellow to brown	0.25	1.271	44.0	6255	6274	19
		7.47	37.36	52.67	2.50							
15	Batan Island, Military Reservation	5.18	40.76	45.51	8.55	Buff	0.22	1.117	47.2	6079	5871	—208
16	do	5.88	38.28	49.41	6.43	Brick red	0.09	1.291	43.6	6298	6054	—244
17	do	5.87	38.99	50.30	4.84	do	0.09	1.290	43.7	6359	6164	—195
18	do	5.99	39.83	49.86	4.32	do	0.11	1.252	44.4	6374	6174	—200
19	do	6.07	39.96	49.53	4.44	do	0.10	1.239	44.6	6455	6154	—301
20	do	5.70	46.30	40.28	7.72	Gray		0.870	53.5	6126	5744	—382
21	Batan Island, Military Reservation (lower seam No. 5)	5.76	39.64	51.76	2.84	Light	0.18	1.306	43.4	6722	6318	—404
22	Batan Island, Military Reservation (upper seam No. 5)	5.52	42.84	48.68	2.96	Yellow	0.11	1.136	52.5	6567	6239	—328
23	Batan Island, Military Reservation (seam No. 4)	5.59	39.69	53.18	1.54		0.20	1.340	42.7	6794	6435	—359
24	Borneo, Labuan mines[d]	5.48	41.03	50.81	2.68		0.74	1.222	45.0	6664	6311	—353
		5.38	41.67	50.30	2.65							
25	Polillo	5.19	38.84	53.12	2.85		0.33	1.355	42.5	6573	6386	—187
		5.04	39.32	52.84	2.80							
26	do	4.60	40.03	52.09	3.28		0.05	1.300	43.5	6875	6363	—512
		4.51	40.08	52.01	3.40							
27	do	4.87	39.71	52.48	2.94		0.08	1.315	43.1	6835	6387	—448
		4.54	40.06	52.43	2.97							

28	do	5.88 5.90	39.18 39.39	48.90 48.75	6.04 5.96	Red		1.243	44.6	6285	6059	—226
29	Polillo, Visita de Burdeus[c]	5.50 	39.30 	50.98 	4.22 4.38	Reddish		1.297	43.5	6448	6235	—213
30	Polillo[c]	4.36 4.51	39.32 39.49	52.42 52.30	3.90 3.70	Red		1.329	42.9	6752	6353	—399
31	do	5.62 5.62	37.83 37.84	44.96 44.83	11.59 11.71	do	0.27	1.187	45.7	5883	5665	—218
32	do	8.61	39.95	46.33	5.11	Brownish red		1.160	46.3	6232	5894	—338
33	Philippines[ef]	6.90 7.13	37.55 	48.70 	6.85 	Reddish		1.297	43.5	6108	5958	—150
34	do	6.76	37.24	49.32	6.68	do		1.324	43.0	6180	5991	189
35	Cebu, near Compostela	9.48	38.32	51.14	1.06	do	0.21	1.335	42.8	6402	6196	—206
36	do	7.50	37.45	51.31	3.74	do	0.62	1.370	42.2	6357	6163	—194
37	Cebu, near Cebu (coking)	1.42	42.41	48.00	8.17	Brownish red	1.80	1.132	46.9	7405		
38	do	1.29	42.02	50.09	6.60		1.62	1.192	45.6			
39	Cebu, Comansi	11.02	38.24	48.05	2.69	Light brown		1.257	44.3	6264	5942	—322
40	Cebu, Comansi (vein No. 1)	7.65	38.36	45.55	8.44		1.90	1.187	45.7	5943	5746	—197
41	Cebu, Comansi (vein No. 2)	11.28	38.20	46.76	3.76		0.38	1.224	45.0	6230	5835	—395
42	Cebu, Comansi (vein No. 3)	10.71	37.24	46.45	5.60		0.29	1.247	44.5	6010	5759	—251
43	Cebu, near Carmen	14.61 14.71	35.58 35.43	48.16 48.29	1.65 1.57	Reddish	0.12	1.358	42.4	5923	5809	—114
44	do	14.38 14.33	38.35 37.75	39.96 40.28	7.31 7.64	do	1.70	1.054	48.7	5248	5289	+41
45	do	13.51 13.38	35.58 34.90	44.49 45.13	6.42 6.59	Yellow	0.23	1.272	44.0	5497	5519	+22
46	do	15.71 15.65	35.48 35.30	45.58 45.72	3.23 3.33	Buff	1.05	1.290	43.7	5535	5595	+60

[a] These names are arranged alphabetically except those beginning with P, which are placed after those beginning with B for convenience of classification.

[b] $\frac{\text{Fixed carbon.}}{\text{Volatile combustible.}}$

[c] Analyzed for me by Mr. H. S. Walker.

[d] Imported by Behn, Meyer & Co. The coal is of the same character and grade as West Batan Island, Polillo, etc., coal.

[e] Incipient coking.

[f] Exact source unknown but near Polillo.

TABLE II.—*Proximate analyses and calorific values of Philippine coals*—Continued.

No.	Source.[a]	Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Color of ash.	Total sulphur.	Fuel ratio.[b]	$\frac{100 \text{ V. C. M.}}{\text{V. C. M. F. C.}}$	Calories. Calorimeter.	Calories. Calculated.	Variation of the calculated from the determined calories.
47	Cebu, northern end Danao-Compostela coal field	17.56	32.59	44.41	5.44		0.11	1.363	42.3	5293	5344	+ 51
48	do	15.98	33.90	47.04	3.08	Buff	0.14	1.388	41.9	5702	5626	— 67
		15.89	33.87									
49	do	17.30	32.80	44.10	5.80	do	0.09	1.348	42.6	5479	5325	—154
		17.26	32.62									
50	do	16.95	34.15	46.71	2.19	Red	0.59	1.374	42.1	5661	5615	— 46
		17.03	33.95	46.87	2.15							
51	do	15.86	35.40	47.69	1.05	Reddish	0.29	1.348	42.6	5784	5768	— 16
		15.78	35.46	47.85	0.91							
52	do	15.14	34.35	47.93	2.58	Buff	0.44	1.392	41.8	5803	5725	— 78
		15.22	34.48	47.90	2.40							
53	do	14.74	34.30	45.35	5.61	do	0.53	1.335	42.8	5581	5543	— 38
		14.60	34.25	45.66	5.49							
54	do	15.26	34.59	47.33	2.82	Light brown	0.16	1.368	42.2	5719	5688	— 31
		15.32			2.78							
55	do	15.08	34.18	49.47	1.27	Reddish	0.13	1.444	40.9	5755	5834	79
		15.26	34.25	49.30	1.19							
56	do	14.84	32.93	49.07	3.16	Brown	0.88	1.496	40.1	5588	5745	+157
		14.82	32.82	49.28	3.08							
57	do	15.66	34.62	46.85	2.87	Buff	0.13	1.351	42.5	5593	5652	59
		15.64	34.73	46.84	2.79							
58	do	18.32	34.93	38.76	7.99	Grayish	0.40	1.105	47.5	4860	5011	+151
		18.26	35.10	38.63	8.01							
59	do	18.25	36.93	39.42	5.40	Reddish	2.75	1.079	48.1	5108	5188	+ 80
		18.06	36.69	39.99	5.26							

60	do	18.06	35.48	40.13	6.33	Light gray	0.96	1.131	46.9	5077	5158	+ 76
		18.25			6.25							
61	do	18.03	35.44	44.28	2.25	Red	0.43	1.241	44.6	5352	5484	+132
		18.03	35.70	44.04	2.23							
62	do	18.96	36.69	40.07	4.28	Light brown	1.43	1.094	47.8	4917	5210	+293
		19.06	36.59									
63	do	21.72	34.58	40.08	3.62	Yellow	0.19	1.158	46.3	4863	5103	+240
		21.52	34.67									
64	do	19.04	36.01	40.14	4.81	Reddish brown	1.60	1.115	47.3	4918	5181	+263
65	do	19.77	35.23	41.59	3.41	Light yellow	0.52	1.181	45.7	4945	5257	+312
66	do	17.33	38.17	40.73	3.77	Brown	1.34	1.067	48.4	4990	5345	+355
67	do	20.00	35.20	41.41	3.39	Light brown	0.22	1.174	46.0	4817	5235	+418
		19.95	35.19	41.25	3.61							
68	do	14.16	32.76	39.84	13.24	Light gray	0.46	1.219	45.1	4861	4987	+126
		14.02	32.71	39.99	13.28							
69	Cagayan Province, 5 kilometers northeast of Alcala	19.28	38.83	30.29	11.60	Brown		0.780	56.2	4275	4534	+259
70	Catanduanes Island (coking)	1.14	23.46	45.44	29.96	Gray		1.937	34.0		4938	
71	Dinigat Island	26.88	32.26	32.87	7.99	Buff		1.019	49.5	4318	4404	+ 86
		26.86	32.44	33.05	7.65							
72	Lepanto-Bontoc, Banaueg [c][g]	18.27	34.74	37.10	9.89		0.29	1.072	48.3	4564	4878	+314
		18.17	34.73	37.33	9.77							
73	Mindanao, near Mati	11.47	23.87	14.08	50.58					1749		
74	Mindanao, Zamboanga Peninsula, Sibugney River	5.75	39.14	50.84	4.27			1.299	43.5	6550	6216	− 334
75	Mindoro	16.34	43.87	31.75	8.04	Reddish white		0.724	58.0	4992	4927	− 65
		16.35	43.94	31.82	7.89							
76	Mindoro, Bulalacao (1907) [h]	15.34	46.02	32.50	6.14			0.697	58.9	5434	5090	344
		15.37	46.49	31.98	6.16							
77	Mindoro, Bulalacao, weathered (1907)	17.85	42.64	37.32	2.19			0.875	53.3	5269	5308	+ 39
		17.84			2.20							

[a] These names are arranged alphabetically except those beginning with P, which are placed after those beginning with B for convenience of classification.

[b] Fixed carbon. / Volatile combustible.

[c] Analyzed for me by Mr. H. S. Walker.

[g] Specific gravity, 1.34

[h] Specific gravity, 1.30.

TABLE II.—*Proximate analyses and calorific values of Philippine coals*—Continued.

No.	Source.[a]	Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Color of ash.	Total sulphur.	Fuel ratio.[b]	$\frac{100 \text{ V. C. M.}}{\text{V. C. M. F. C.}}$	Calories. Calorimeter.	Calories. Calculated.	Variation of the calculated from the determined calories.
78	Mindoro, Bulalacao (1905)	10.84	39.70	47.84	1.62	Yellowish red	-----	1.215	45.2	5569	6012	+ 443
		10.71	39.41	48.27	1.61							
79	Negros, near Cadiz	18.19	32.03	31.74	18.04	White	0.00	0.992	50.2	4008	4288	+280
		18.29	31.98	31.77	17.96							
80	Negros, Escalante	12.97	37.13	40.32	9.58	-----	1.67	0.814	55.1	4903	5258	+355
		13.00	37.29	40.29	9.42							
81	Rizal	9.06	37.00	47.99	5.95	-----	0.46	1.297	43.5	5986	5870	—116
82	Samar, Paranas	9.01	39.76	47.75	3.48	Red	-----	1.191	45.6	6124	5989	—135
		9.13	40.06	47.31	3.50							
83	Samar	15.24	45.38	36.36	3.02	Reddish white	-----	0.803	55.5	5213	5377	+164
		15.26	45.29	36.40	3.05							
84	Sorsogon, near Montúfar	15.99	39.26	38.21	6.54	-----	-----	0.973	50.7	4711	5198	+487
85	Sorsogon, near Montúfar, picked	13.62	42.93	41.35	2.10	-----	-----	0.963	50.9	5138	5650	+512
86	Tayabas, Atimonan	12.21	44.66	39.43	3.70	Yellow	-----	0.879	53.2	-----	5581	-----
		12.33	44.80	39.18	3.69							
87	Zamboanga[c]	6.23	39.27	50.72	3.78	Red	0.06	1.287	43.7	6199	5770	—429

[a] These names are arranged alphabetically except those beginning with P, which are placed after those beginning with B for convenience of classification.

[b] $\frac{\text{Fixed carbon.}}{\text{Volatile combustible.}}$

[c] Incipient coking.

In the Goutal formula the second factor of the equation is a function of the ratio between the volatile and the fixed combustible matter. The analytical data given in the preceding table have been recalculated to the ash and water free (pure coal) basis, which shows this ratio, and the results are given in the following table:

TABLE III.

No.	Source.	Fixed carbon.	Volatile combustible matter.
		Per cent.	*Per cent.*
1	Batan Island, eastern end of	49.07	50.93
2	do	49.87	50.13
3	do	50.92	49.08
4	Batan Island, north side of eastern end	50.06	49.94
5	Batan Island, south side of eastern end	50.96	49.04
6	do	50.57	49.43
7	Batan Island, Betts' (1905)	50.96	49.04
8	Batan Island, Betts' (April, 1907)	51.22	48.78
9	Batan Island, Betts' (May, 1907)	48.85	51.15
10	Batan Island, Betts' (June, 1907)	50.43	49.57
11	Batan Island, Military Reservation	55.72	44.28
12	do	58.93	41.07
13	do	55.06	44.94
14	Batan Island, Military Reservation (seam No. 5)	58.64	41.36
15	Batan Island, Military Reservation	52.75	47.25
16	do	56.35	43.65
17	do	56.33	43.67
18	do	55.59	44.41
19	do	55.35	44.65
20	do	46.52	53.48
21	Batan Island, Military Reservation (lower seam No. 5)	56.63	43.37
22	Batan Island, Military Reservation (upper seam No. 5)	47.45	52.55
23	Batan Island, Military Reservation (seam No. 4)	57.26	42.74
24	Borneo, Labauan mines	55.01	44.99
25	Polillo	57.54	42.46
26	do	56.51	43.49
27	do	56.91	43.09
28	do	55.42	44.58
29	Polillo, Visita de Burdeus	56.47	43.53
30	Polillo	57.06	42.94
31	do	54.27	45.73
32	do	53.70	46.30
33	Philippines	56.46	43.54
34	do	56.98	43.02
35	Cebu, near Compostela	57.16	42.84
36	do	57.82	42.18
37	Cebu, near Cebu	53.09	46.91
38	do	54.38	45.62
39	Cebu, Camansi	55.68	44.32
40	Cebu, Camansi (vein No. 1)	54.28	45.72
41	Cebu, Camansi (vein No. 2)	55.04	44.96
42	Cebu, Camansi (vein No. 3)	55.50	44.50
43	Cebu, near Carmen	57.60	42.40
44	do	51.32	48.68

TABLE III—Continued.

No.	Source.	Fixed carbon.	Volatile combustible matter.
		Per cent.	*Per cent.*
45	Cebu, near Carmen	55.98	44.02
46	do	56.33	43.67
47	Cebu, northern end Danao-Compostela coal field	57.68	42.32
48	do	58.12	41.88
49	do	57.42	42.58
50	do	57.88	42.12
51	do	57.42	42.58
52	do	58.20	41.80
53	do	57.17	42.83
54	do	57.78	42.22
55	do	59.07	40.93
56	do	59.93	40.07
57	do	57.47	42.53
58	do	52.50	47.50
59	do	51.90	48.10
60	do	53.08	46.92
61	do	55.39	44.61
62	do	52.23	47.77
63	do	53.65	46.35
64	do	52.71	47.29
65	do	54.14	45.86
66	do	51.62	48.38
67	do	54.00	46.00
68	do	54.95	45.05
69	Cagayan Province, northeast of Alcala	43.82	56.18
70	Catanduanes Island		([a])
71	Dinagat Island	50.47	49.53
72	Lepanto-Bontoc, Banaueg	51.72	48.28
73	Mindanao, near Mati		([a])
74	Mindanao, Zamboanga peninsula	56.50	43.50
75	Mindoro	41.99	58.01
76	Mindoro, Bulalacao (1907)	41.07	58.93
77	Mindoro (1907), weathered	46.67	53.33
78	Mindoro (1908)	54.85	45.15
79	Negros, near Cadiz	49.80	50.20
80	Negros, Escalante	51.99	48.01
81	Rizal	56.47	43.53
82	Samar, Paranas	54.36	45.64
83	Samar	44.52	55.48
84	Sorsogon, near Montúfar	49.32	50.68
85	Sorsogon, near Montúfar (selected)	49.06	50.94
86	Tayabas, Atimonan	46.77	53.23
87	Zamboanga	56.28	43.72

[a] On account of very high ash, are probably not normal samples.

These results, which express the ratio of the volatile combustible matter to the fixed carbon are represented graphically by fig. 2.

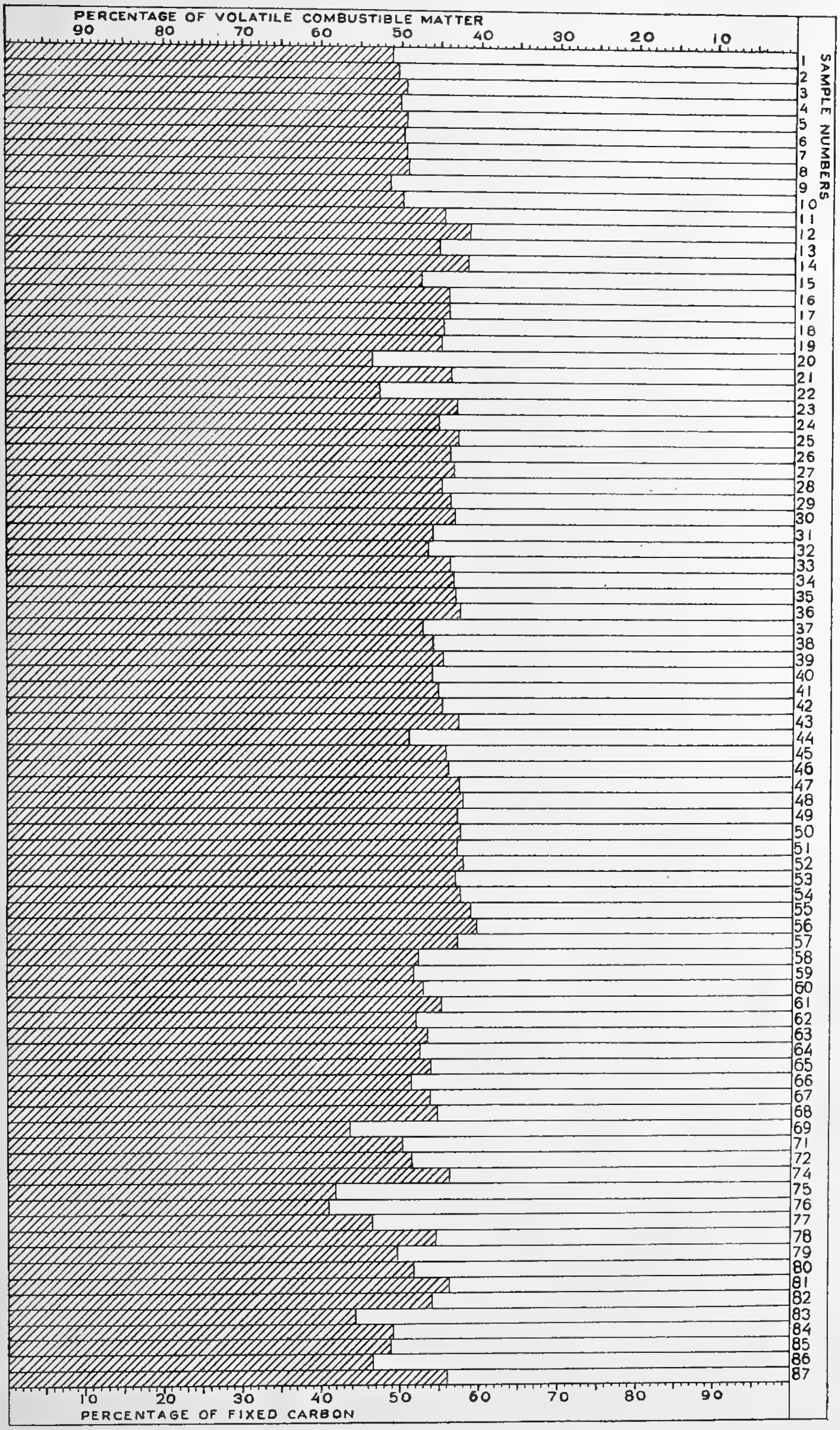


FIG. 2.—Chart showing the ratio of the volatile combustible matter to the fixed carbon in Philippine coals when calculated free from water and ash (pure coal).

The relative amounts of fixed carbon and volatile combustible matter vary very little as is shown by the figure. The coals given are representative of all the Islands and we can assume the average as a fair representation of Philippine coals. Not only the amount, but also the calorific power of the gaseous portion of these coals is approximately the same in all varieties. The following results (Table IV) regarding the calorific value of the volatile combustible matter of coals from this Archipelago have been calculated from work already published.

TABLE IV.

Source of coal.	Yield of gas per kilo of total combustible matter— In liters.	Yield of gas per kilo of total combustible matter— Calorific value in calories.	Per cent of volatile combustible matter in the total combustible matter.	Yield of gas per kilo of volatile combustible matter.	Calorific value of the gas produced per kilo of volatile combustible matter in calories.
Batan Island	335	$1.4 \cdot 10^6$	50.45	665	$2.8 \cdot 10^6$
Cebu	307	$1.5 \cdot 10^6$	51.45	597	$3.0 \cdot 10^6$
Negros	297	$1.6 \cdot 10^6$	51.1	581	$3.1 \cdot 10^6$
Zamboanga	309	$1.8 \cdot 10^6$	45.4	680	$3.8 \cdot 10^6$
Polillo	333	$1.9 \cdot 10^6$	46.6	714	$4.0 \cdot 10^6$

The numbers representing the calorific value of the gas produced per kilo of combustible matter and also of volatile combustible matter in calories are nearly, though not absolutely, constant.[51] The coals from the Military Reservation in Batan Island, from Polillo, and from the Compostela region in Cebu have a somewhat higher value, while that for all others thus far investigated is practically constant. The samples are arranged in the order of the slightly increasing value of the calorific power, and it will be seen from Table IV that the numbers representing the percentage of volatile combustible matter arrange themselves almost in the reverse order.

I have calculated the values of "*a*" in Philippine coals from the proximate analyses and determined calorific values given in Table II and using as the calorific power of the fixed carbon the value 81$\times$ the percentage, the results are as follows:

[51] The gas from Australian coal has a somewhat higher calorific value than any of the above.

TABLE V.

	Batan Island Military Reservation, 13 samples.	Polillo, 8 samples.	Compostela, 6 samples.	All others, 58 samples.
Value of "a"	58.8	58.4	59.0	
	58.9	66.4	58.8	
	62.8	64.8	62.0	
	53.1	59.4	57.7	
	58.7	59.0	63.9	
	60.0	63.7	63.0	
	58.6	59.4		
	58.6	62.0		
	61.1			
	61.8			
	63.8			
	61.3			
	62.6			
Average	60.0	61.6	60.7	50.0

The above averages confirm the facts brought out by actual comparison of the calorific value of the gas. The volatile combustible matter in the coal from the Military Reservation on Batan Island, from Polillo, and from the Compostela region in Cebu has a somewhat higher calorific value than from the others.

For the following percentages of volatile combustible matter in the pure coal the results are as follows:

TABLE VI.

40–42 per cent.		42–43 per cent.		43–44 per cent.		44–45 per cent.		45–46 per cent.		46–48 per cent.		48–50 per cent.		50–52 per cent.		52–58 per cent.	
No.	"a"	No.	"a"	No.	"a"	No.	"a"	No.	"a"	No.	"a"	No.	"a"	No.	"a"	No.	"a"
12	58.9	23	62.6	16	60.0	11	58.8	31	59.4	15	58.7	3	44.2	1	51.8	20	61.8
14	53.1	25	58.4	17	58.6	13	62.8	40	58.7	32	62.0	4	51.1	2	48.1	22	61.2
48	55.8	30	63.7	21	63.8	18	58.6	65	44.7	58	49.3	5	47.3	9	47.6	69	46.9
52	55.9	35	59.0	26	66.4	19	61.1	68	49.7	60	51.5	6	48.5	79	44.8	75	55.1
55	51.3	36	58.8	27	64.8	24	62.1	78	42.4	62	45.6	7	39.3	80	44.0	76	61.0
56	48.8	43	56.8	29	59.0	28	59.4	82	57.0	63	46.7	8	42.2	84	41.2	77	52.7
		47	52.0	33	57.6	39	62.0			64	46.3	10	48.9	85	41.7	83	50.0
		49	58.3	34	58.7	41	63.9			67	41.7	44	52.5			86	32.2
		50	54.9	46	51.9	42	63.0					59	51.4				
		51	54.0	74	62.1	45	53.0					66	44.3				
		53	54.7	81	56.7	61	49.9					71	50.9				
		54	57.4	87	53.5							72	44.6				
		57	51.9														
	[a]54.0		[a]57.1		[a]59.4		[a]59.5		[a]56.0		[a]50.2		[a]47.1		[a]45.6		[a]52.6

[a] Average.

The above figures perhaps show that there is an increase in the calorific value of the volatile combustible matter with a decrease in the percentage, but the difference in any event is very slight and there are many weak points in such a deduction. I believe the assumption that it is constant for all known Philippine coals to be equally accurate. When a technical problem is concerned and it is the desire to draw a general conclusion, it is always necessary to attempt to determine a middle value which will serve all samples equally well. If sufficient data were at hand we probably would derive a slightly smaller value for *"a"* for the larger percentages of volatile combustible matter in the above table. This would give the highest degree of accuracy.[52] However, after considering the remarkable regularity and similarity of the Philippine coal,[53] the data regarding which have been brought out in this paper, and which also have been continually observed in the researches of this laboratory, and using the data given by Table VI, an average value for *"a"* has been derived for our coals, namely 53.6; that is, the variable factor *"a"* becomes a constant for coals of this Archipelago and is expressed by the value 53.6. It is somewhat less than that applicable to coking coals of the same grade.

We now have all the factors for the development of an equation for the calculation of the fuel value of a Philippine coal from its proximate analysis. This formula is as follows:

$P = 81C + 53.6V$, where
P=The calorific value in calories,
C=The percentage of fixed carbon,
V=The percentage of volatile combustible matter.

The coals must be analyzed by the "smoking-off method"[54] which is the only one giving reliable results with Philippine coals. In most cases there is fairly close agreement between results calculated by the use of the formula and those actually determined in the calorimeter; this is shown by Table II, where they are given side by side. It is possible to point out the limits of error by using the foregoing results obtained directly by the calorimeter and calculated by the use of the formula. The average discrepancy between the determined and the calculated heat of combustion of the coals is about 200 calories or nearly four per cent, while the maximum deviation in the case of three or four

[52] Results already published (Cox, A. J. *This Journal* (1906), 1, 892 et seq.) show that the volatile matter of Philippine outcrop coals contains variable proportions of noncombustible matter other than water which probably accounts for the observed irregularities.

[53] The results sometimes suggest the possibility of these beds all having been continuous at one time, the differences in them as we now find them having been produced by metamorphism and other conditions since the breaking up.

[54] *This Journal, Sec. A.* (1907), 2, 41.

highly weathered outcrop samples is about 500 calories. When it is definitely known that a sample is from one of the regions enumerated in Table V, then it would be more accurate to use the average value for *"a"* there given, and the discrepancies between the calorimeter and the calculated calories would be greatly reduced.[55] Such a degree of accuracy gives a good working formula and is as close an agreement as is to be found between many of the calorimeters in actual use to-day. Should future development and deeper boring prove that better coal exists in these Islands and that this formula is no longer applicable, let it be remembered that the data from which this formula is derived are not changed one iota. In a recent publication Constam and Rougeot[56] conclude that a variation for the same coal of over three per cent may be expected. They used a Parr calorimeter, which is in wide use in America for this work. Lunge and Grossmann[57] discuss the paper of Constam and Rougeot and state that an apparatus which varies 100 calories is sufficiently accurate for technical purposes. The results of my formula do not greatly exceed these limits and are fairly satisfactory when we consider that two independent samples of the same coal show as great variation as this.

The heating value of the upper bed Philippine coals may be easily determined by the chart given in fig. 3, when the results of the proximate analyses are known. The intersection of that ordinate, which corresponds to the proper percentage of fixed carbon (respectively volatile combustible matter) in the total combustible matter read on the abscissa, with the curve representing the percentage of water and ash in the coal, designates the abscissa which in turn indicates the calorific value given on the ordinate.

Authors[58] sometimes recommend corrections or modifications of the present analytical methods used in the determination of the composition of coal, such as that the chemical tests be limited to the determination of the ash and the heating power of the pure coal, abandoning in the future the determination of the moisture, volatile matter, fixed carbon, sulphur and evaporating power of the coal.[59] These, when sifted down

[55] The physical and chemical properties, the character, the water content (Kohr, O. *Chem. Ztg.* (1908), **32**, 580, Cöthen) and the color of the ash (Knappe, G. *ibid.*, 657) may be of assistance in verifying the locality from which a coal comes. Such observations are especially valuable on samples purporting to be from well established coal fields.

[56] Constam, E. J. and Rougeot, R. *Ztschr. f. angew. Chem.* 1906, **19**, 1805.

[57] Lunge, G. and Grossmann, H. *Ibid.*, 1963.

[58] Bement, A. *Eng. Record* (1906), Oct. 27, 473.

[59] Our present methods for the proximate analysis of coal probably had their origin in the "immediatanalyse" of L. Gruner (*Ann. Mines* (1873), III, **2**, 511; **4**, 169; *Polytech. Journ.*, (Dingler) (1874), **213**, 73.) who believed that the simplest and safest method of ascertaining the real value of a coal was the determination of the water, coke, and ash.

FIG. 3.—Chart for finding the calorific value of Philippine coals when the proximate analyses are known.

often have originated from a misconception of the moisture in coal. Moisture as ordinarily determined is indeed variable, but is of great importance. The coal-testing plant of the United States Geological Survey [60] have advanced in the right direction in reporting their results in two ways, first, upon the sample as received and secondly, upon the air-dried coal. Almost every coal seam has an amount of water which is characteristic of the coal itself and this has an important significance in the estimation of the value of the fuel; this is indicated by the amount of moisture in the air-dried coal. The difference between this value and the sample as received at the laboratory gives the amount of water which is variable with the exposure of the coal, the season of the year, the state of the weather, the temperature, etc., or perhaps the wetting it has received at the hands of an unscrupulous dealer. In 1866, Reder [61] carried on some interesting experiments with regard to the variation in weight of coal and coke produced by rain, when they are transported in open railway cars. He found that they increased in weight under the conditions of his experiments from 4.6 to 9.6 per cent after from one to five days' exposure. If the plan of the coal-testing plant [62] is followed consistently, the confusion with regard to the moisture in coal will disappear and the interpretation of the results be simplified. However, usually the purchaser wishes to know how much water is in the ton of coal which he buys, regardless of how it came there. It is the same inert body with respect to the fuel value of the coal in any event, and the heating power of the sample is lowered approximately in proportion to the quantity of this present, as well as by the percentage of ash. The calculation of the results to the basis of dry coal is very simple, if that is a more satisfactory basis for specification.

Even from a practical standpoint it is of great importance to know the amount of volatile and fixed combustible matter in coals. This plan for the analysis of coal was originally formulated when the bulk of the coal used was coking and it was desirable to know the amount of coke that could be produced from a given coal. However, this is a natural distinction and is very useful for noncoking coals, for the two kinds of combustible matter differ in heating power. The calorific value of the fixed carbon is nearly the same for all coals, but that of the volatile combustible matter is very variable for widely different coals. If the specifications in the purchase of coal should be made on a basis of the dry coal, it is still necessary to determine the moisture in order to calculate the amount of coal received. If it is more intelligible to

[60] Somermeier, E. E. *Journ. Am. Chem. Soc.* (1906), 28, 1630.

[61] Reder, *Ztschr. d. Vereins deutscher Eisenbahnverwaltungen* (1866), No. 43; *Polytech. Centralbl.* (1866), N. F. II, 20, 1447; *Jahresb. d. chem. tech.* (1867), 12, 723.

[62] Somermeier, *loc. cit.*

the mechanical engineer to have results reported on such a basis, the interpretation from an ordinary proximate analysis and the recalculation of the calorific value of the coal as analyzed are easily made. To the geologist and chemist the present commercial method is more satisfactory than the suggested modifications and it also gives all that is required to determine the value of coal as a commercial commodity.

REFERENCES TO THE LITERATURE OF CALORIMETERS.

ANDREWS, T. *Phil. Mag. & Journ. Sci.* (1848), III, **32**, 321; *Ann. d. Phys. u. Chem.*, (Poggendorff) (1848), **75**, 27, 244.

ATWATER, W. O., and WOODS, C. D. *Report Storr's (Conn.) Exper. Sta.* (1894), 135; Atwater, W. O. and Blakesley, O. S. *Ibid.* (1897), 199; Atwater, W. O. and Snell, J. F. *Journ. Am. Chem. Soc.* (1903), **25**, 659; *cf.* Fries, J. A. *Ibid.* (1909), **31**, 272.

BARRUS, G. H. *Trans. Am. Soc. Mec. Eng.* (1893), **14**, 816 (Lewis Thompson's calorimeter improved).

BERTHELOT, M. *Compt. rend. Acad. sci.* (1880), **91**, 188; (1892), **115**, 201; *Ann. chim. et phy.* (1878), V, **13**, 5; (1881), **23**, 160; (1885), VI, **6**, 546; (1887), **10**, 433; (1888), **13**, 289; *cf. Ibid.* (1873), IV, **29**, 94 to 186; (1875), V, **5**, 5; *cf.* Stohmann, F. Kleber, Cl. and Langbein, H. *Ztschr. f. angew. Chem.* (1896), **9**, 486; *Journ. f. prakt. Chem.* (1889), N. F. **39**, 507.

BOLLEY, P. *Schweizerische polytech. Ztschr.* (1865), **10**, 18; *Ztschr. f. anal. Chem.* (1865), **4**, 234; Handbuch der technisch-chemischen Untersuchungen (1876), 528.

BOUGHTON, L. F. *Power* (1906) **26**, 524.

BUNSEN, R. *Ann. d. Phys. u. Chem.*, (Poggendorff) (1870), **141**, 1; *cf.* Andrews, *Ibid.* (1871), **142**, 320; Bunsen, *Ibid.*, 616; Bohn, C. *Ibid.*, 618; Schuller, A. and Wartha, V. *Ber. d. deutschen chem. Ges.* (1875), **8**, 1011.

CARPENTER, R. C. *Trans. Am. Soc. Mec. Eng.* (1895), **16**, 320; *cf.* Zahn, G. H. B. *Ztschr. f. Ing.* (1897), 1446; *Ztschr. f. angew. Chem.* (1898), **11**, 116.

DESPRETZ, C. *Ann. chim. et phys.* (1824), II, **26**, 337; (1828), **37**, 180; *Ann. d. Phys. u. Chem.*, (Poggendorff) (1828), **12**, 519.

DULONG, M. *Compt. rend. Acad. sci.* (1838), **7**, 871; *Ann. d. Phys. u. Chem.*, (Poggendorff) (1838), **45**, 461; *Chem. Centralbl.* (1839), **10**, 92.

EMERSON, C. J. *Journ. Ind. & Eng. Chem.* (1909), **1**, 17.

FAVRE, P. A., and SILBERMANN, J. T. *Ann. chim. et phys.* (1852), III, **34**, 403; **36**, 1; *cf.* Thomsen, J. *Ber. d. deutschen chem. Ges.* (1869), **2**, 701; (1871), **4**, 591; (1872), **5**, 614; Favre, *Ann. chim. et phys.* (1872), IV, **26**, 385; **27**, 265; (1873), **29**, 87; Berthelot, M. *Ibid.* (1872), **26**, 529; **27**, 533.

FISHER, F. *Polytech. Journ.*, (Dingler) (1879), **232**, 341; **233**, 135; **234** 390; (1885), **258**, 330; *Ber. d. deutschen chem. Ges.* (1879), **12**, 1694; *Ztschr. f. angew. Chem.* (1899), **12**, 334.

FRANKLAND, E. (Devised by Lewis Thompson but modified by Frankland) *Phil. Mag. & Journ. Sci.* (1866), IV, **32**, 182; *Jahresbr. f. Chem.* (1866), 732; *cf.* Thompson, L.

GOTTLIEB, E. *Journ. f. prakt. Chem.* (1883), **28**, 399.

GRASSI, C. *Journ. de Pharm.* (1843), **8**, 170; *Ann. d. Chem.*, (Liebig) (1845), **56**, 185.

HEMPEL, W. *Ztschr. f. angew. Chem.* (1892), **5**, 389; (1896), **9**, 486; *Journ. Soc. Chem. Ind.* (1893), **12**, 179.

LANGBEIN, H. *Ztschr. f. angew. Chem.* (1900), **13**, 1235 *et seq.; cf.* Berthelot, *loc. cit.*

MAHLER, P. *Compt. rend. Acad. sci.* (1891), **113**, 774; *Bull. Soc. encourag. ind. nat.* (1892), **91**, 317 to 374; Contribution à l'étude des Combustibles, Paris, Librairie polytechnique Baudry et Comp. (1893); *Journ. Soc. Chem. Ind.* (1892), **11**, 840; *Ztschr. f. angew. Chem.* (1892), **5**, 491; *cf.* Stohmann and others, *Journ. f. prakt. Chem.* (1894), N. F. **49**, 100.

PARR, S. W. *Journ. Am. Chem. Soc.* (1900), **22**, 646.

SCHEURER-KESTNER, A. Method described, *Bull. industr. Mulhouse* (1868), 712.

SCHWACKHOFER, F. *Ztschr. f. anal. Chem.* (1884), **23**, 453.

STOHMANN, F. (Frankland's improved) *Journ. f. prakt. Chem.* (1879), N. F. **19**, 115; (1885), **31**, 273; Landwirthschaftl. Jahrbücher (1884), **13**, 513; *cf.* v. Rechenberg, C. *Journ. f. prakt. Chem.* (1880), N. F. **22**, 244.

THOMPSON, L., *Chem. news* (1881), **43**, 135; *Journ. Soc. Chem. Ind.* (1886), **5**, 581; *ibid.* (1888), **7**, 868; *Bull. Soc. industr. Mulhouse* (1888), 506; *cf.* Frankland, also Barrus, *loc. cit.*

THOMPSON, W. *Journ. Soc. Chem. Ind.* (1886), **5**, 581; (1889), **8**, 525.

THOMSEN, J. Thermochemische Untersuchungen, **2**; *Ann. d. Phys. u. Chem.*, (Poggendorff) (1873), **148**, 180, 368 (not suited for solid substances).

URE, A. *Ann. d. Phys. u. Chem.*, (Poggendorff) (1840), **75**, 48.

VÖLCKNER, C. *Ztschr. d. österr. Ingenieur- u. Architektenvereins* (1882), 31; *Jahresbr. d. chem. Technol.* (1883), **28**, 483.

WILLIAMS, H. J. *Pop. Sci. Monthly* (1899), Aug.

To the above may be added the very early imperfect forms which are of interest only from an historical point of view.

CRAWFORD, Experiments and observations on animal heat, London (1788); Dalton, Ein neues System des chemischen Theils der Naturwissenschaft, Berlin (1812), 87; Davy, Essay on Heat, Light, etc. (1799); Works II, London (1836); Lavoisier and Laplace (ice calorimeter), Histoire de l'Académie de France (1781), 379; Oeuvres de Lavoisier, II; Rumford, *Ann. d. Phys.*, (Gilbert) (1813), **45**, 1; (1814), **46**, 225; *Phil. Trans. Roy. Soc. London* (1798), **88**, 80.

FISHER, F. *Polytech. Journ.*, (Dingler) (1879), **234**, 390; *Chem. Centralbl.* (1880), III, **11**, 97 has critically collected the methods and apparatus for the determination of the heating power of fuels, giving a description of some of the early calorimeters brought into use after the ones given above; and v. Knorre, G. *Chem. Ind.* (1894), **17**, 93 and 125 has collected some of the latter literature.

ILLUSTRATIONS.

THE ECONOMIC POSSIBILITIES OF THE MANGROVE SWAMPS OF THE PHILIPPINES.

By Raymond F. Bacon and Vicente Q. Gana.

(From the Chemical Laboratory, Bureau of Science, Manila, P. I.

In the United States, and in other countries where large amounts of leather are manufactured, the forests yielding native tanning materials have been so far exhausted that these nations must look to other countries for their source of supply. At the present time very large quantities of tan barks and cutch are imported into the United States from Borneo, Dutch East Africa, Brazil and other tropical countries, and the use of mangrove tanning materials is constantly increasing. The most abundant source ot tanning substances in the Philippines is the mangrove swamps of the Islands. At the present time there is no mangrove bark exported from the Philippines, and as yet the area of these swamps is not known. They occur as narrow fringes along the coast or in considerable areas at the mouths of large rivers, especially at the head of bays. Some limited areas have been mapped and measured by the Forestry Bureau. These are as follows:

(1) Island of Mindoro, about 10,000 hectares, which will yield approximately 50,000 tons of bark.

(2) The east coast of the Zamboanga Peninsula, Mindanao, contains about 9,000 hectares of mangrove swamp; this will yield at least 90,000 tons of bark, found on a coast line about 45 miles in length. In the same region, on the other side of the Gulf of Subuguay, there are probably 9,000 hectares more which will also yield at least 10 tons per hectare. With the exception of a number of areas of 1,000 hectares or less, no further regions have been examined carefully. The above statement gives a very small proportion of the total area of the mangrove swamps. It is believed that the swamps of Mindanao alone will yield enough bark to furnish a continuous supply to a very large cutch factory.

The tan barks of Mindanao average from 23 to 25 per cent of tannin, and these are the best that have thus far been examined from the Islands. Such bark could not be profitably shipped to the United States to compete with the East African barks carrying 50 per cent of tannin. A careful analysis of conditions shows that the only method of handling the tan barks commercially is by means of a cutch factory at the source of supply and it appears that such a factory could be operated very profitably, as soon as there is free trade between the Philippines and the United States. At the present time the United States imposes a duty of seven-eighths of a cent per pound on cutch. The Bureau of Forestry could grant to a company running a cutch factory a twenty-year license agreement to exploit large areas of timber, provided that they carry on the work economically. These grants might be made on the following general conditions:

(1) All trees destroyed must be used for firewood or for timber. The firewood industry of the Islands is a very important one, and could be carried on in connection with the gathering of the bark. During the past fiscal year, taxes were paid on 192,526 cubic meters of firewood. Any company could probably make contracts with small cutters of firewood to obtain the bark at a very low price. The mangrove swamps of Mindanao also furnish valuable timber which is marketed at the present time usually in the shape of telegraph poles. These are known to yield as high as 29,000 board feet of lumber per hectare. One company now lumbering in these swamps does not use the bark at all, and would be glad to dispose of it at a low price.

(2) Restrictions as to cutting should be imposed to insure reproduction. This would be a help rather than a hardship, because it would insure a perpetual supply of bark to the company. The figures of yield of bark given above are based on the cutting of trees 25 centimeters and over in diameter, and are very conservative. In many places clean cutting would be permitted, and then the yield would be much greater. All restrictions made would depend on the condition of the swamp at the time the cutting begins. At the present time, the mangrove barks are assessed on an arbitrary value of 3 pesos (1.50 dollars United States currency) per 100 kilos, and this value may be changed on three months' notice. The bark is known to sell in the provinces for as low as 1 peso per 100 kilos. During the past fiscal year taxes were collected upon 1,847 tons of tan barks of which probably 90 per cent consisted of mangrove barks. These mangrove barks are used in tanning carabao hides, and to a minor extent, for coloring rice.

All the species of mangrove trees of the eastern tropics, which are used commercially for tanning purposes, are also found in the Philippines. These are:

Rhizophora mucronata Lam.
R. conjugata L.
Bruguiera gymnorhiza Lam.
B. eriopetala W. & A.
B. parviflora W. & A.
B. caryophylloides Blume.
Ceriops tagal (*Perr.*) C. B. Robinson.

There are three large cutch factories in Borneo using tan barks from the same species of mangrove as those found in the Philippines. These factories regard the process of manufacturing cutch as a trade secret, but we can not believe that these so-called trade secrets are of a very formidable nature, as we have succeeded in preparing very good grades of cutch without any complicated processes in this laboratory. Our cutch is a dry, brown solid with a brillant, almost metallic, fracture. It is easily and completely soluble in water and the analysis shows the following constituents:

Constituent.	In parts per 100 of water-free material.	
	I.	II.
	Per cent.	*Per cent.*
Moisture	2.6	5.7
Insoluble	1.9	1.3
Soluble	98.1	98.7
Non Tannin	28.8	26.1
Tannin	69.3	72.6

The following was the method used to prepare the cutch:

The finely ground bark was leached with cold water, and this solution evaporated to dryness *in vacuo*. Hot water extracts too much of the coloring matter, and no more tannin than cold water. The evaporation, at least the latter stages, must always be made *in vacuo* to avoid burning the cutch. It is sufficiently obvious that the extraction on a large scale would be carried out in such a manner that strong solutions would be employed to leach fresh bark while weak ones would be used to extract the last percentages of the tannin from the partly exhausted bark. All the parts of the factory, except the vacuum dryers, could be built on the ground, and it is evident that the fuel for the boilers and for the dryers would cost very little, so that it would appear that if the cutch manufacture were taken up in connection with the lumbering or firewood industry that it would be exceedingly profitable.

Tables of analyses made on mangrove tan barks are given below. It will be noted that the barks from Mindanao run very much higher in tannin than those from Mindoro, and it has often been observed that, as the equator is approached, the tannin percentage increases. The analyses below were made by the methods of the International Leather Chemists Association, using the American "shake modification." As our machine does not give very violent shaking and as we have used unchromed hide powder, it is possible that our results may be as much as 2 per cent low. We are now taking measures to standardize our analyses with those made by a recognized leather chemist and in a subsequent communication will report several hundred analyses of mangrove tan barks from the southern islands, so that perfectly reliable data will be at hand for possible investors in this field.

Botanical determinations of the mangrove bark samples: First lot, from Mindoro. Mr. Merrill of the Botanical Section of this Bureau made the identifications. The botanical material was very poor and was not preserved.

Second lot, from Zamboanga, collected by Dr. H. N. Whitford and W. I. Hutchinson of the Bureau of Forestry in January, 1908.

Forestry Bureau No.	Field No.	Common name.	Scientific name.
9356	2056	Tabique	*Xylocarpus obovatus* A. Juss.
9357	2057	Tangal	*Ceriops tagal* (Perr.) C. B. Robinson.
9358	2058	Bacauan	*Rhizophora mucronata* Lam.
9359	2059	Pototan	*Bruguiera parviflora* W. & A.
9360	2060	Pototan	*Bruguiera gymnorrhiza* Lam.

Third lot, from Mindoro, collected by M. L. Merritt, of the Bureau of Forestry in March, 1908.

Forestry Bureau No.	Field No.	Common name.	Scientific name.
9779	1911	Bacauan	*Rhizophora conjugata* L.
9780	1912	Bacauan	Do.
9781	1913	Hagalay	*Bruguiera parviflora* W. & A.
9782	1914	Pototan	*Bruguiera gymnorrhiza* Lam.
9783	1915	Bacauan	*Rhizophora mucronata* Lam.
9795	1921	Tangal	*Ceriops tagal* (Perr.) C. B. Robinson.
9816	1922	Tangal	Do.
9851	1984	Tangal	Do.

TABLE I.—*Analysis of barks from Port Banga, Zamboanga.*

Forestry Bureau No.	Field No.	Common name.	Scientific name.	Moisture (per cent).	In parts per 100 of water-free bark.			
					Insolubility (per cent).	Total extract (per cent).	Non-tannin (per cent).	Tannin (per cent).
9356	2056	Tabique	*Xylocarpus obovatus* A. Juss	14.9	69.7	30.3	8.6	21.7
9357	2057	Tangal	*Ceriops tagal* (Perr.) C. B. Robinson.	12.4	65.2	34.8	11.6	23.2
9358	2058	Bacauan	*Rhizophora mucronata* Lam	14.4	61.7	38.3	12.4	25.9
9359	2059	Pototan	*Bruguiera parviflora* W. & A	13.9	84.1	15.9	7.1	8.8
9360	2060	Pototan	*Bruguiera gymnorrhiza* Lam	16.1	63.0	36.96	9.8	27.2
		Tabique	*Xylocarpus obovatus* A. Juss	14.2	67.6	32.4	7.7	24.7

These barks were collected on January 1908 by Dr. H. R. Whitford and W. I. Hutchinson from Port Banga, Zamboanga. They are rather large quills with thick, harsh, dirty brown scales on the outer surface. Tabique gave a very dark, red infusion; tangal a somewhat light red infusion; bacauan gave an intense red infusion. Pototan (*Bruguiera parviflora*) is a fibrous bark difficult to grind; it gave a red infusion. Pototan (*Bruguiera gymnorrhiza*) gave the same colored infusion as the previous one.

TABLE II.—*Analysis of barks from Mindoro.*

Forestry Bureau No.	Field No.	Common name.	Scientific name.	Moisture (per cent).	In parts per 100 of water-free bark.			
					Insolubility (per cent).	Total extract (per cent).	Non-tannin (per cent).	Tannin (per cent).
9779	1911	Bacauan	*Rhizophora conjugata* L.	13.2	67.4	32.6	12.0	20.6
9780	1912	do	do	14.4	66.6	33.4	10.7	22.7
9781	1913	Hangalay	*Bruguiera parviflora* W. & A.	14.0	77.4	22.4	9.6	12.8
9782	1914	Pototan	*Bruguiera gymnorrhiza* Lam.	13.9	60.2	39.8	11.6	28.2
[a]9783	1915	Bacauan	*Rhizophora mucronata* Lam.	13.2	64.3	35.7	14.1	21.6
9795	1921	Tangal	*Ceriops tagal* (Perr.) C. B. Robinson	11.8	69.1	30.9	9.7	21.2
9816	1922	do	do	12.3	72.5	27.5	10.5	17.0
9851	1984	do	do	12.7	71.5	28.5	8.0	20.5
[a]9780	1912	Bacauan	*Rhizophora conjugata* L.	13.5	64.8	35.2	10.8	24.4
	1912½	do	do	14.1	67.1	32.9	10.0	22.9
	[a]1913½	Hangalay	*Bruguiera parviflora* W. & A.	14.8	75.5	24.5	9.6	14.9
	1913¾	do	do	12.9	82.1	17.9	8.3	9.6
	1914½	Pototan	*Bruguiera gymnorrhiza* Lam.	13.9	63.4	36.6	12.6	24.0
	[a]1915½	Bacauan	*Rhizophora mucronata* Lam.	13.4	67.1	32.9	15.1	17.8

[a] Analysis of inner bark.

The barks were collected by Mr. M. L. Merritt in Mindoro in March 1908. Bacauan bark is brittle and is very easily ground. It has a dirty brown scale of variable thickness which is very easily removed from the true or inner bark.

Analyses were made on both entire and inner bark of each variety. In every case inner bark showed a higher percentage of tannin than when entire bark was assayed.

Bacauan numbered 1912 contained approximately 10 per cent outer scale.

Bacauan infusions were red, but varied in intensity.

The Hangalay barks are reddish-brown in color with rough, dark brown scales.

The inner bark of Hangalay is fibrous and the ground bark was very irritating to the mucous membranes of the nose and throat when inhaled. They also gave red infusions.

Barks of Pototan and Tangal also possess rough, brownish scales.

The infusions were somewhat lighter than those of Bacauan.

TABLE III.—*Analysis of barks from Port Banga, Zamboanga.*

Field No.	Common name.	Scientific name.	Moisture (per cent).	In parts per 100 of water-free bark.			
				Insolubility (per cent).	Total extract (per cent).	Non-tannin (per cent).	Tannin (per cent).
11534	Bacauan	*Rhizophora conjugata* Lam.	13.4	68.7	31.3	13.3	18.0
11535	Tangal	*Ceriops tagal* (Perr.) C. B. Robinson	11.9	58.6	41.4	19.1	22.3
11536	Pototan	*Bruguiera gymnorrhiza* Lam.	13.5	62.0	38.0	13.5	24.5
11537	Lañgaray	*Bruguiera parviflora* W. & A.	13.8	80.4	19.6	8.0	11.6

This table shows results of analysis made on another lot of barks from Port Banga, Zamboanga, collected by H. N. Whitford on December, 1908.

TABLE IV.—*Analysis of mangrove barks from Sarawak, Borneo.*

Common name.	Scientific name.	Moisture. (per cent).	Insolubility (per cent).	Total extract (per cent).	Non-tannin (per cent).	Tannin (per cent).
Gayong	*Rhizophora mucronata* Lam	14.4	70.1	29.9	9.4	20.5
Bakô	*Rhizophora conjugata* Lam	14.7	58.3	41.7	9.6	32.0
Putut	*Bruguiera gymnorrhiza* Lam	15.5	64.3	35.7	9.0	26.7
Tumu	*Bruguiera eriopetala* W. & A	16.1	64.0	36.0	8.8	27.2
Tangal	*Ceriops tagal* (Perr.) C. B. Robinson	13.8	63.8	36.2	6.9	29.3

Analysis was made of some samples of mangrove barks brought from Sarawak, Borneo by Dr. Foxworthy of the botanical division of this Bureau. These barks are used by cutch factories and among the species in Borneo probably yield the highest amount of tannin.

PHILIPPINE RAW CEMENT MATERIALS.[1]

By Alvin J. Cox.

(From the Laboratory of Inorganic and Physical Chemistry, Bureau of Science, Manila, P. I.)

The essential constituents of Portland cement are calcium oxide (CaO), silica (SiO_2), and alumina (Al_2O_3) or some other flux such as ferric oxide which, similarily to alumina is able to promote the union of silica and lime. Calcium oxide does not occur in nature in the free state, but in combination as calcium carbonate (limestone, chalk, etc.). Silica and alumina are found in the form of minerals such as quartz and corundum, but in this form they are not suitable for the manufacture of cement, owing to the difficulty of grinding the materials to a sufficiently fine state to cause them to combine with lime; therefore, combinations of these two oxides occurring as silicates of alumina, termed clay or shale, are the chief source of these constituents in the raw materials used in cement manufacture. The majority of limestones contain some clay, and clays often contain a certain amount of limestone, these facts are taken into account in proportioning the raw materials.

RAW CEMENT MATERIALS ON THE ISLAND OF BATAN.

Limestone occurs abundantly on nearly every Island of the Philippine Archipelago and in this region is uniformily remarkably pure. On the other hand, suitable shale or clay for the manufacture of a high grade Portland cement is more difficult to obtain. It will be seen by referring to any of the military records of drill holes made when prospecting for coal on Batan Island with a standard diamond 2-inch core drill, that the holes penetrate thick layers of grayish-blue shale separated by more or less thin layers of fossil or calcareous shale and limestone. It was thought that analyses of these blue shales might show the variation to be expected, reveal the presence of some materials not otherwise easily accessible and that they would help to form an opinion as to what, if any, siliceous cement materials exist on this island. The beds encountered are not horizontal; the dip indicates that they outcrop somewhere on the island. If these are suitable for the purpose of cement

[1] The first discussion of this subject was published in *This Journal, Sec. A.* (1908), **3**, 391.

manufacture, the material might be easily available. On the other hand, if the proper constituents were to be found, these shales might be mined after the manner adopted by some successful cement companies now operating.

The samples were obtained from a drill hole made in the Moncao basin on the left bank of the river about 1.5 kilometers from its mouth and at an elevation of 5.8 meters.

A vertical section of the drill hole shows:

Material.	Thickness.	Total depth of hole.
	Meters.	*Meters.*
Surface clay	1.8	1.8
Blue shale	22.5	24.3
Limestone	0.3	24.6
Fossil shale	5.6	30.2
Blue shale	17.9	48.1
Limestone	9.1	57.2
Blue shale	4.6	61.8
Shale and limestone	6.0	67.8
Blue shale	7.7	75.5
Shale and limestone	3.1	78.6
Blue shale	1.0	79.6
Shale and limestone	3.5	83.1
Limestone	2.9	86.0
Shale and limestone	7.7	93.7
Limestone	4.4	98.1
Shale and limestone	3.4	101.5
Limestone	8.6	110.1
Blue shale	1.5	111.6
Limestone	2.3	113.9
Blue shale	19.1	133.0
Limestone	0.6	133.6
Blue shale	0.3	133.9
Limestone	0.8	134.7
Blue shale	6.5	141.2
Shale and limestone	1.2	142.4
Limestone	1.5	143.9
Blue shale	39.9	183.8
Limestone	0.3	184.1
Shale and limestone	2.4	186.5
Limestone	4.5	191.0
Shale and limestone	1.6	192.6

The chemical analyses of some of the materials are given in Table I. I also give the average of the analyses of two limestones which agree very closely in composition; these were taken from drill holes numbers 5 and 6.

TABLE I.—*Analyses of shales and limestones from Batan Island.*

	1.	2.	3.	Limestone.
Depth in meters	1.8–48.1	57.2–61.8	114–133	
Silica (SiO_2)	42.72	35.02	34.80	0.97
Alumina (Al_2O_3)[a]	17.23[b]	13.21	11.70	0.56
Ferric oxide (Fe_2O_3)	2.13	2.13	2.69	0.25
Ferrous oxide (FeO)	4.11	3.49	3.47	0.11
Lime (CaO)	11.12	17.44	17.19	53.86
Magnesia (MgO)	3.65	2.84	2.84	0.19
Soda (Na_2O)	0.87	1.29	1.46	
Potash (K_2O)	1.44	0.68	0.80	0.16
Loss on ignition[c]	[d]15.58	[d]17.50	17.19	43.18
Water below 110°	1.85	5.31	4.90	0.30
Titanium oxide (TiO_2)	[b]Above.	0.77	0.95	
Sulphuric anhydride (SO_3)	None.	None.	None.	
Sulphur (S)	0.44	0.61	0.61	
Manganese (MnO)		Trace.	0.09	
Correction			[e]1.45	
Total	101.14	100.29	100.14	
Less O=S	0.22	0.31	0.31	
Total	100.92	99.98	99.83	99.58

[a] Includes possible phosphoric anhydride (P_2O_5).

[b] Includes titanic oxide (TiO_2).

[c] A number of chemical changes are involved in this factor including both losses and gains, and the amount of these depends largely on the temperature employed. With the crucible covered and a moderate heat, carbon dioxide, water and carbonaceous matter are entirely driven off, the sulphides are oxidized to sulphates and all the sulphur is retained as sulphates by the calcium. With continued heating at a slightly higher temperature all of the iron is oxidized. With intense heat the sulphates are gradually decomposed with the ultimate loss of the entire sulphur and the alkalies are volatilized.

[d] Ignited so that very little if any oxidation occurred.

[e] For the oxidation of the sulphur and ferrous iron on ignition.

About two years ago, W. A. Aiken proposed a theoretical analysis for Lehigh district cement as follows:

	Per cent.
Minimum silica (SiO_2)	21
Maximum alumina (Al_2O_3)	9 } =12.25
Maximum iron (Fe_2O_3)	3.25 }
Lime (CaO)	62.5–63.25
Maximum magnesia (MgO)	3.0

In order to confirm this theoretical analysis, Mr. Aiken[2] made very thorough tests on fourteen brands of Portland cement in the laboratory of the New York Subway Construction. Eight of these brands showed an average analysis practically in agreement with the theoretical one; the remaining six failed to comply with the minimum silica and three of these failed to comply with the theoretical

[2] Concrete, **8**, No. 2, 33 to 34.

analysis by excess of lime. The best results are shown by the eight brands that agree closely with the theoretical analysis.

Mr. Aiken has continued his work and taken samples from several Portland cement mills. He[3] gives results of the tests of these different brands and says "The results herein given certainly emphasize the fact that much cement is of the best and that *there is no monopoly of material* or proportioning in manufacture, as shown by these tests of average output from eight different brands, three of them *not Lehigh district material.*"

Portland cement was thought by Le Chatelier[4] to be composed of tricalcium silicate, $3CaO . SiO_2$, and tricalcium aluminate, $3CaO . Al_2O_3$. In 1897 S. B. and W. B. Newberry[5] showed that this idea should be modified to dicalcium aluminate $2CaO . Al_2O_3$ since the latter showed superior qualities. Richardson[6] and other investigators have concurred in the opinion that tricalcium silicate is an essential constitutent of Portland cement; recently, however Day and Sheperd[7] have shown rather conclusively that no such compound as tricalcium silicate exists and therefore the so-called tricalcium silicate is simply a mixture of lime and dicalcium silicate. The only rational deductions from these facts are those given by R. K. Meade,[8] namely: "That the lime in Portland cement clinker exists in three forms: *First,* in combination with silica, alumina, iron, etc., to form a magma of orthosilicates, $2CaO . SiO_2$, orthoaluminates, $2CaO . Al_2O_3$, etc.; *second,* as the oxide itself in solid solution in this magma of silicates, aluminates, etc., and *third,* as undissolved oxide; that is lime merely disseminated through the magma forming with the latter simply a mechanical mixture." The fact remains that under the most ideal conditions of fluxing and burning, a cement will carry an amount of lime very nearly corresponding to the Le Chatelier molecular formula as modified by Newberry and Newberry, *viz.,* $x\ [(3CaO)SiO_2] + y\ [(2CaO)Al_2O_3]$. Overlimed cements are unsound, but up to this point the more lime that is present the greater will be the strength of the cement. Bleininger, as mentioned in my previous paper[9] has shown from his experiments that "for the dry, ground mixtures the formula $(2.8\ CaO)SiO_2(2CaO)Al_2O_3$ is the safest." Even this give a percentage of lime in the burned product higher than that encountered in many cements.

Magnesium not to exceed three of four per cent of the finished product may replace calcium in Portland cement without deleterious results, and iron in any amount may replace alumina.[10] A certain amount of iron acts as a flux, lowers the fusion point of the mixture and promotes the combination of the calcium oxide and silica. Several articles have recently appeared in the literature advocating the superiority of a cement for use in sea water, in which practically all of the alumina

[3] *Concrete Review* **2**, No. 11, 2 to 7.

[4] *Ann. des Mines* (1887), **11**, 345.

[5] *Journ. Soc. Chem. Ind.* (1897), **16**, 887.

[6] Address, Assoc. Portland Cement Manufacturers, Atlantic City, N. Y., June 15th, 1904; *Journ. Soc. Chem. Ind.* (1905), **24**, 733.

[7] *Journ. Am. Chem. Soc.* (1906), **28**, 1107.

[8] *Chem. Eng.* (1907), **5**, 344.

[9] *This Journal, Sec. A.* (1908), **3**, 405.

[10] Newberry, S. B. and W. B.: *Journ. Soc. Chem. Ind.* (1897), **16**, 891.

is replaced by iron and showing that iron-ore cement has been used with efficiency for such works of construction.[11]

If the international atomic weights for 1909 are used in the above limiting molecular formula of Bleininger, then for every part by weight of silica 2.60 of calcium oxide are required, for every part of alumina 1.10 of calcium oxide, for every part of ferric oxide 0.70 of calcium oxide, and for every part of ferrous oxide 0.78 of calcium oxide. As the clay itself contains a certain proportion by weight of calcium oxide, this amount must be deducted from the total required (the amount of magnesiam present is equivalent to 1.4 its weight of calcium oxide). On the other hand, the limestone contains silica, alumina and oxides of iron which take up some of the calcium and accordingly reduce the amount available.

The calculation of a cement mixture from shale number 1 and the limestone would be as follows:

SHALE.

$42.72\times2.60=111.07$ parts calcium oxide required by silica in 100 parts shale.
$17.23\times1.10=18.95$ parts calcium oxide required by alumina in 100 parts shale.
$2.13\times0.70=1.59$ parts calcium oxide required by ferric oxide in 100 parts shale.
$4.11\times0.78=3.21$ parts calcium oxide required by ferrous oxide in 100 parts shale.

134.82 parts calcium oxide required by 100 parts shale.
$11.12+(3.65\times1.4)=16.23$ parts calcium oxide equivalent to calcium and magnesium in 100 parts shale.

(1) 118.59 parts calcium oxide to be added to 100 parts shale.

LIMESTONE.

$53.86+(0.21\times1.4)=54.13$ parts calcium oxide equivalent to calcium and magnesium in 100 parts limestone.

$$\left.\begin{array}{l}0.97\times2.60=2.52\\0.56\times1.10=0.62\\0.25\times0.70=0.17\\0.11\times0.78=0.09\end{array}\right\}3.40 \text{ parts calcium oxide in 100 parts limestone which is not available.}$$

(2) 50.73 parts calcium oxide available in 100 parts limestone.

$$\frac{(1)}{(2)}=\frac{118.59}{50.73}=2.34 \text{ parts limestone required by 1 part shale.}$$

The limestone and shale number 1 combined according to this calculation give the following results:

[11] Newberry, S. B.: *Cement Age*, **4**, 38; *Monthly Consular and Trade Report* (1908), June, 165; *Cement and Eng. News* (1908), **20**, 112, 168.

TABLE II.

[The numbers give parts of the material by weight.]

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide[a] (Fe_2O_3)	Calcium oxide (CaO).	Magnesium oxide (MgO).	Volatile (CO_2, H_2O, etc.).
Limestone	234	2.27	1.31	0.87	126.03	0.44	101.74
Shale No. 1	100	42.72	17.23	6.69	11.12	3.65	17.43
Unburned	334	44.99	18.54	7.56	137.15	4.09	119.17
Volatile	119.2						
Burned	214.8	20.95	8.63	3.52	63.85	1.90	----------

[a] Estimating all of the iron as ferric oxide.

The limestone and shale number 2 calculated after the same method give the following results:

TABLE III.

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide[a] (Fe_2O_3)	Calcium oxide (CaO).	Magnesium oxide (MgO).	Volatile (CO_2, H_2O, etc.).
Limestone	174	1.69	0.97	0.64	93.72	0.33	75.65
Shale No. 2	100	35.02	13.21	6.00	17.44	2.84	22.81
Unburned	274	36.71	14.18	6.64	111.16	3.17	98.46
Volatile	98.5						
Burned	176.5	20.8	8.03	3.76	62.98	1.80	----------

[a] Estimating all of the iron as ferric oxide.

The limestone and shale number 3 combined according to a similar calculation give the following results:

TABLE IV.

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide[a] (Fe_2O_3)	Calcium oxide (CaO).	Magnesium oxide (MgO).	Volatile (CO_2, H_2O, etc.).
Limestone	171	1.66	0.96	0.63	92.10	0.32	74.35
Shale No. 3	100	34.80	11.70	6.54	17.19	2.84	22.09
Unburned	271	36.46	12.66	7.17	109.29	3.16	96.44
Volatile	96.4						
Burned	174.6	20.9	7.25	4.11	62.60	1.81	----------

[a] Estimating all of the iron as ferric oxide.

The limiting formula given above does not give entire satisfaction, since there are two undetermined variables. Limits for the silica-alumina (respectively iron oxide) ratio must also be set.

E. D. Campbell[12] has shown in his experiments that the best cements were produced from lean clays high in silica, with a ratio $3>1$. He says "the substitution of Al_2O_3, or Fe_2O_3 for SiO_2, that is, the use of a rich clay, lowers the overburning temperature" that with lean clays heavily limed there is a wide margin between the proper clinkering temperature and the overburning temperature, while with rich clays great care must be exercised in order to prevent overburning.

Bleininger,[13] says, "The clay must have a percentage ratio of silica to alumina of from 3 to 1 to 4 to 1" and in drawing conclusions from his own work, continues[14] "The ratios of silica to alumina given on several occasions seems to be correct, for the safest cements in the boiling test, though not the highest in the tensile test are those with a silica-alumina ratio of from 3 to 1 to 4 to 1. *Aluminous cements* are to be condemned." Experiments of this Bureau[15] lead to the conclusion that the composition of Portland cement best adapted for use in a tropical climate should have a high silica-alumina ratio; that is, at least 3 parts of silica to 1 part of alumina. R. K. Meade[16] places the limits for a freshly made American Portland cement as follows:

	Per cent.
Silica	20–24
Alumina	5– 9
Iron oxide	2– 4
Lime	60–63.5
Sulphur trioxide	1– 2

Le Chatelier[17] places the limits of the amount of individual constituents usually present in good commercial Portland cement as follows:

	Per cent.
Silica	21–24
Alumina	6– 8
Iron oxide	2– 4
Lime	60–65
Magnesia	0.5– 2

The above calculations show that cements agreeing nicely with the theoretical analysis for Lehigh district cement could be produced from materials such as those taken from the drill hole on Batan Island. On the other hand, the silica-alumina ratio is low and the composition of the burned product shows that this would barely come within the highest limits proposed by Meade and Le Chatelier. I am of the opinion that it would be found necessary to add silica to the materials in some shape to produce a wholly satisfactory cement.

[12] *Journ. Am. Chem. Soc.* (1902) **24**, 969.

[13] The manufacture of Hydraulic Cements, *Bull. Geol. Sur.*, Ohio 4th Ser. (1904), **3**, 223.

[14] *Ibid.*, 237.

[15] Reibling, and Salinger, L. A. *This Journal, Sec. A.* (1908), **3**, 185.

[16] *Chem. Eng.* (1907), **5**, 349.

[17] *Trans. Am. Inst. Min. Eng.* (1893), **32**, 16.

Attention might also be called to the fact that owing to a relatively large amount of calcium oxide contained in these shales themselves, only a comparatively small amount of limestone would have to be combined with them and therefore a much larger deposit than is usual for ordinary siliceous shales, would be necessary for a given output.

THE RAW MATERIALS OF MOUNT LICOS REGION, NEAR DANAO, CEBU.

Although a few borings have been made, there is little doubt but that there is a large supply of raw materials in the Mount Licos region the quality can be ascertained from the following pages. The map of the Danao-Compostela coal district[18] shows the extent of the limestone. Mount Licos is capped with a white, orbitoidal limestone, 30 to 150 meters thick. Limestone occurs abundantly in more or less detached areas over the whole region as remnants of what was most probably originally a continuous blanket. The shales and sandstone are mapped under one color (blue). Dr. Smith has estimated that the total thickness of the coarse, gray sandstone and the coal measure shales, including five coal seams, is 90 to 150 meters[19]; this also includes the shales which have locally been weathered to clay. The lower part of the coal measures consists of gray shales and the upper portion of the coarse, gray sandstone. The dip of the beds is naturally with the coal, which varies upward from 20°. Some of the outcrops of the siliceous materials are obliterated by covers of talus, others may be followed all the way up the mountain side, whereas still others have been uncovered or more exposed by railway cuts and mine drifts. The samples here discussed represent large quantities, but were chosen rather to indicate what is known of the character of the materials of the region than to represent any particular bed. A knowledge of its chemical composition is of first importance in the investigation of the suitability of a material for the manufacture of a hydraulic cement and the data for the clays, shales and limestone given in Table V will give the information required.

DESCRIPTION OF SAMPLES.

No. 1. Clay from a short distance beyond the upper terminus of the railway of the Insular Coal Company.

No. 2. Clay found under the Danao coal.

No. 3. Shale dried at 105° C.

No. 4. Calcareous shale from railway cut about 300 meters east of the terminus.

No. 5. Shaly limestone.

No. 6. Shaly limestone from the cut of the railway about 500 meters east of the terminus.

No. 7. Upper limestone from Mount Licos. Especial attention is called to the absence of magnesium.

[18] Smith, W. D. *This Journal, Sec. A.* (1907), **2**, 405.

[19] *Ibid*, 390.

TABLE V.—*Analyses.*

[The numbers give percentages.]

Constituent.	1.	2.	3.	4.	5.	6.	7.
Silica (SiO_2)	60.17	43.38	53.35	44.35	29.00	24.02	0.38
Alumina (Al_2O_3)[a]	22.65	29.44	24.11	20.26	11.38	7.49	} 0.18
Iron oxide (Fe_2O_3)[b]	4.66	0.48	9.03	4.64	5.35	2.00	
Calcium oxide (CaO)	0.31	9.50	0.80	11.37	26.25	33.88	55.62
Magnesia (MgO)	1.85	0.61	2.22	2.59	0.65	2.12	0.00
Alkalies (K_2O+Na_2O)		1.56			1.98		
Loss on ignition	6.35	10.75	8.72	14.30	23.00	28.25	43.50
Water (H_2O) below 110°C	(c)	5.30	(c)	(c)	3.84	(c)	0.17

[a] Includes possible titanium oxide (TiO_2).
[b] Total iron determined as ferric oxide.
[c] Included under loss on ignition.

These materials may be combined, according to the method of calculation outlined under the preceding head. If clay number 1 is combined with limestone number 7, the formula would require 3.28 parts of limestone to every part of clay and the results would be as follows:

TABLE VI.

[The numbers give parts of the materials by weight.]

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3)	Calcium oxide (CaO).	Magnesia (MgO).	Volatile (CO_2, H_2O, etc.).
Clay (No. 1)	100	60.17	22.65	4.66	0.30	1.85	6.35
Limestone (No. 7)	333.5	1.27	0.60		185.49		143.25
Unburned	433.5	61.44	23.25	4.66	185.80	1.85	151.99
Volatile	152.0						
Burned	281.5	21.83	8.26	1.65	66.00	0.66	

It will be noticed from the parts by weight (percentage composition) of the burned product that the content of lime is higher than that of the average Portland cement. The results of the formula represent the maximum of lime which a cement can carry, if it were manufactured under ideal conditions. In actual practice these are seldom met with and it is therefore necessary to carry the lime lower than that indicated by the formula. Furthermore, a cement which has a comparatively low overburning temperature is always burned at the lowest possible point and at this temperature will usually not carry the maximum quantity of lime. A mixture which would more nearly correspond to the theoretical analysis of Lehigh Portland cement given above is as follows:

TABLE VII.

[The numbers give parts of the materials by weight.]

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3)	Calcium oxide (CaO).	Magnesia (MgO).	Volatile (CO_2, H_2O, etc.).
Clay (No. 1)	100	60.17	22.65	4.66	0.3	1.85	6.35
Limestone (No. 7)	292	1.05	0.5		162.6		127.65
Unburned	392	61.22	23.15	4.66	162.9	1.85	134.
Volatile	134						
Burned	258	23.7	8.97	1.80	63.1	0.72	

While the limiting formula is of great assistance in the proportioning of cements, it leaves undetermined the silica-alumina ratio, which is of utmost importance. There is every reason to believe that clay number 1 would produce a better cement if silica in some shape were added to the clay base. With the substitution of a certain amount of silica for alumina or iron oxide, molecule for molecule, in the limiting formula a safer cement would be produced in that the overburning temperature would be increased.[20] The state of subdivision of the free silica in the raw materials used for this purpose is an extremely important consideration. The sandstones of the region, although high in silica, are probably not suited for this purpose in that they are composed of oxides of iron and alumina and quartz grains so large as to be unsuited to cement manufacture.

This sandstone, which contains approximately 73 per cent silica, when pulverized to the degree necessary for rock analysis and one gram digested in 200 cubic centimeters of 5 per cent sodium hydroxide for 45 minutes on a water bath, allowed 7.6 per cent of the silica to pass into solution.[21] It is unnecessary to resort to physical means to determine that the greater part of the silica is crystalline, for the quartz grains are visible to the naked eye and very distinct with a lens. The grains are very loosely held together and can be broken apart by rubbing be-

[20] The ideal mixture can not be overburned.

[21] Quartz is not absolutely insoluble in caustic alkalies (Lunge, G. and Millberg, C.: *Ztschr. f. angew. Chem.* (1897), **10,** 393, 425), as is sometimes supposed to be the case and the use of a dilute solution of the latter does not give a correct separation of quartz and amorphous silica, however the error can generally be neglected. Hillebrand (*Bull. U. S. Geol. Sur.* (1907), **305,** 166), recommends as the most satisfactory the use of a dilute solution of sodium hydrate in which the solution of the amorphus silica is almost immediate.

tween the fingers, or gently in a mortar. The state of subdivision will be seen from the following numbers:

Sieve.		Per cent.	
Size.	Meshes per centimeter.	Passed.	Not passed.
100	40	45	55
80	32	57	43
60	24	76	24
50	20	94	6
40	16	98½	1½

A large formation of schist occurs on the Island of Romblon; this is so high in silica that it is doubtful if it could be used alone for the manufacture of cement, but a small amount of material of this nature could successfully be employed for recomposing the ordinary clay or shale base.

It is not improbable that highly siliceous materials similar to those in Romblon occur along tectonic lines and if so, then possibly a similar schist more available to Cebu, might be found on some of the smaller islands lying nearer to it. In fact, schists have been found on Cebu itself. These occur and outcrop only in a few places along the *Cordillera* under the capping. One such schist has been described as rhyolite by H. G. Ferguson.[22]

Analyses of these materials rich in silica are given in Table VIII.

Sample No. 8. Sandstone which outcrops above the coal at the Compostela mine.

Sample No. 9. Average of two analyses, agreeing fairly well, of independent samples taken from the schist formation near Romblon, Romblon.

Sample No. 10. Cebu rhyolite.

TABLE VIII.—*Analyses of materials rich in silica.*

[The numbers give percentages.]

Constituent.	8.	9.	10.
Silica (SiO_2)	72.76	80.12	67.25
Alumina (Al_2O_3)[a]	15.58	12.56	13.12
Iron oxide (Fe_2O_3)[b]	1.42	1.15	0.24
Lime (CaO)	0.62	0.12	1.23
Magnesia (MgO)	Trace.	0.48	1.10
Potash (K_2O)	------	2.38	4.38
Soda (Na_2O)	------	1.31	0.59
Loss on ignition	3.53	1.94	6.11
Water (H_2O) below 110°C	1.84	0.21	6.15

[a] Includes possible titanium oxide (TiO_2).

[b] Total iron determined as ferric oxide.

[22] *This Journal, Sec. A.* (1907), 2, 408.

Suppose that we recompose clay number 1 with schist number 9 so that, $\frac{\text{alumina (resp. iron oxide)}}{\text{silica}}=\frac{1}{3}$. The calculation is as follows:

Clay number 1.—$22.65+\left(4.66\times\frac{102.2}{159.8}\right)=25.63$ parts alumina equivalent to alumina and iron oxide in 100 parts clay.

$$\frac{60.17}{25.63}=2.346 \text{ or } \frac{\text{silica}}{\text{alumina}}=2.346.$$

Schist number 9.—$12.56+\left(1.15\times\frac{102.2}{159.8}\right)=13.30$ parts alumina equivalent to alumina and iron oxide in 100 parts schist.

$$\frac{80.12}{13.30}=6.025 \text{ or } \frac{\text{silica}}{\text{alumina}}=6.025.$$

For any given intermediate ratio, parts of each must be combined, inversely in proportion as the found ratio varies from that given. For a ratio of 3 to 1 therefore, 0.654 (*i. e.*, 3−2.346) part of schist would need to be combined with 3.025 (*i. e.*, 6.025−3) parts of clay, or a mixture of 82.25 per cent $\left(\frac{3.025}{3.025+0.654}\right)$ clay number 1 and 17.75 per cent $\left(\frac{0.654}{3.025+0.654}\right)$ schist number 9 would be required.

Accordingly, a new siliceous material would be obtained as follows:

TABLE IX.

[The numbers give parts of the materials by weight.]

Material.	Individual constituents.					
	SiO_2.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	Loss on ignition.
82.25 clay (No. 1)	49.50	18.62	3.84	0.26	1.52	5.23
17.75 schist (No. 9)	14.23	2.23	0.20	0.02	0.09	0.38
100	63.73	20.85	4.04	0.28	1.61	5.61

The formula requires 3.475 parts of limestone number 7 to every part of the above material to give the maximum of lime which should be present in the cement mixture as follows:

TABLE X.

[The numbers give parts of the materials by weight.]

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3).	Calcium oxide (CaO).	Magnesia (MgO).	Volatile (CO_2+ H_2O+, etc.)
Clay (No. 1)	82.25	49.50	18.62	3.84	0.26	1.52	5.23
Schist (No. 9)	17.75	14.23	2.23	0.20	0.02	0.09	0.38
Limestone (No. 7)	347.50	1.32	0.62		193.50		152.00
Unburned	447.50	65.05	21.47	4.04	193.8	1.61	157.6
Volatile	157.6						
Burned	289.9	22.48	7.40	1.39	66.8	0.55	

In ordinary practice this material would probably be combined with not more than 3 parts of limestone number 7 as follows:

TABLE XI.

	Total.	Individual constituents.					
		Silica (SiO_2).	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3).	Calcium oxide (CaO).	Magnesia (MgO).	Volatile (CO_2+ H_2O+, etc.)
Clay (No. 1)	82.25	49.50	18.62	3.84	0.26	1.52	5.23
Schist (No. 9)	17.75	14.23	2.23	0.20	0.02	0.09	0.38
Limestone (No. 7)	300.	1.14	0.54		166.86		131.
Unburned	400.	64.87	21.39	4.04	167.16	1.61	136.6
Volatile	136.6						
Burned	263.4	24.62	8.12	1.53	63.46	0.61	

In like manner the materials numbered 2 to 6 inclusive could be mixed with schist number 9 and limestone number 7. The following proportions would give a correction of the silica-alumina ratio to 3 to 1.

Sample number.	Parts sample.	Parts schist.
2	66.3	33.7
3	71.3	28.7
4	73.5	26.5
5	74.4	25.6
6	92.1	7.9

The composition of the ash of the coal has not been considered in preparing the above figures, but the relative proportions of the raw constitutents may be varied to include this factor, which is not a large one.

It is not only the existence in this region of a superabundance of limestone and of shales that could readily be recomposed to be suitable for the manufacture of cement which attracts attention, but the coal is at hand; the city of Cebu is an open port making transportation easy and the cost of labor and supplies should be as low as they would be at any other point in the Islands.

FUEL FOR BURNING CEMENT.

The item of fuel used in the burning of Portland cement is an important one. In 1885 Mr. F. Ransome[23] patented a rotary kiln for calcining cement in which the firing was effected by means of producer-gas. The powdered raw material was fed in by means of a hopper at the upper end of the kiln and traveled slowly down the furnace in consequence of an angle of inclination and a constant revolution of the kiln, while the producer gas in a large volume of flame entered the kiln at the opposite end. The interior of the cylinder contained a series of projecting longitudinal steps by which the raw material was caught

[23] Redgrave, G. R. and Spackman, C., Calcareous Cements London (1905), 167.

up and carried until it would fall almost directly across the flame to the bottom, to be carried up again. It was found that the finely divided cement material was carried by the draft completely out of the kiln, and that it had to be intercepted at the exit end and returned to the feeding hopper. The use of producer-gas, without a regenerator (an apparatus for preheating the air to be mixed with the gas) failed to yield the requisite, steady temperature for the process of calcination, and when a regenerator using the waste gases was added, it speedily became clogged with the cement powder carried into it by the draft. Later inventors have overcome the greater portion of the difficulties and the mechanical defects of Ransome's apparatus have been removed by modifications and improvements, but the consumption of producer-gas does not seem as yet to have been brought to such a state of perfection that it competes with coal as a fuel for firing cement kilns. Both oil and natural gas have been and are still used as fuels.

The chief combustible for firing cement kilns is powdered coal, although ordinary gas coke has been used to a considerable extent. The class of coal to be employed is of special importance. Bituminous coal has been found to be most suitable. It must contain the proper quantity of volatile combustible matter to render it easy of ignition at the proper height in the cylinder in order to produce the maximum temperature at the right point. Anthracite and coke are more difficult to ignite, and therefore this maximum, when the latter are employed, occurs higher in the cylinder; the result is increased difficulty in watching the vitrification of the clinker and a less even distribution of the heat throughout the length of the cylinder.

The coal must be thoroughly dried, usually by rotary driers heated by hot air from the clinker coolers, before it can be ground to a sufficient degree of fineness. Care must be exercised in this operation that the temperature does not rise sufficiently to expel volatile combustible constituents of the coal.

The estimated coal consumption, based on the barrel as a unit, varies as much as from 30 to 100 kilograms because so many factors enter into the calculator. Theoretically, the amount of fuel needed in the kiln must be sufficient to expel any moisture, to drive off the carbon dioxide from the calcium carbonate and to produce the chemical combination of the silica and lime, and the silica and alumina; practically the amount is much larger than that required by theory because the ordinary rotary kiln has never been made to work economically. The calorific value of the coal, the burning temperature required, the heat lost by the radiation from the kiln walls, by the discharge of the hot clinker and the escaping gases, the completeness of combustion of the fuel, the excess of air supply, the moisture in the raw materials and the experience of the burner must all be considered. The consumption of fuel is much greater with slurry, which usually enters the kiln with 50 per cent of water, than with dry flour, while the output is less.

Richards [24] has worked out a balance sheet of the heat generated within and the distribution of the heat of a rotary cement burner, 60 feet long by 6 feet external diameter, fired by pulverized bituminous slack, at the plant of the Dexter Cement Company at Nazareth, Pennsylvania. The coal, which was from Fairmont, West Virginia, and which required 50 kilograms per barrel, gave the following analysis:

Constituent.	Per cent.
Moisture	0.60
Volatile combustible matter	38.10
Fixed carbon	53.24
Ash	8.06
Total	100
Calories (calculated)	7,900

The average results were 1,650 kilograms of clinker with 90 kilograms of flue dust per hour from 2,710 kilograms of mixture fed to the kiln. The temperature of the clinker falling out of the lower end of the kiln was 1,200° and the temperature of waste gases in the chimney about 1 meter from the upper end of the kiln was 820°. The following table gives a summary of the results obtained by Richardson.

TABLE XII.

The ground cement mixture from which the carbon dioxide and water had to be expelled.		The burnt cement clinker (per cent).	The waste gases.	
Constituent.	Per cent.		Constituent.	Per cent.
Silica	13.38	21.27	Carbon dioxide	10.2
Aluminium oxide	6.04	6.42	Oxygen	11.8
Ferric oxide		3.18	Carbon monoxide	0.2
Calcium oxide	41.96	66.70	Sulphur dioxide	([a])
Magnesium oxide	1.53	2.43	Water	([a])
			Nitrogen	([a])
Carbon dioxide	34.65			
Water	0.43			

[a] Undetermined.

The items and results of the investigation are shown by the following table, based on the consumption of 100 kilograms of coal, or the production of 2 barrels of cement.

Heat generated.

	Calories.
(1) Theoretical heating power of the fuel	790,000
(2) Heat of combination of the ingredients forming clinker	142,819
Total	932,819

[24] Richards, J. W.: *Journ. Am. Chem. Soc.* (1904), **26**, 80.

Heat distributed.

	Calories.	Percentage of the whole.
(1) Heat in the clinker	100,050	10.7
(2) Heat in the chimney gases:		
(*a*) In the excess air admitted	336,000	36.0
(*b*) In the necessary products	340,000	36.5
(3) Heat in flue dust	2,112	0.2
(4) Lost by imperfect combustion	12,248	1.3
(5) Evaporation of water of charge	1,446	0.2
(6) Expulsion of carbon dioxide from carbonates	21,628	2.3
(7) Loss by radiation and conduction	119,335	12.8
Total	932,819	100.0

Richards calls attention to the fact that the maximum temperature to which the 790,000 calories (the available heat of combustion) will heat the gases is 1,000°, while the clinker leaves the kiln at 1,200°. The difference is due to the heat of combustion of the mixture. In the zone of highest temperature the clinker is unquestionably heated much more than 200° above the estimated flame temperature, for the heat of reaction, which is equal to 15 per cent of all the heat developed, is generated in this region; furthermore Campbell [25] has shown that "the minimum temperature necessary to produce Portland cement which will give a perfect pat test from fresh clinker is about 1,450° C. This temperature is for a minimum amount of calcium oxide. It increases with increase of calcium oxide until in ordinary commercial cements it reaches 1,550°. It depends somewhat on the length of time required to pass through the rotary, slow driving tending to lower the temperature."

EXPERIMENTAL.

It is of especial importance that an examination of available Philippine coals from the point of view of their usefulness as a fuel for cement burning be undertaken. A few results are given in Table XIII.

[25] Campbell, E. D.: *Journ. Am. Chem. Soc.* (1902), 24, 991.

TABLE XIII.—*Analyses of some available Philippine coals and of some foreign coals.*

		Philippine coals.					Foreign coals.	
		Camansi (vein No. 2) near Danao, Cebu.	Camansi (general picked sample).	Military Reservation, Batan Island.	Betts', Batan Island.	Polillo.	Australia.[a]	Fairmont, West Virginia, gas coal.[b]
Moisture		11.28	11.02	5.87	18.61	5.89	2.80	1.34
Volatile combustible matter		38.20	38.24	38.99	36.50	39.29	34.23	35.88
Fixed carbon		46.76	48.05	50.30	34.86	48.82	50.94	54.03
Ash[c]	Silica (SiO_2)	1.03	0.67	1.40	4.70	3.00	6.81	3.59
	Alumina[d] (Al_2O_3)	1.36	0.85	1.28	0.78	1.08	3.64	3.58 (alumina and iron oxide)
	Iron oxide (Fe_2O_3)	0.71	0.60	1.05	1.31	0.58	0.92	
	Lime (CaO)	0.47	0.40	0.42	1.06	0.82	0.32	0.75
	Magnesia (MgO)	0.13	0.08	0.54	0.49	0.22	0.14	0.03
	Soda (Na_2O)	0.04	0.03	0.05	0.12	0.04	0.11	0.10
	Potash (K_2O)	0.01	0.01	0.02	0.04	0.03	0.09	0.16
	Sulphuric anhydride (SO_3)	0.01	0.05	0.08	1.53	0.23	0.00	0.54
		3.76	2.69	4.84	10.03	6.00	12.03	8.75
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur (separately determined)		0.38		0.09	1.21		0.09	1.77
Calorific value (calories)		6,230	6,264	6,359	4,560	6,285	6,614	

[a] This coal was purchased by the Insular Government at ₱10.75 per ton of 2,240 pounds, piled in its sheds and yards. Coal of this class is available on the Manila market.

[b] *The Chem. Eng.* (1905), **2**, 223.

[c] Manganese and phosphoric anhydride were present in traces or not at all.

[d] Includes titanic oxide (TiO_2).

I am indebted to Mr. L. A. Salinger of this laboratory for his assistance in making these analyses.

DISCUSSION.

Meade[26] has shown by three experiments that the changes between the clinker as analyzed, when calculated without its water and carbon dioxide, and the raw material calculated to a clinker are as follows:

TABLE XIV.—*Loss or gain.*

[The numbers give percentages.]

Constituent.	1.	2.	3.	Average.
SiO_2	+0.46	+0.72	+0.67	+0.62
TiO_2	0.02	−0.03	−0.03	−0.03
Al_2O_3	+0.41	+0.32	+0.39	+0.37
Fe_2O_3	+0.26	+0.30	+0.32	+0.29
FeO	−All.	−All.	−All.	------
MnO	0.01	------	0.00	0.00
CaO	−0.20	+0.09	+0.08	0.00
MgO	+0.05	−0.08	+0.03	0.00
Na_2O	−0.06	−0.12	−0.09	−0.09
K_2O	−0.44	−0.51	−0.51	−0.49
P_2O_5	−0.02	+0.01	−0.00	0.00
SO_3	−0.43	−0.72	−0.87	−0.67

The results show that there is almost complete oxidation of the iron present in the raw state, that over one-half of the alkalies are expelled in the kiln, and especially that there is a large loss of sulphur and almost complete oxidation of the remainder. The greater part of the sulphur is present as iron sulphide in the coal and the original rock which, when heated to the temperature of the kiln, burns to sulphur dioxide and ferric oxide. It is quite probable that in the coal ash as obtained in the laboratory all of the sulphur is fixed by being roasted to sulphates which do not give off sulphuric anhydride at a gentle heat. At kiln temperatures sulphuric anhydride would be partially expelled from these and for this reason we would expect a loss of sulphur. As regards sulphur, then, even the Philippine coals containing the highest percentage that I have found would be available for burning cement.

Meade shows that the silica, ferric oxide and alumina of the clinker have been increased by approximately one-half of the coal ash. On the other hand, he finds a marked loss of material in the dust, which the analyses indicates to be a mixture of coal ash, partially burned raw material and the volatile constituents of the latter. The figures show that theoretically 254 kilos of rock should make a barrel of cement (172 kilos), but that few manufacturers use less than 276 kilos, showing a loss of 12 kilos as dust, etc., per barrel of cement produced. Mr. Meade further says:

"Undoubtedly in the rotary kiln much of the ash is carried out with the gases by the strong draft of the kiln. This we would expect to be the case when we

[26] *Chem. Eng.* (1905), 2, 222–223.

consider that the particles of ash are of the same volume as the particles of coal, and yet only one-tenth their weight, for when the coal burns it leaves its ash in the form of a skeleton. These particles of ash are already in motion and are in the full draft. The gases have a velocity of at least 600 meters per minute, which is quite sufficient to carry the particles up the chimney. It seems probable in view of these facts that what ash does contaminate the clinker comes from the impinging of the flame upon the material in the kiln."

The sulphur content in nearly all of the Philippine coals which have been analyzed by the Bureau of Science would not be injurious were it accepted as a fact that all of it is absorbed by the cement clinker. The other constituents of the ash may be incorporated into the cement clinker by proper fluxing. When one-half of these are lost to the stack, the additional amount of raw material which must be added is small. It is probable that if the coal is ground to a sufficient degree of fineness the ash particles will be almost entirely swept out of the kiln by the draft and the factor of the ash will become very small.

There remains the question of the heating value of the coal. The average of 51 samples of Fairmont coal[27] which has been considered above as a fuel for burning cement, shows the following analysis and calorific value:

Water	1.43
Volatile combustible matter	37.47
Fixed carbon	53.83
Ash	7.27
Sulphur	2.59
Calories	7,785

This analysis, which represents a vast territory and perhaps the best American fuel for cement kilns, when calculated to the dry coal would have a calorific value of about 7,900 calories. Other coals of less calorific value have been satisfactorily used as a fuel for burning cement. The Philippine coals, the analyses of which are given in the table on page 227 when calculated to the dry coal would have a calorific value of about 7,090, 7,110, 6,800, 5,715 and 6,715, respectively, while that of the Australian coal would be 6,775 calories. While the fuel value of the Philippine coals is not as great as the well-known gas coal of Fairmont, West Virginia, our coals appear to be as good under these conditions as any at present available in the Philippines and neighboring countries and I am of the opinion that they will be very useful as a fuel for burning cement.

[27] *Report of the Geol. Sur. W. Va.* (1903), **2**, 231.

EDITORIAL.

PHILIPPINE TURPENTINE.

Considerable local interest has been aroused recently in the industrial possibilities of turpentine products from the pine forests of Benguet Province, Luzon.

The Benguet pine, "Saleng," *Pinus insularis* Endl., is found distributed from Zambales Province to the extreme north end of Luzon. The Bureau of Science herbarium shows collections of this species from the Provinces of Zambales, Benguet, Ilocos Sur, Abra, Lepanto, and Bontoc.

The tree, in its leaf, fruit, and wood characters, shows a close resemblance to the western yellow pine, *Pinus ponderosa* Dougl., of the United States and to the Khasya pine, *Pinus khasya* Royle, of British India. Neither of the above-mentioned species to my knowledge are tapped for the commercial production of turpentine at the present time, although the latter is reported to produce a good grade of resin.

Some Benguet pine trees were boxed and the turpentine collected by Mr. B. T. Brooks of the chemical staff of the Bureau of Science, who reported in substance as follows:

"On March 13, fourteen trees situated in the forest adjoining the claim of the Headwaters Mining Company were boxed. The trees were selected at random and included several trees of the variety known to lumbermen and turpentine collectors as 'scrub pine.' Six hours later thirteen of the trees showed an abundant flow of resin, while one was hard and did not flow. The collected resin weighed 1,761.5 grams.

"On March 14, thirty trees were boxed in another locality about 2 miles distant from Baguio. They were selected with the idea of including both healthy and unhealthy looking trees and some which had been damaged by ground fires. On the following day these trees were again visited and all but three, which were hard and did not flow, were still running slowly. The collected resin weighed 4,400 grams.

"*Method of boxing.*—The boxes were cut about 30 to 40 centimeters wide, 12 to 18 centimeters deep, and 6 to 8 centimeters from front to back, varying with the size of the trees. They were made by inexperienced laborers and were so badly split and bruised that much of the fresh resin was lost, hence the yields obtained do not accurately represent the total flow of resin.

"One of the best flowing trees had a diameter of about 85 centimeters and produced 857 grams of resin in thirty-two hours, although a portion was lost by overflowing the box.

"These samples being taken during the dry season probably represent a smaller yield than would be obtained during the rainy season when the trees have more life and the loss by evaporation is less.

"The cup and gutter system of collection would also give large yields by minimizing the loss."

A sample of the crude turpentine collected under the above conditions was submitted for an examination and for an opinion as to its commercial value. It had much the appearance and consistency of crystallized honey and possessed a mild, pleasant odor. 1,961.5 grams were subjected to steam distillation as received without any previous filtering for the removal of an appreciable quantity of foreign matter in the form of chips, bark, etc. Exhaustive distillation gave 412.2 grams (23.4 per cent) of oil of turpentine which was water-white in color and after drying over calcium chloride it possessed the following constants: Specific gravity, $\frac{30°}{30°}=0.8593$; $N\frac{30°}{D}=1.4656$; $A\frac{30°}{D}=+26.5$. Ninety-six per cent distilled between 154° and 165°.5 C.

The residue from the steam distillation, amounting to 76.6 per cent of the original resin by difference, was freed from approximately 15 grams of foreign material by hot filtration. It consisted of prime colophony of a clear, pale amber color.

GEORGE F. RICHMOND.

INDUSTRIAL ALCOHOL AND ITS POSSIBILITY AS A SOURCE OF POWER IN THE PHILIPPINES.

Alcohol can be used as a motor fuel for all purposes for which gasoline is at present employed. Exhaustive tests made by the United States Government[1] have demonstrated that any gasoline or kerosene engine of ordinary type can with proper manipulation operate with alcohol without material change in its construction. The engine will give slightly more power (about 10 per cent) when alcohol is used but this increase is at the expense of greater consumption of fuel. Experiments of the United States Geological Survey[2] have shown that when denatured alcohol is employed the lowest fuel consumption is obtained with the highest practical degree of compression (11.6 to 13.7 kilograms per square centimeter), but since the vaporization temperature of alcohol is higher than that of gasoline a modified combustion chamber and carburetor is to be preferred. Some gasoline engines are not sufficiently heavy to stand the desired high explosion pressure when alcohol is used and therefore a machine especially designed for alcohol is preferable to one planned to operate with gasoline or kerosene.

The United States Geological Survey made a series of over 2,000 individual tests, comparing gasoline of about 0.699 specific gravity (73° Baumé) and commercial fully denatured alcohol.[3] Tests which corre-

[1] Lucke, C. E. and Woodward, S. M.: *Farm. Bull. U. S. Dept. Agr.* (1907), **277**; Holmes, J. A.: *Eng. News* (1908), **59**, 424.

[2] Holmes, J. A.: *Ibid;* C. A. (1908), **2**, 2147.

[3] Holmes, J. A.: *Ibid.*

sponded in the method of manipulation showed that alcohol was more efficient than gasoline and they also proved that equal volumes of gasoline and alcohol produced about the same power. This result is not usually achieved in practice. Ordinary commercial gasoline engines of stationary or marine type will consume from 1.5 to 2 times as much alcohol as gasoline when operated under the same conditions.

Alcohol is especially suited to air-cooled automobile engines, as the exhaust is not so hot as when gasoline or kerosene is used, while on the other hand the temperature of the cylinder may be hotter without danger of backfiring. The storage and use of alcohol in engines is much less dangerous than that of gasoline or petrol and the engines operating on the former run more quietly and produce a less offensive odor. No more skill is required to operate an alcohol engine than one arranged for gasoline or kerosene.

The relative heat values of gasoline, alcohol and coal are shown by the following approximate numbers:

	Calories.
Gasoline	11,100
Alcohol (100 per cent)	7,183
Pennsylvania anthracite	7,500

The calorific value of alcohol is of course lower by impurities, so that commercial (90 per cent) alcohol has a calorific value of about 60 per cent of that of gasoline, or a comparative heat value of over 70 per cent by volume. Alcohol of 85 per cent is the common grade of industrial alcohol used in Europe. The United States Geological Survey found difficulties in starting and regulating when the experimenters employed 80 per cent alcohol and the fuel consumption increased more rapidly than the percentage of alcohol decreased.

The effect upon motors, lamps, etc., of using denatured alcohol has been discussed and deterioration has usually been attributed to the denaturant.[4] It may be possible that all of the evils coming from the latter may be remedied in the future. Lucke and Woodward found that the interior of an alcohol engine had no tendency to become sooty, as is the case with gasoline and kerosene and there was no undue corrosion of the interior due to the use of alcohol.

The raw materials from which industrial alcohol comes consist of those substances which contain starch, sugar and other fermentable bodies, named in the order of their importance, capable of easily being converted into a fermentable sugar. The cereals, rice, wheat, oats, rye, maize and barley, the potato, cassava or manioc and some other roots contain large percentages of starch. From all of these as well as from sugar cane and sugar-cane molasses, sorghum and fruit juices which contain large percentages of sugars, alcohol is made. The artichoke

[4] Suchemin, R.: *Rev. gén. chim.* (1906), 9, 437 to 443; Lucke, C. E. and Woodward, S. M.: *loc. cit.*

which contains neither starch nor sugar but a number of other fermentable carbohydrates of which inulin and levulin are the principal constituents has been highly recommended and rather extensively used in Germany for the manufacture of alcohol.[5] At the present time alcohol is made on a large commercial scale from corn, rye, potatoes, sugar beets, sugar cane, and sugar-cane molasses. Rice has the largest percentage of starch among the cereals, but it is not the cheapest source of alcohol. Indian corn, which hitherto has formed the chief raw material for fermentation and distillation, contains approximately 70 per cent of fermentable bodies and under the best conditions a kilo of corn will usually yield about 340 grams of alcohol (420 cubic centimeters of 95 per cent alcohol by volume at 15° C.). If the average price of corn be placed at 3 centavos per kilo and the cost of manufacture, storage, profit, etc., be taken as an equal amount, industrial alcohol (95 per cent) from this source, untaxed, would sell wholesale for about 14 centavos a liter.[6]

	Retail price per liter, in centavos.	Annual consumption (million liters).
Germany	16	140
Cuba	21	....
France	23	40
England	....	15
United States	32	13

Besides rice, Indian corn, and sugar cane, the available sources from which alcohol can be manufactured in this Archipelago are the sap of many palms and the cassava. At present nearly all of the alcohol produced comes from the bled sap of the nipa and other palms.[7] Alcohol from the nipa has a disagreeable odor which is somewhat difficult to remove, but for industrial purposes this would be of no consequence. A description of this palm (*Nipa fruticans* Wurmb.) may be found in many places.[8] It is a species widely distributed all the way from India to Malaya, in northern Australia and Polynesia. A very detailed study of the culture and bleeding of this palm has been published by Ayala & Co.[9]

The nipa grows in low, salt-water tidal swamps and the plant is completely developed in about four years after planting the seed. The palms, fruit about every two years, at no particular season. When the tree is ready to bleed, the

[5] Wiley, H. W.: *Farm. Bull. U. S. Dept. Agr.* (1906), **268**, 14.

[6] The following retail prices and annual consumption of denatured alcohol (approximately 95 per cent) are calculated from data given by R. F. Herrick (*Technol. Quart.* (1908), **21**, 7 to 9):

[7] During the fiscal year 1907–8, the figures of the Bureau of Internal Revenue show that the production from all sources was equivalent to about 4½ million liters of 95 per cent alcohol. There were practically no exports.

[8] Hooker, *Fl. Brit. Ind.* (1892), **6**, 424; Blanco, *Fl. Filip.* (1837), 662; Ed. 2 (1845), 461.

[9] Conrado, A., and Zobel, E., Estudio de la Planta Nipa, Manila (1906).

fruiting stem is cut as close to the young fruit as possible and the emerging liquid (*tuba*) caught in a joint of bamboo. Every day a very thin slice is cut from the stem to prevent the pores from becoming clogged. The removal of thick slices will destroy the stem before all the tuba can be drawn.

The production of tuba from a mature tree usually increases during the first fifty to sixty days after tapping and decreases during twenty-five to thirty days more. If tuba is drawn for a longer period the tree will die. The tuba from mature stems is white, has an aromatic odor and is sweet. That from palms having less mature fruit is bluish and less sweet and, therefore, has less fermentative value. The average yield per tree fluctuates from one-half to 3 liters per day, with a total of from 30 to 40 liters (sp. gr. 1.07 to 1.08 at 15°. The juice contains approximately 12 per cent of fermentable material which is largely saccharose. Thirty-two to 34 liters of tuba will usually produce one liter of pure alcohol. In the Provinces of Bulacan and Pampanga, where the price of the molasses residues from sugar cane is low, the latter is mixed with the tuba before fermentation and is said to give a larger yield of alcohol than would the two if fermented separately.

Alcohol is removed from the fermented tuba by distillation. The method used in the provinces produces a distillate containing about 50 per cent of alcohol. By redistilling a sufficient number of times a 95 per cent alcohol might be produced, but the process would be very expensive; therefore, the crude alcohol is shipped to the large distilleries in Manila, where it can be refined more economically. In the latter, the process is continuous; the vapors pass through several stills and are cooled just sufficiently to condense them in each one until the proper purity is reached. It will, therefore, be seen that after an alcohol once passes the crude 50 per cent stage a purity of 95 per cent can be produced with very little more expense per proof liter than one of lower grade. The economy of the purer form is obvious.

The manufacture of alcohol from tuba is rather expensive and it is doubtful if the process could be greatly cheapened. Denatured alcohol (95 per cent) from this source is sold wholesale at 2.40 pesos, Philippine currency (1.20 dollars, United States currency) per 15 liters, while the above estimated price for the product from corn would be 2.30 pesos per 15 liters. If a market for alcohol as a fuel were opened it could undoubtedly be produced from tuba for 2 pesos per 15 liters, but with the present spasmodic usage it can not be sold at that figure.

Cassava is grown in the United States over a large area of the South Atlantic and Gulf States and numerous analyses made by the Division of Chemistry, United States Department of Agriculture [10] have shown that the roots contain about 30 per cent of starch. With the exception of cereals it contains the largest amount of fermentable matter.

"An average crop of cassava in the United States may be placed at 5 tons of roots per acre on the ordinary lands of Florida, with proper preparation and

[10] *Farm. Bull. U. S. Dept. Agr.* (1903), **167**, 23; **268**, 17; *Bull. U. S. Dept. Agr. Div. of Chem.* (1900), **58**, 36.

cultivation and appropriate fertilization, a yield of from 4 to 7 or perhaps 8 tons per acre may be reasonably expected."[11] At present there are no reliable figures on the amount that can be produced on a given area of land in the Philippines. R. F. Bacon,[12] thinks that it is perfectly safe to figure on a production of 22½ metric tons per hectare (10 tons per acre). "With this yield," he says, "there is only one other substance which seems able to compete with it as a source of alcohol, namely, the molasses residue from the crystallization of cane sugar." E. B. Copeland,[13] estimates that when starch made from cassava sells at its present local price (15 centavos per kilo), alcohol from the same source would be worth about 17½ centavos per liter or 2.60 pesos per 15 liters.

At present prices, it would be more profitable to produce starch than alcohol at a price below the latter figure. If at any time the production of cassava becomes more abundant and the utilization for other purposes less remunerative, alcohol from this source may be placed on the market very cheaply.

Some experiments with alcohol were carried out in Manila a few months ago with the 25-horsepower motor road roller purchased by the city of Manila. In all cases the machine was operated on a level road and at a standard speed. A crude alcohol such as is shipped to Manila by provincial distillers was used. The motor was first heated to a slight extent by being run for about ten minutes with gasoline; it ran for twelve minutes on the alcohol and then stopped. An examination showed that the explosions of the alcohol did not furnish enough heat to evaporate all of the water present and that a quantity had collected in the combustion chamber. When 90 and 94.5 per cent alcohol were employed the motor ran smoothly, with a consumption of 1.8 and 1.6 times, respectively, the quantity of gasoline used for the same time. Lucke and Woodward[14] say that a small engine required 1.8 times as much alcohol (probably 85 per cent) as gasoline per horsepower hour.

The utilization of alcohol as a fuel is an established fact. The economy is the only open question. Gasoline (73°) is now sold in Manila at 2.38 pesos per 15 liters (about 16 centavos per liter). On the basis of an engine consuming 1.5 times as much 95 per cent alcohol as gasoline the former would need to be sold at 1.60 pesos per 15 liters in order to compete with the latter. In localities where alcohol can be produced cheaply and which are remote from gasoline supply, alcohol may immediately compete with gasoline as a power fuel, otherwise it is not probable that it will be as economical a fuel as gasoline in these Islands for some time to come and I do not anticipate an immediate change in our motor fuel.

ALVIN J. COX.

[11] *Bull. U. S. Dept. Agr. Div. Chem.* (1900), **58**, 36, 42.
[12] This *Journ. Sec. A.* (1907), **2**, 93.
[13] *Phil. Agr. Rev.* (1908), **1**, 145.
[14] *Loc. cit.*, 39.

PREVIOUS PUBLICATIONS—Continued.

Bureau of Science—Annual Reports.

ORDER No.

201. Fifth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1906.
202. Sixth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1907.
203. Seventh Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1908.

Philippine Museum.

(Now Section of Ornithology.)

* *No. 1, 1903.*—On Birds from Luzon, Mindoro, Masbate, Ticao, Cuyo, Culion, Cagayan Sulu and Palawan. By Richard C. McGregor.
* *No. 2, 1903.*—List of Bird Skins Offered in Exchange.
43. *No. 3, 1904.*—Birds from Benguet Province, Luzon, and from the Islands of Lubang, Mindoro, Cuyo, and Cagayancillo. By Richard C. McGregor.
* *No. 4, 1904.*—The Birds of Calayan and Fuga, Babuyan Group. By Richard C. McGregor.

Mining Bureau.

(Now Division of Mines.)

45. *1890.*—Descripción física, geológica y minera en bosquejo de la Isla de Panay por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
* *1890.*—Memoria descriptiva de los manantiales minero-medicinales de la Isla de Luzón, estudiados por la comisión compuesta de los Señores D. José Centeno, Ingeniero de Minas y Vocal Presidente, D. Anacleto del Rosario y Sales, Vocal Farmacéutico, y D. José de Vera y Gómez, Vocal Médico.
47. *1893.*—Estudio descriptivo de algunos manantiales minerales de Filipinas ejecutado por la comisión formada por D. Enrique Abella y Casariego, Inspector General de Minas, D. José de Vera y Gómez, Médico, y D. Anacleto del Rosario y Sales, Farmacéutico; precedido de un prólogo escrito por el Excmo. Sr. D. Angel de Avilés, Director General de Administración Civil.
48. *1893.*—Terremotos experimentados en la Isla de Luzón durante los meses de Marzo y Abril de 1892, especialmente desastrosos en Pangasinán, Unión y Benguet. Estudio ejecutado por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
49. *1901.*—The Coal Measures of the Philippines. Charles H. Burritt.
50. *1902.*—Abstract of the Mining Laws (in force in the Philippines, 1902). Charles H. Burritt.
51. *1902., Bulletin No. 1.*—Platinum and Associated Rare Metals in Placer Formations, H. D. McCaskey, B. S.
52. *1903.*—Report of the Chief of the Mining Bureau of the Philippine Islands. Charles H. Burritt.
53. *1903, Bulletin No. 2.*—Complete List of Spanish Mining Claims Recorded in the Mining Bureau. Charles H. Burritt.
54. *1903, Bulletin No. 3.*—Report on a Geological Reconnoissance of the Iron Region of Angat, Bulacan. H. D. McCaskey, B. S.
55. *1904.*—Fifth Annual Report of the Mining Bureau. H. D. McCaskey.
56. *1905.*—Sixth Annual Report of the Chief of the Mining Bureau. H. D. McCaskey.
57. *1905, Bulletin No. 4.*—A Preliminary Reconnoissance of the Mancayan-Suyoc Mineral Region, Lepanto, P. I. A. J. Eveland, Geologist.
58. *1905, Bulletin No. 5.*—The Coal Deposits of Batan Island. Warren D. Smith, B. S., M. A., Geologist.

Division of Mines.

301. *1908.*—The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products during the year 1907, issued by Warren D. Smith, Chief of the Division of Mines.

Ethnological Survey.

(Now Division of Ethnology.)

401. *Vol. I, 1905.*—The Bontoc Igorot, by Albert Ernest Jenks. Paper, ₱2; half morocco, ₱3.
402. *Vol. II, Part 1, 1904.*—Negritos of Zambales, by William Allen Reed. Paper, ₱0.50; half morocco, ₱1.50.
403. *Vol. II, Part 2 and Part 3, 1905.*—The Nabaloi Dialect, by Otto Scheerer. The Bataks of Palawan, by Edward Y. Miller. (Bound also in one volume with Part 1, Negritos of Zambales.) Paper, ₱0.50; half morocco, ₱1.50. Combined, half morocco, ₱3.
404. *Vol. III, 1904.*—Relaciones Agustinianas de las razas del Norte de Luzon, by Perez. Paper, ₱0.75; half morocco, ₱2.
405. *Vol. IV, Part 1, 1905.*—Studies in Moro History, Law, and Religion, by Najeeb M. Saleeby. Paper, ₱0.50; half morocco, ₱1.50.

Division of Ethnology.

406. *Vol. IV, Part 2, 1908.*—History of Sulu, by Najeeb M. Saleeby. Paper, ₱1.50.
407. *Vol. V, Part 1 and Part 2, 1908.*—The Batán Dialect as a Member of the Philippine Group of Languages, by Otto Scheerer. "F" and "V" in Philippine Languages, by C. E. Conant. Paper, ₱1.60.
408. *Vol. V, Part 3.*—A Vocabulary of the Igorot Language as spoken by the Bontok Igorots, by the Rev. Walter Clayton Clapp. Igorot-English, English-Igorot. Paper, ₱1.50.
409. Directions for Ethnographic Observations and Collections, 1908. *For free distribution.*

NOTE.

Those of the above-listed publications which are for sale may be obtained from the Director of Printing, Manila, P. I. Publications for free distribution, listed above, may be had by writing to the Business Manager, Philippine Journal of Science, Manila, P. I. Please give order number.

---

* Out of print.

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.
Authors receive 100 copies of their papers free.
The numbers of each section will appear as rapidly as material is available. Each section will be separately paged and indexed.
Subscriptions may be sent to the DIRECTOR OF PRINTING, Manila, P. I. Correspondence should be addressed to the Business Manager, Philippine Journal of Science, Manila, P. I.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
Messrs. WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
Messrs. MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
Messrs. KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
Messrs. A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

A limited number of unbound copies of previous volumes are available which may be secured from the Director of Printing at the following rates: Volume I, 1906 (not divided into sections), $5, United States currency; Supplement to Volume I, $2.50, United States currency; Volume I (without supplement), $3, United States currency; all later volumes at current subscription prices.

VOL. IV JULY, 1909 No. 4

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., PH. D.

CO-EDITOR,

RICHARD P. STRONG, PH. B., M. D.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. GENERAL SCIENCE

MANILA
BUREAU OF PRINTING
1909

PREVIOUS PUBLICATIONS.

ORDER No.

Bureau of Government Laboratories.

** No. 1, 1902, to No. 14, 1904.*

15. *No. 15, 1904, Biological and Serum Laboratories.*—Report on Bacillus Violacevus Manilæ: A Pathogenic Micro-Organism. By Paul G. Woolley, M. D.

* *No. 16, 1904, Biological Laboratory.*—Protective Inoculation against Asiatic Cholera: An Experimental Study. By Richard P. Strong, M. D.

17. *No. 17, 1904.*—New or Noteworthy Philippine Plants, II. By Elmer D. Merrill, Botanist.

* *No. 18, 1904, Biological Laboratory.*—I. Amebas: Their Cultivation and Etiologic Significance. By W. E. Musgrave, M. D., and Moses T. Clegg. II. The Treatment of Intestinal Amœbiasis (Amœbic Dysentery) in the Tropics. By W. E. Musgrave, M. D.

19. *No. 19, 1904, Biological Laboratory.*—Some Observations on the Biology of the Cholera Spirillum. By W. B. Wherry, M. D.

20. *No. 20, 1904.*—*Biological Laboratory:* I. Does Latent or Dormant Plague Exist Where the Disease is Endemic? By Maximilian Herzog, M. D., and Charles B. Hare. *Serum Laboratory:* II. Broncho-Pneumonia of Cattle: Its Association with B. Bovisepticus. By Paul G. Woolley, M. D., and Walter Sorrell, D. V. S. III. Pinto (Paño Blanco). By Paul G. Woolley, M. D. *Chemical Laboratory:* IV. Notes on Analysis of the Water from the Manila Water Supply. By Charles L. Bliss, M. S. *Serum Laboratory:* V. Frambœsia: Its Occurrence in Natives in the Philippine Islands. By Paul G. Woolley, M. D.

21. *No. 21, 1904, Biological Laboratory.*—Some Questions Relating to the Virulence of Micro-Organisms with Particular Reference to Their Immunizing Powers. By Richard P. Strong, M. D.

22. *No. 22, 1904, Bureau of Government Laboratories.*—I. A Description of the New Buildings of the Bureau of Government Laboratories. By Paul C. Freer, M. D., Ph. D. II. A Catalogue of the Library of the Bureau of Government Laboratories. By Mary Polk, Librarian.

* *No. 23, 1904, Biological Laboratory.*—Plague: Bacteriology, Morbid Anatomy, and Histopathology (Including a Consideration of Insects as Plague Carriers). By Maximilian Herzog, M. D.

24. *No. 24, 1904, Biological Laboratory.*—Glanders: Its Diagnosis and Prevention (Together with a Report on Two Cases of Human Glanders Occurring in Manila and Some Notes on the Bacteriology and Polymorphism of Bacterium Mallei). By William B. Wherry, M. D.

25. *No. 25, 1904.*—Birds from the Islands of Romblon, Sibuyan, and Cresta de Gallo. By Richard C. McGregor. (*For first four bulletins of the ornithological series, see Philippine Museum below.*)

26. *No. 26, 1904, Biological Laboratory.*—The Clinical and Pathological Significance of Balantidium Coli. By Richard P. Strong, M. D.

27. *No. 27, 1904.*—A Review of the Identification of the Species Described in Blanco's Flora de Filipinas. By Elmer D. Merrill, Botanist.

28. *No. 28, 1904.*—I. The Polypodiaceæ of the Philippine Islands. II. Edible Philippine Fungi. By Edwin B. Copeland, Ph. D.

29. *No. 29, 1904.*—I. New or Noteworthy Philippine Plants, III. II. The Source of Manila Elemi. By Elmer D. Merrill, Botanist.

30. *No. 30, 1905, Chemical Laboratory.*—I. Autocatalytic Decomposition of Silver Oxide. II. Hydration in Solution. By Gilbert N. Lewis, Ph. D.

31. *No. 31, 1905, Biological Laboratory.*—I. Notes on a Case of Hæmatochyluria (Together with Some Observations on the Morphology of the Embryo Nematode, Filaria Nocturna). By William B. Wherry, M. D., and John R. McDill, M. D., Manila, P. I. II. A Search into the Nitrate and Nitrite Content of Witte's "Peptone," with Special Reference to Its Influence on the Demonstration of the Indol and Cholera-Red Reactions. By William B. Wherry M. D.

32. *No. 32, 1905.*—*Biological Laboratory:* I. Intestinal Hæmorrhage as a Fatal Complication in Amœbic Dysentery and Its Association with Liver Abscess. By Richard P. Strong, M. D. II. The Action of Various Chemical Substances upon Cultures of Amœbæ. By J. B. Thomas, M. D., Baguio, Benguet. *Biological and Serum Laboratories:* III. The Pathology of Intestinal Amœbiasis. By Paul G. Woolley, M. D., and W. E. Musgrave, M. D.

33. *No. 33, 1905, Biological Laboratory.*—Further Observations on Fibrin Thrombosis in the Glomerular and in Other Renal Vessels in Bubonic Plague. By Maximilian Herzog, M. D.

* *No. 34, 1905.*—I. Birds from Mindoro and Small Adjacent Islands. II. Notes on Three Rare Luzon Birds. By Richard C. McGregor.

35. *No. 35, 1905.*—I. New or Noteworthy Philippine Plants, IV. II. Notes on Cuming's Philippine Plants in the Herbarium of the Bureau of Government Laboratories. III. Hackel, "Notes on Philippine Grasses." IV. Ridley, "Scitamineæ Philippinenses. V. Clarke, "Philippine Acanthaceæ." By Elmer D. Merrill, Botanist.

36. *No. 36, 1905.*—A Hand-List of the Birds of the Philippine Islands. By Richard C. McGregor and Dean C. Worcester.

* Report of the Superintendent of Government Laboratories for the Year Ending August 31, 1902. (Appendix M of Third Annual Report of the Philippine Commission.)

* Report of the Superintendent of Government Laboratories in the Philippine Islands for the Year Ending September 1, 1903. (Appendix G of the Fourth Annual Report of the Philippine Commission.)

39. Third Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1904.

40. Fourth Annual Report of the Superintendent of the Bureau of Government Laboratories for the Year Ending August 31, 1905.

Bureau of Science—Publications.

101. Price and Exchange List of Philippine Bird Skins in the Collection of the Bureau of Science, Manila, P. I. (Effective January 1, 1908.)

102. *No. 1, 1909.*—A Check-List of Philippine Fishes. By David Starr Jordan and Robert Earl Richardson. *In press.*

103. *No. 2, 1909.*—A Manual of Philippine Birds. By Richard C. McGregor, Parts I and II. A systematic index to the orders, families, and genera. Paper, ₱8 for the two parts.

---

* Out of print.

(Concluded on third page of cover.)

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV | JULY, 1909 | NO. 4

THE IFUGAOS OF QUIANGAN AND VICINITY.

By FR. JUAN VILLAVERDE.

(Translated, Edited and Illustrated by Dean C. Worcester. With Notes and an Addendum by L. E. Case.)

The Spanish missionary priests who played such an important part in the civilizing of the wild tribes of the Philippines had a wonderfully favorable opportunity for ethnological work. It is greatly to be regretted that most of them did not deem their observations relative to the manner of life of these peoples to be of sufficient importance to be recorded and perpetuated, but, as a matter of fact, they did not.

However, every rule has its exceptions. Fr. Juan Villaverde was born in the Spanish Province of Navarra on June 23, 1841, was sent as a missionary among the Ifugaos on February 3, 1868, and remained in or near the Ifugao country until the early part of 1897, when he contracted the illness which resulted in his death on July 8 of the same year. He has written a very interesting and valuable account of the Ifugaos of which a translation follows.

In referring to these people, Fr. Villaverde almost invariably employs the word "Igorrotes." As this is the name applied generally to the hill people of northern Luzon by Spanish writers, I have invariably substituted for it the word "Ifugaos" now ordinarily employed to designate the "Igorrotes" of this particular region.

Fr. Villaverde's account of the Ifugaos forms a part of his *"Informe Sobre la Reducción de los Infieles de Luzón,"* written in response to a request for information as to practical means for subjecting the non-Christian tribes of northern Luzon and organizing them into Christian towns, sent out by the Superior Government of the Philippine Islands.

It is worthy of more than passing note that the suggestions made by Fr. Villaverde relative to the means which might be employed to civilize the Ifugaos were of a highly practical and most sensible nature, and that many of them were directly in line with the policy looking to this end which has since been so successfully carried out.

Captain L. E. Case, of the Philippines Constabulary, was stationed in the Ifugao country for a period of four years, having his headquarters at Banaue during the greater part of this period. I have submitted the translation of Fr. Villaverde's article to him for comment, and his observations thereon, as well as a few of my own, have been added in the form of footnotes.

Since the American occupation, work for the civilizing of the Ifugaos has progressed with a rapidity which is remarkable, considering the difficulties to be overcome. It is believed that there are fully 101,000 of these naturally wild and war-like people, and they occupy one of the most inaccessible and rugged mountain regions in the entire Philippine Archipelago. Captain Case was himself remarkably fortunate in winning their good-will and respect, and gave a very strong impulse to the work looking for their betterment. His successor, Lieutenant Jeff. D. Gallman, of the Philippines Constabulary, has been extraordinarily successful in forwarding the work thus auspiciously begun, and in recognition of his very valuable services has recently been appointed lieutenant-governor of the subprovince of Ifugao which has now been segregated from Nueva Vizcaya and added to the recently established Mountain Province.

Within the past few years an extensive system of trails has made the territory occupied by the Ifugaos comparatively accessible, and the friendliest relations have been established with them. At this time (May 14, 1909) there has not been a human head taken in the entire subprovince of Ifugao for a year and a half.

With two exceptions the photographs with which this article is illustrated were taken either by the Government photographer, Mr. Charles Martin, or by myself.

The translation of Fr. Juan Villaverde's article follows.

DEAN C. WORCESTER.

OCCUPATIONS OF THE IFUGAOS OF QUIANGAN AND THE NEIGHBORING REGIONS.

The Ifugaos live without forming any society which is worthy of the name, grouped in settlements for the most part subdued. In the less rugged mountains, where they cultivate rice, these settlements are frequently large; and according to the testimony of eyewitnesses there are numerous other settlements in the main part of the cordillera.

In Quiangan,[1] which is one of the large and less rugged valleys, some of the settlements have 90 to 100 houses, others 30 to 70, and others less. (Plate I, fig. 2.) The houses all have the same architectural plan, not beautiful to be sure, but with sufficient solidity to prevent the entrance of wind and rain. They are rectangular, of about three meters on a side. They are sustained by four posts, a meter high, or a little more, which, while hardly put into the earth, support the house firmly in spite of the strength of the winds. The greater part are of rough boards. Some of them are made of bamboo, but with the floor of boards. (Plate III, fig. 1.)

The Ifugaos of Quiangan and other neighboring regions prefer to cultivate rice where the ground permits, that is to say, wherever they can get spring water for it. As the land is never, or almost never, level, they build various terraces, more or less high, called *"pilapiles,"* in order to make small level surfaces where they can sow rice and keep the water standing, as the culture of this plant demands. They sow it in January or February, or when the rainy season is over. It is of a special quality, very good and with large grains, and it does not give a good crop if planted at the time the Christians of the valley plant their rice. The Ifugaos accordingly let the heavy rains pass, and take advantage of the water of high springs, brought to their fields with much work and no little skill. For this reason, they lose their harvest, or get very little, in the years of drought, without taking account of the plagues of rats which exist in the mountains, eating great quantities of the grain in spite of the beautiful precautions which they take to exterminate them.

Returning to the *pilapiles,* which are the only means of controlling the inclined slopes of the mountains, it is not easy to appreciate the work which they necessitate. On the gentler slopes of the mountains they are of earth, in the shape of sloping banks whose height varies from a meter to a meter and a half. (Plate VI, fig. 2.) When the land allows this class of *pilapiles,* which happens only rarely, it is considered excellent and easy to work. More usually there is need of *pilapiles* made of stone, after the fashion of dykes slightly inclined inward, these having to be higher and more numerous as the slope of the mountain becomes more steep. Sometimes they are more than 4 meters high, although in Quiangan I have not seen them so high as this. Often their height is greater than the breadth of the space which they inclose, and the Ifugaos do not hesitate at the tremendous work involved. (Plates IV and V, and Plate IX, fig. 2.) The trouble is that they do not even find *such* ground with water above it, except by buying it at fabulous prices, on account of its being all occupied and private property. Ownership in it is never lost, although the land remains uncultivated for many generations.

[1] Now usually spelled "Kiangan." (Dean C. Worcester.)

The Ifugaos never make use of the plow in cultivating the soil. They do all their work by hand with large wooden shovels. (Plate VI, figs. 1 and 2.) Their hard work begins in Quiangan about September and ends in January and February which is the time of sowing. This leaves out of account the fact that they have first to clear the ground of the strong underbrush which grows in the four months of rest, and which, after the sowing of the rice, must be continually removed down to the smallest shoots, which otherwise serve to cause the rats to dig holes. How dearly the small amount of rice that they eat costs them! Yet after spending the greater part of the year at this work, still they do not get enough to maintain them, having to supply this lack by borrowing at a horribly usurious rate.

The poorest settlements of other mountains which are very rugged maintain themselves on sweet potatoes, but on the other hand their labor is incomparably less, and the women ordinarily perform it. Sweet potatoes, which grow everywhere, even in mountains which are extremely rugged, are the reliance of the lazy. The latter are at the same time the ones who are accustomed to steal from the granaries of others rice, as well as the quadrupeds and domestic fowls which others raise with great care. They are the bad people of the country as the Ifugaos say. It surprises me that when they might maintain themselves so easily on sweet potatoes, gabi, or Indian corn, they should carry on such hard and difficult work for a little rice. In contrast with their more than barbarous and vicious customs stands out the habit of industry, it being a shameful matter among them not to eat rice, and he who has it considers that he has lowered himself if he plants sweet potatoes.

MANUFACTURES AND INDUSTRIAL RELATIONS AMONG THE IFUGAOS.

There are among them smiths (Plate VII, fig. 1), who know how to temper and work iron, making axes, very rude indeed, but which serve them at the same time for adzes and chisels; also *bolos* or *campilanes* which are very sharp but dull easily on account of not being made of steel. Finally they make lances (Plate VIII, fig. 2), as well as small knives to harvest rice. They use musical instruments called *gansas,* which are similar to timbrels, and are ordinarily made of iron. These gansas are much used, and they as well as the better lances are, I believe, made at a very large settlement in the valley of Japao (Sapao) to the north of Quiangan.[2] In addition to the *gansa* they are accustomed to use a sort of flute of bamboo which they play with the nose. From the cotton which they gather the women weave certain coarse and narrow

[2] Padre Juan was mistaken in believing that gansas are made at Sapao. So far as is known they are not made anywhere in the Philippines, all those that exist having been imported from China or the Straits Settlements. They are invariably made of brass or bronze. (Dean C. Worcester.)

pieces of cloth from which they make their skirts and a sort of jacket without sleeves which they wear in the cold season. (Plate IX, fig. 1.) The Ifugaos eat with the spoon in distinction from the natives of the plain who eat with their fingers. They carve the spoons sometimes with very objectionable figures in relief (Plate X); so also they carve roughly the images of their false divinities (Plate X).

For their work in the fields they are accustomed to gather in groups of six, ten, or even twenty individuals, all relatives or friends, who work one day for one and the next for another; the one for whom they work furnishing food for all. The most influential get laborers by paying them in hens, chickens and rice, the food being at the expense of the one who manages them. They exchange, also in the same way, in their small buyings, sellings and other operations indispensable for life. I must not omit to state that the Ifugaos of Quiangan even buy wood, because all the little neighboring forests are private property. On the occasion of marriages and deaths, and at various other times, they hold frequent reunions in which they eat the flesh of fowls, hogs and carabaos (the latter old and coming from the Christian towns) with the indispensable accompaniment of drunkenness caused by a drink made of water and rice boiled a little, and left to ferment; a very bad drink because it causes a rabid drunkenness, a source of very many misfortunes.[3]

NOBLES AND PLEBEIANS.

I have already said that the Ifugaos have no king, nor ruler. They pay tribute to no one. Each one is the absolute monarch of his house and person, and although this individual liberty is one of the principal causes of their miserable and almost anarchical state, it is certain that it is one of their most dominant passions. But although this is so, nevertheless there is among them a certain class of nobles who exercise in greater or less degree prestige and moral authority over those regarded as plebeians. This class is founded on the power of riches, receiving greater respect if the rich man has acquired a reputation for bravery by killing people and cutting off heads. It makes no difference if he has employed treachery to this end, for dishonesty and meanness,

[3] Curiously enough, Padre Juan has failed to make any mention of the dancing which is so important a part of all these celebrations. The music is supplied by *gansa* players, usually three in number who may stand close to the dancers but more frequently are half hidden among the spectators who gather in a dense circle about the performers. (Plate XI.) The dancers usually move in a circle, in single file. Several men or several women commonly dance at one time, although mixed groups of dancers are by no means uncommon. Ifugao dancers not only keep perfect time to the music with their feet, moving forward as well, but spread the arms, indulging in much flexing of the arms and wrists and moving of the hands. (Plate VIII, fig. 1.) (Dean C. Worcester.)

so repugnant to the heart of civilized society, are not recognized among the Ifugaos; on the contrary they are accustomed always to attack from behind, not doing otherwise unless by virtue of necessity.

The Ifugaos can ascend from the plebeian to the noble class by acquiring riches and making an ostentatious display of them before others in the following fashion: The candidate for noble rank announces his intention beforehand to those of his settlement as well as to his immediate neighbors, and at once they all come forth with great satisfaction and enthusiasm for the dinners that they expect. They go to rather distant forests, and, selecting a very large tree of good wood, make from its trunk a ridiculous figure, similar to a large quadruped, stretching upward with its extremities cut off. While they are making this sign of nobility they continually kill and eat hogs and *carabaos* which the future nobleman pays for with great evidence of generosity. When the work of art is concluded they leave it in the forest and return to their settlements with great glee, eating the flesh of hogs or *carabaos* always at the cost of the one who wishes to become a noble. When the work in the fields is concluded they return again to the forest in order to carry to the settlement the image previously prepared, which they call *tagábi*. (Plate VII, fig. 2.) Then it is that the candidate turns his house inside out in order to acquire a reputation for magnificence among his future inferiors. After eating to excess, and going through with a thousand ridiculous ceremonies, they load the *tagábi* upon the backs of men and begin to walk very slowly to the sound of the *gansa* with great shouting, and as a further proof of riches the future noble goes scattering rice in the path. They leave the *tagábi* in the forest, returning to their houses a third or even a fourth time, finally arriving at the settlement in the midst of an indescribable enthusiasm. When the *tagábi* has been placed under the house of the noble there begins another feast much greater than those which preceded it, during which many hogs and buffaloes [4] are consumed, until the people take their departure drunk and full of meat to their throats. Nobility therefore among the Ifugaos costs them dear, and they spend their fortunes in acquiring it, although they come back to them afterwards with interest. In order to maintain their prestige over the plebeians or poor people they repeat from time to time some little celebration, always enveloped in gross superstition, and without forgetting the inevitable drunkenness which is an honor among them.

When for this or other reasons they kill a *carabao*, the mode of doing it is horrible and is as follows: The animal is tied in front of the house of the man who gives the feast. The guests are arranged (and everyone comes who wishes to take part); they have knives in their hands,

[4] The word "buffalo" throughout this article refers to the *carabao*. (Dean C. Worcester.)

and await impatiently the first blow by the owner on the head of the victim. When this has been given, they all rush up like carniverous animals in order to cut off good pieces, which they carry to their houses. (Plate XII.) In the wink of an eye they cut to pieces the *carabao,* which, kicking and bellowing passes instantly into the hands of his voracious enemies in the midst of horrible confusion and tremendous outcry. They get very angry when they can not obtain any meat. Some of them take away from others, if they can, what the latter have obtained. (Plate XIII.) The most audacious threaten the more timid with the knife in order to make them abandon the prize, and almost always some of them get wounded in order to eat a little meat. But it is the custom that he who is wounded shall bear it, because the action is considered involuntary. They carry away even the contents of the intestines as a thing which pleases them greatly. The nobility acquired and preserved in this manner endures only while the riches last. These for the most part are not handed down to the descendants, although the latter are called always "sons of nobles," a fact which they appreciate highly.

VENERATION FOR THE OLD, CONSIDERATION FOR WOMEN, AND RESPECT OR LACK OF CONFIDENCE AMONG THEMSELVES.

They have great respect for the aged, even regarding them with superstitious fear, the reason being that they are their priests and diviners, and the interpreters of their idolatrous customs to which they are very closely wedded. This is the circle by which is limited the authority of these old people without its reaching even indirectly individual liberty, and the usages of life. In case of invasion by enemies, they exert a moral influence, the Ifugaos following the bravest and those of the strongest character; guided in this rather by the spirit of self-preservation than by respect and veneration. For the rest, if one did not wish to do his share for fear or other motives, nothing would happen to him except blushes and shame, of which they make much account.

Women are held in high respect, so much so that in case of a war between family and family, settlement and settlement, or those inhabiting contiguous territories, the Ifugaos of Quiangan do not attack women or children, avenging themselves only on the men of adult age.[5] The women and children can go where they like without any fear.

[5] The Ifugaos of Quiangan have no more respect for women and children than do those of other regions. They will all kill women and children of their enemies and take their heads whenever they get the opportunity. All through the Quiangan Valley the people of the different rancherías are intermarried. The Ifugao does not hesitate, in a spirit of revenge, to kill a male relative, but I have never known him to kill a female relative. This fact possibly accounts for the theory that the Quiangan Ifugaos do not molest women and children. (L. E. Case.)

It is the custom of the Ifugaos to regard as unendurable the slightest bodily punishment. Not only this, but they can hardly endure a word which among the Christians passes almost unnoticed, and it is extremely dangerous for them even to get to joking with each other, especially if they are strangers or not related. The Ifugao is, and believes himself, an absolute king, avenging with his ever ready lance the smallest offense not only against his person, but also against his house and his estate. In the intercourse which they must necessarily have with others they are very circumspect and reserved, especially with strangers. I do not mean to say by this that their manners are fine, for they do not even know words and salutations, and comport themselves like wild beasts when they meet each other, but I do mean that in their extreme barbarism they fear to compromise themselves in matters which do not concern them, and they know that if they do not know how to endure, the same thing is true of their fellows.

For example: When a military expedition was encamped in one of these mountains, various Ifugaos of influence came down to present themselves to the leader, bringing him presents. It occurred to one of the expeditionary force to play a joke on an old man, pulling out some of the few hairs which he had in his beard. This was enough to make him furious, although he was in the midst of the encampment, and he gave the war cry to the others, although, coming in friendly spirit, they did not carry lances. The result was tremendous confusion. More Ifugaos came up and the forces had to deploy and fire until they drove them away. All this was the result of an unimportant joke. I heard this from a person who saw it.

On another occasion, in a settlement somewhat removed from Quiangan, individuals did not wish to pay homage nor to aid in certain public works that were being constructed. As a result a few soldiers were sent from the fort to compel them to obey, but when they reached the settlement they found only an old man; all the rest had fled. It occurred to a soldier to make fun of certain idols, and furthermore to catch a few hens in punishment for their rebellion, whereupon the old man with fire in his eyes, attempted to sheath his dagger in the breast of the soldier, without fear of the rifles and bayonets. Other similar instances might be enumerated, as well as accidents which have occurred on expeditions for insignificant causes of this sort, especially when women were insulted in the smallest degree. I think I have said enough to show that it is not easy to have to do with these Ifugaos without knowing thoroughly their instincts and character, and it can be understood why the missionary priests are almost afraid to have detachments of troops in the missions, especially since in other ways, and working with wisdom, their submission might be brought about gradually.

EDUCATION OF CHILDREN.

In order to make more clear what I have said concerning the ferocity of character of these Ifugaos, it is well to indicate the difference which exists between those who live on sweet potatoes in the more rugged and distant mountains, and those who are accustomed to work in the fields in the cultivation of rice. Nevertheless, even these differences are difficult to detect. Speaking of those to the north and east of the Cordillera, those of the southwest, although they only give themselves to their gardens of gabi and sweet potatoes, are more timid and docile as I was able to observe in the journeys that I made through their mountains.

From birth they are accustomed to do as they please in every thing on account of the extremely bad education which they receive from their parents, who, although they hate like death the least domination on the part of strangers, submit like slaves to the caprice and insolence of their children. The children give orders in the house, and if at some time their parents do not yield to their stupid caprices they begin to cry furiously, and immediately their parents hasten to quiet them, giving them a thousand caresses, and in addition allowing them what they ask. They do not whip or punish them as do the Christian natives. The lightest slap is not employed among the Ifugaos, and would be received very badly and criticised among the others if it should be observed at any time. The most that happens, especially with the women—the mothers—is to shout at them, when their caprices are too repugnant and prejudicial to the interests of the house, but they gain nothing by this, because if they (the children) are small they only weep the harder, and if they are larger they pick up stones or lances, and attack their parents, driving them out of the house, to which they do not return until they see the children pacified and quiet. It seems incredible that people so hard and cruel with strangers should be so sensitive and affectionate with their own. Nevertheless, so it is, as is proved by experience. Wild beasts, also, in spite of their bloody instincts, love their offspring tenderly and risk their lives for them.

MARRIAGES.

The relations which these Ifugaos maintain hardly deserve this name. They divorce themselves as readily as they marry, the men seeking other wives and the women other husbands. The Ifugaos seldom grow old without having changed their wives one or more times. The slightest annoynace, the least caprice, a single word, is frequently enough to dissolve the contract, but the most influential and common reason on the part of the man for divorcing his wife is barrenness, and the commonest reason on the part of the wife for divorcing her husband is laziness.

In order to get married a man must make presents of considerable value in cloth or similar articles to the uncles of the women, and in lack of these to the brothers or cousins. When he wants to marry another wife because the first has died, or because he is obliged to abandon her, he must again make the same presents to the same people, adding a *carabao* in compensation for lack of respect to the departed one or for the abandonment, if she still lives. He has also to make the same presents to the uncles, brothers or cousins of the second, and so on successively. The expenses and feasts which occur on such occasions are also at the cost of the man. It seems that they ought to cut down expenses, on account of changing wives so frequently. But it makes little impression on them, because they are very obstinate and capricious.

JUSTICE, DEFENSE AND VENGEANCE AMONG THE IFUGAOS.

There does not exist among them any superior authority to defend them or to punish their mutual aggressions. Each one supplies this deficiency after a fashion with his lance, and this in the hands of so fierce a people is the cause, in turn, of an infinite number of misfortunes and cruelties.

For every murder committed, although it be involuntary, inexorable vengeance follows, carried out by the relatives of the dead person, on the author or some one of his nearest relatives. Among the Ifugaos vengeance is a rigorous precept which must be fulfilled. When a plebeian or a rustic, as they say, kills another rustic, justice is satisfied by the death of another of the same rank. In case the murdered man is an important person or a noble his relatives are not satisfied by killing the aggressor if he is rustic, or by killing some relative of the same rank, for they say how will there be equality if we only kill this fellow who is like a dog? Therefore they look to see if there is among the relatives of the rustic some important person in order to wreak their vengeance on him, and, if not, thinking it beneath them to kill those whom they regard as dogs, they wait until some of them ascend to the rank of headmen. It results that an act which is originally individual becomes always a question of family, even if it does not involve the whole settlement, as often happens. When the death, or deaths have been avenged, by others equal in number and rank, the individuals of one and the same family and even of the same settlement are wont to quiet down and become friends, either in the desire of self-preservation or because they weary of perpetual ambushes and surprises, with the consequent harmful results to their crops and their interests. For the rest, between those of different mountains or districts, and especially between those who give themselves on the one side to the cultivation of rice and on the other to that of sweet potatoes, there exist interminable hatred and wars ever more bloody, the men going forth to kill their fellows as if they were going to hunt deer or hogs, and afterwards carrying the heads of the victims to their settlements, making great feasts, honoring themselves with the name of "the brave," and decorating the fronts of their houses with the skulls of their victims.[6] (Plate III, figs. 1 and 2.)

If it is a matter of wounds which are not fatal, or of other assaults, the matter is arranged readily with the healing of the injuries caused. The frequency of deaths and wars even among the families of a settlement, may be imagined when one takes into account the egotism and independence of this barbarous people, their brutal manner of living, the commonness of drunkenness, and the fact that they hold as honorable their gross errors, their idolatry and their superstition.

IDOLATRY AMONG THE IFUGAOS.

I have proposed at various times to follow the course of the stories and narratives of these Ifugaos, and noting at every step monstrous contradictions and violent transitions, I questioned them to see if they could follow the thread of the discourse, but always in vain, for they answered me that they did not know the reasons of these transitions and contradictions. It is to be noted in some of these narratives that this race has possessed in very remote times remarkable astronomical knowledge, especially of the signs of the zodiac, and I believe that even now, if one were to go deeply into the meaning of their little stories which are handed on from generation to generation by means of a sort of traditional verse, which they very often sing, he might perhaps determine with considerable accuracy the epoch of the arrival of the Malayan race in these Islands.

They pay great attention to the spots and the phases of the moon. They believe that certain planets influence more or less the affairs of

[6] As for taking heads, this is only done between rancherias which have a feud or are strangers. If an Ifugao from one rancheria kills another from a friendly rancheria in a dispute it is only a family affair; but if he should cut off his head it would then become a rancheria affair and the feud would begin. An ordinary killing is generally fixed up by the exchange of a few hogs or of other property, but when a head is taken the rancheria from which it was taken must get a head in return. It makes no difference whose head it is so long as it comes from the rancheria which took the first head. Of course the more important the victim whose head is taken the better pleased are the avengers; still they will lose no time in waiting for an important person, but will take the first opportunity that presents itself to secure a head, whether it be that of a man, a woman, or a child, and if the party is large and its members wish to secure more than one souvenir over which to hold their *cañaos* they will cut off feet, legs, arms, or hands, and carry them home. I have had Ifugaos urge with tears in their eyes that if I objected to their cutting off the head of a man who had been killed in a fight I let them cut off only a finger so that they would have something to take home and give a *cañao* over. (L. E. Case.)

man. Observing the different phases of the moon, they suppose them to be two distinct entities, husband and wife, whose older children are the various planets which appear larger to our sight, the younger children being the remaining stars of the firmament. For the same reason they ought to imagine that there are two suns. These Ifugaos establish very easily relations among things, taking as a base the male and a female which they call husband and wife, for to everything which appears large and important it appears that they attribute intelligence. Even when they see two conspicuous rocks or mountains which are similar and near together, they believe thus in mutual marriage.

There is no notable phenomenon in nature which does not arouse in them serious fears which hold them enslaved in all their movements and operations, although they find a universal remedy in the sacrifice of birds, hogs and buffaloes, whose entrails they study uselessly before introducing them into their own voracious stomachs.

They believe in two places to which they go after death. For those who die a natural and ordinary death they believe the abiding place to be in the earth and toward the north, calling it *Kadungayan,* the word by which they designate the northern region. They say that the dead live there reunited in a forest of special trees, which, although they appear by day as such, become converted into houses similar to those of living Ifugaos when the obscurity of night arrives. They are positive that they have gardens of sweet potatoes and other vegetables and that the spirits eat the invisible substance of the animals, rice and other things which their living relatives offer them. Thus, they say that the wine which the living drink serves as a drink for the dead, each getting what belongs to him according to his state. They affirm that those who rob or kill without reason receive here their deserts, and if one dies without paying the penalty the same conditions will continue in the towns of the dead as in the living. He will pay there for his fault with some lance thrust which one of the dead will give him. When the story has come to this point, to which only some old and wise man is able to bring it, they do not answer further. If one attempts to go on they only destroy what they have said with monstrous contradictions. They say that some of the spirits from that region come back to visit the place and settlements of the living Ifugaos. One of them, according to the story, came with his wife to visit his relatives who maintained them with the most excellent rice flour. When the relatives got tired of such heavy expense they sent them away, it is not known where, and they finally came to rest on one of the mountains of the Mayoyaos to the east of Cauayan in Isabela. While the man was sitting on a rock in the shade of a tree there fell upon his head the droppings of a bird which was perching there, from which it resulted that while he remained seated there burst forth from his very head a tree that they call *basisi,* from the bark of which the poor Ifugaos make their skirts. This tree grew very large and still exists over the sitting Ifugao. Two ladders represent them; the one this man, and the other, I believe, his wife. The Ifugaos are wont to have them at the entrance of their granaries as guardians and protectors of the rice. They offer or place before them a little rice flour during the feast which they make at the end of the harvest, while they are filling up on the flesh of hogs and buffaloes and are getting as drunk as possible. Those who die from lance thrusts or who die any other violent or sudden death, as well as women who die in childbirth, they assign to heaven, or the abode of the gods which they worship, and they mean by heaven, or the abode of the gods, the stars and planets, especially the sun. They give the following account of the origin of the sun. The Lord of the Sun, whom they call Mananahagut, gave orders that certain Ifugaos should go and kill another one for some fault or other, the Ifugao in question being left, as a result, dead and headless. Lord Mananahagut, moved, it would appear, by compassion, sent his wife, Bugan, charged to invite him and persuade him with gifts and caresses to ascend into heaven, but the spirit of the Ifugao refused the caresses, and refused to go to heaven, in spite of the beetle nuts, tobacco, and *vino* which were given him, because the woman was peculiarly dressed and looked very strange. The wife of Mananahagut, noting this, disposed of the greater part of her clothing, remaining half naked, as is the custom with the Ifugaos, caressing further the dead Ifugao, and offering him endless pleasures in heaven. Satisfied with this, the Ifugao accompanied her immediately to heaven being received with the greatest joy by Lord Mananahagut, who gave him splendid feasts and dances. For this reason, and I know not for what other, the Ifugaos believe that people who are killed by lance thrusts go to the abode of the gods, but although in said place they are happy, their happiness consists in filling themselves with the flesh of hogs and *carabaos* and in drinking, and getting drunk on the *vino* which they make. Neither for their gods nor for the souls of the dead, nor for those who live in mortal flesh is there any greater happiness than the satisfaction of the carnal appetites. The practices and ceremonies which they employ with the dead vary, according to whether the deceased died a natural or a violent death. For the first they spend all and more than they have, ransacking the neighborhood, gathering hogs, *carabaos* and *vino,* which they give to eat and drink to all their relatives, because they believe that the souls or the spirits of the animals which they eat are the food of those who go to *Kadungayan.* They keep the body four, six, ten and even fifteen days without burial, placed below the house. All depends on the rank of the deceased; the more important he was the longer he is left without burial. But when they bury those who go to heaven, especially the trunks of the corpses the heads of which have been carried away by the enemies who have killed them, they only kill the hog, which is eaten by some of the oldest and most experienced in the rites which they have practiced, because, they say, those who go to heaven get no good from the spirits of the animals which their relatives eat, but, on the other hand, the animals which the assassins kill and eat in the great feasts which they celebrate, when the brave are crowned, serve for the spirits of those whom they have decapitated. They say that the Ifugaos die twice, understanding by one of the times their falling sick. They affirm also that the spirits do not go immediately to their final destinations, but that they remain for a longer or shorter time near by, leaping from rock to rock, and from tree to tree, maintaining themselves on the remnants which they can obtain by entering the houses at night. The object of remaining in this way is to see if they can take with them the spirits of their relatives, in order that husband and wife may live together, and that children may live with their parents. In consequence, they believe also that sickness consists in the departure of the spirit of the sick man from the body, attracted or violently carried away by the spirit of the deceased relative; wherefore, when they become somewhat seriously sick they call the charm-healer that he may make the spirit return and give health to the body. These charm-healers, who are a pack of frauds and deceivers, cure in the following manner: Hardly has the healer entered the house of the sick person when they give him a fowl, which he kills in the name and honor of the old woman and wife of *Kadungayan*. He observes the state of the gall immediately, and after having looked very intently at the sick man, states his diagnosis in the following terms, or others somewhat similar: "The spirit of this sick person is in such or such a place, having gone to visit the spirit of his grandfather, wife, son, father, etc. In order to bring it about that it may return, there is need of so many hogs and a *carabao* or two, because in that way the soul will decide to return with great pleasure." The family then diligently prepares what has been indicated, procuring it by some means if they do not have it at hand. When the animals indicated have been killed, or while they are killing them, the healer calls the spirit with the point of a lance, in order that it may come down by the lance to the sick person. He invites it to come down, saying that there are so many hogs prepared, so many *carabaos,* and so much *vino;* sometimes he seizes a *gansa* and produces upon it a tremendous noise. I do not know why it does not break the head of the sick man. At other times he announces that he sees the spirit in such and such a place; that now it is coming down; that it now has left the spirit of its grandmother, and that now the sick man will get well. More, since the sick man dies or is cured according to the will of God, he often remains as sick as he was before, or becomes sicker; his friends then call the healer again, or summon some other healer with a greater reputation, if there is one, and the same performance is repeated. The healer says: "The soul of this person has gone away again; such and such a spirit detains it in such and such a place. It would seem that it has become accustomed to the other life, or wishes to live with its dead wife; there is need of more hogs and more buffaloes to make it come down." Finally the sick man dies, if it is the will of God, after those of his household have spent everything they have. This is the way of curing the sick, at whose expense the well eat and drink, the healer carrying away meat enough to last for many days in addition to his pay. As a result, the family often is completely ruined, the usurers getting away from them their estates or fields.

BELIEF OR FAITH OF THE IFUGAOS IN SIGNS.

I asked a certain Ifugao, who narrated to me with the utmost simplicity many of the things that I have just set forth, "Do you believe in these necessities which serve only to ruin you?" to which he replied: "I do not know, father, how much truth there may be in what other persons relate, because I have not seen it. I do believe what I saw very plainly on one occasion when I was sick for a whole year. It seemed that my spirit had gone up into heaven. There I ate and drank very well; I saw other Ifugaos who did the same, eating and drinking until they got drunk; their houses were like ours, and those who go about there without their heads on account of having had them cut off by the Mayoyaos, had others, although very small. When I awoke, after having dreamed all of these things, I hardly wished to eat, and desired to die."

Here is the principal reason for the persistency of the Ifugaos in their gross and stupid idolatrous practices. Dreams which they look upon as supernatural things, hold them all fascinated, especially the more simple of them. By this means, in which the devil may exercise so much influence, they are perfectly filled with the most stupid and absurd errors; they act upon impulse, and do or leave undone what vanity dictates or what is suggested by their insane imaginations, excited by the father of lies.

I ascribe the tenacity with which they adhere to their idolatrous practices to the fact that these things are quite in accord with their passions and their stomachs; and especially because they are confirmed as true and good by the apparent evidence, and the sort of vision, which more or less vivid dreams produce, in which they trust as facts revealed by hell or their hellish divinities. They dream what they do, and are going to do, and they believe what they dream. Thus it is that it is well-nigh useless to attempt to reason with the Ifugaos as to the evil course which they follow, and there is no other human means of making them abandon gradually their infidelity than by educating their children and their young. Thus, and in no other manner, speaking in general terms, have Christianity, the truth, and civilization been introduced among the other wild tribes that have been subdued.

DRUNKENNESS AMONG THE IFUGAOS.

Since they believe that the happiness and prosperity of their gods and ancestors consists in filling their bellies with the abstract and spiritual substance of the fowls, the hogs, and the old buffaloes whose flesh they themselves eat, and believing also that an important part of the happiness of the same beings consists in drinking to excess the same abstract principle of a *vino* which they call *bubud,* it is plain that they will be very diligent and fervid in drinking the concrete article until they get drunk, if possible, in honor of those whom they venerate as drunkards and gluttons of the first order. It is, therefore, easily seen that far from regarding drunkenness as a vice, they regard it, on the contrary, as a virtue, and an efficacious means of appeasing their pretended divinities, and in their vanity they regard it as a great honor to appear drunk even when they are not so. Thus, for example, to free themselves from the danger of being struck by lightning they have no better means than that of offering it the abstract *vino,* which they, of course, drink in its natural state; because they say that the lightning enjoys it greatly and after drinking *bubud* will not eat man.

This *vino,* or *bubud,* which is such a delicacy among the Ifugaos and their gods, they make in the following way: First they add to a small quantity of rice flour a very acrid and strong juice which they extract from a creeping plant. When this is made and dried in the sun, they have what may be called yeast, which they preserve very carefully. When they wish to make *vino* they cook a considerable quantity of rice with water alone, making the ordinary boiled rice. After drying this in the sun also, they mix it with some of the above-described yeast and introduce it into an earthen jar of suitable dimensions, which they cover perfectly tight, leaving it so eight or more days. Meanwhile it ferments, changing into a liquid of a very disagreeable taste, both acid and biting, which is called *bubud,* which serves them for food and drink; for, as they say, "it has food and it has drink." This liquid does not cause drunkenness, properly speaking, but rather a rabid fury which nothing will placate.[7] They make it and use it whenever they can, in all of their sacrifices, but especially and without fail in the following cases:

First, when they begin their work in the fields, at which time each one kills and eats as many hogs and *carabaos* as is possible for him, and as conforms to his estate.

Second, in the cases of severe infirmity and its cure, as has been explained.

Third, when they commit some murder, in which case they have

[7] My own observations do not confirm this statement as to the effect of *bubud.* (Dean C. Worcester.)

great feasts and ceremonies for the crowning of the brave, killing and eating the best that they have or can borrow, offering all of this, together with the dances and the great drunkenness, to the soul of the murdered person, whose head, placed on the point of a pike, is the principal trophy and the central point of the shameless orgy. For this reason, even the relatives of the deceased person, who seek an inexorable vengeance, seem to respect these ferocious feasts, not exacting their due until the feasts have ceased.

Fourth, before beginning the rice harvest, when they do the same as at the beginning of their labors in the fields.

Fifth, when the rice has been harvested and put into the granaries, in which case, on account of the satisfaction they find in entering upon a period of rest, and in order to obtain from their gods the preservation, and even the increase of what they have harvested, they leap and dance, eat and drink, which is a pleasure for them and a horror and alarm for anyone who is looking on.

Sixth, and last; in a sort of Lent, which they observe in honor of the god Baco, at which time their eating and their drunkenness reaches the highest grade, causing the origin of innumerable enmities, many deaths, and a thousand misfortunes, which occur for the most part between relatives and friends.

In all that I have narrated, I refer to the Ifugaos in the mountains. Those of the mission of Ibung, situated in the plain, do not do so much as the shadow of what the others do. They are gradually becoming accustomed to live submissively after the fashion of the Christians.

DIVINATIONS AND IDLE OBSERVANCES OF THE IFUGAOS.

In order to free themselves from the fears which beset them, they have a book which every Ifugao knows how to read. If at the first, second, or third reading, it does not appease the anger of their divinities they read it a fourth, fifth, or even more times, but it should be noted that each time it is read costs money, often equal to the value of a *carabao* or of an Ifugao soul; this book, and this reading, are the entrails of every fowl or animal that is eaten and the observation of the same. Their auguries are reduced ordinarily to the observation of the state of the gall of the animal which they kill. If it appears to them that the gall indicates good or fortunate results in the enterprises which they are about to undertake, they do not kill more fowls or hogs. But if the business turns out badly they repeat the killing of animals until they attain their end, although at the cost of their interests; for the fowls and the hogs which they are wont to borrow they have to pay their weight in gold according to the fearfully usurious rates which prevail among them.

Who can calculate the numberless times and occasions on which they believe it necessary to make use of this augury to free themselves from the thousand stupidities which cause them fear of death, of sickness, or of some other harm to their fortunes? Who could enumerate the fowls and other animals which they kill on account of their journeys to somewhat distant places, on which they fear the lances of their enemies; or by reason of their troubles, or those of their families; or when they are surprised in their labors in the fields by the song of some innocent bird, by the rainbow, or by other natural phenomena? For all of these imaginary evils they seek a remedy in what, on the other hand, causes them an interminable series of debts.

EXORBITANT USURY AMONG THE IFUGAOS.

It is an immemorable custom among the Ifugaos, received and practiced by all, that a pullet borrowed but not returned within a certain time, produces a hen or the equivalent of a hen; so it is that a hen must be given in payment for it if a sufficient time has passed since it was borrowed for it to grow into a hen. If a still longer time has passed, so that it is calculated that if it had lived it might have laid eggs and raised chickens, the price ascends to a hog of moderate size. If another year passes it is converted into a hog of the largest dimensions. And finally when the third year since the borrowing has passed, it makes itself into a *carabao*. It makes no difference whether it was a male or a female; in any event, it makes a hen a hog or a buffalo. In an analogous manner they return payment for other small things borrowed.

According to the Ifugao principle of interchangeable justice, the debts of parents descend to their sons, and if they have none, to their nearest relatives and their sons, although they did not enjoy any benefit from what was borrowed, nor inherit any estate from their elders. All of this is constantly carried out without anyone finding fault with anyone else. At the most, the only complaint is bad luck. They say it is a custom among them, and the fact that it is a custom is reason enough for its being venerated and carried out without complaint. Furthermore, everyone who borrows does the same, and it often happens that he who is the debtor to some, is the creditor of others.

The most unfortunate are the orphans whose parents were sick for a long time and who incurred heavy debts for the many pullets which they were obliged to kill.

This iniquity has an attendant circumstance which perennially augments it. The rich men, who are the nobles and the headmen, are always seeking opportunity to lend these things to everyone who asks. The poor are always ready to ask for loans, both because they can get them without difficulty, and because their creditors do not compel them to pay promptly, while the latter usurers, who do nothing but fill themselves with meat, get drunk, and pass an idle life, desire that they may delay to pay their debts. The whole load, therefore, goes to the orphans, who have to pass nearly all their lives sweating blood in the Christian towns to pay for the numberless buffaloes which are demanded of them, as well as the pullets and hogs which their parents spent on their stupid practices.

When I was at the mission of Quiangan a young fellow came to tell me that he was going down to the towns. "What do you go to seek there?" I asked. "I go to work in order to pay my debts, because if I do not do it I fear that they may kill me or sell me." "What debts are these?" "The debts that my father contracted when he was sick, for the fowls and the hogs which he spent in order to be cured." "It is a hard matter that you should have to pay for the caprice of your father." "It is our custom." "And how much do you have to pay?" "I do not know exactly; every one is after me and I reckon that it will be a matter of 40 *carabaos.*" Many years ago this young fellow went down to the town. He has worked harder than a negro, he has paid many of his debts; at the same time incurring others as the result of following the customs and practices of his people. Although he should die an old man, he could never pay them all. So it is that the rich hold the poor enslaved.

In other districts further in the interior of the mountains, and extending to Japao,[8] in which, on account of the distance, the Ifugaos can not or dare not go to the towns and earn money for paying their debts, a few sweet potatoes, a quart of rice, or a fowl are frequently the cause of the selling of the debtor or his children as slaves. A hundred of them go to Isabela every year, and there they are bought or sold secretly for a hundred dollars, or a *carabao* or two, each. Therefore, the value of a few sweet potatoes, a handful of rice, or a pullet, ascends to a hundred dollars plus a *carabao,* and, what is more, to the value of a man. The usurers, who, in order to count a dozen have to make use of their fingers and, when the number passes ten, to sit down in order to count their toes, do not lose the count of the chickens which they lend, nor of a single sweet potato.

Ibung, January 31, 1879.

Fr. Juan Villaverde.

ADDENDUM.

Captain L. E. Case, of the Philippines Constabulary, who was stationed for a number of years at Banaue, furnishes the following interesting account of the story told him by an old Ifugao to explain the prevalence of the custom of head-hunting among his people:

[8] Sapao.

WHY THE IFUGAOS TAKE THE HEADS OF THEIR ENEMIES.

When I was seeking to ascertain the reason for head-taking, the following was related to me by one of the aged inhabitants of Banaue. The tale is told throughout the Ifugao district of Nueva Vizcaya; also in Bontoc Province, except that different settlements almost all disagree as regards places and the duration of the flood.

"A long time ago all the country round about was level and had no woods growing on it, with the exception of two mountains; one in the north called *"Amuyao,"* and one in the southwest called *"Alauitan."*

"The people grew a small quantity of rice and caught fish in the river. They also hunted deer and wild hogs among the tall cogon grass on the banks of the river.

"One *chupa* of rice at that time was equal to two *gantas* at the present time, for a tablespoonful of rice after being cooked made a good meal for one person.

"Once when the wet season should have come it did not, and a dry season followed a dry season.

"The rice would not grow but burned up, and the cogon grass burned up; then the river began to get smaller and smaller until at last it sank out of sight in the ground. Then the people began to die and the *Apos* said: 'If we do not get water soon we shall all die. Let us dig down into the grave of the river, for the river is dead and has sunk into his grave, and perhaps we shall find the spirit of the river and it will save us from dying.'

"So they began to dig. At the end of three days the water rushed up, and it came so fast that some of them were drowned before they could get out of the way of it. Then there was plenty of water and the people were happy.

"They brought a dog and a wild cat and turned them loose in a vacant rice field to fight, that the people might be amused; and while the dog and cat were fighting, it became very dark and rain began to fall, and the people became afraid because it got dark while it was yet morning, and one old *Apo* began lamenting and saying 'the river God is angry with us for disturbing the grave of the river, now we shall all find our graves in the water;' and the water poured down from the sky faster than it came out of the river.

"Bugan and her brother Uigan had brought out their two dogs to take part in the fighting with the cat, but when it got so dark that they could not see they took hold of the dogs' tails thinking thereby to be guided back home, and thus they followed on after the dogs until they became exhausted and lay down and slept, and when they awoke they found they were on the top of Mount *Amuyao*. It was still raining and it rained for fifteen days. After the rain stopped the water began to go down, and as it slowly got lower, here and there they could see the tops of mountains sticking out; and after the water had all gone down they saw that in place of the level ground that they had known before the rain, all round about them were mountains with rivers running here and there.

"One day while Uigan slept Bugan set out to see if she could find some other people, for she thought that there must have been others who escaped up into the mountains; so she traveled till she came to Mount *Alauitan,* without finding anyone.

Uigan on awakening and finding his sister gone started out to look for her and trailed her with his dog. On coming near *Alauitan,* he saw a large smoke rising from the top of the mountains and concluded that there were some other people saved beside himself and his sister, but, on arriving where the fire was, he found only his sister.

"It was then for the first time that they realized that they were the only people left alive after the rain, so taking his sister with him Uigan returned to *Amuyao* where they lived on an open spot cleared by them on the top of the mountain.

"To this day nothing grows on this spot, and the print of Bugan's foot is still to be seen.

"In due course of time there were born to them five sons and four daughters, Balangao, Honanga, Banol and Etnig, each taking a sister for his wife.

"There being only four sisters and five brothers, Igon, the youngest of the brothers, had no one for his wife, and the other four brothers concluded that as Igon had no wife it would be better for them to kill him and thus possibly save themselves future trouble. So they killed Igon.

"Then Bugan and Uigan said, 'Now that you have killed Igon, you must kill some animals and have a feast to make peace with his spirit,' so the brothers caught a deer, but Uigan said, 'No, that did not cause you any sweat, your dog caught that. What you have for this feast must have cost you work.' So, leaving their dogs at home they went and caught deer and wild hogs while their wives prepared the rice and *bubud.*

"Then Uigan said, 'You must take the head of Igon and put it on a pole and you must dance around it that the *linaoua* (spirit) of Igon may be pleased.'

"After the feast was ended Uigan commanded that they boil the head of Igon till the flesh all came off the bones, and then fasten it up on the side of the house so that they might always be reminded that they had killed their brother.

"Finally the brothers began to get jealous of one another, and each one decided that he would like to have the heads of his other three brothers to fasten up on his house; but Uigan and Bugan, knowing how things stood, told them to separate, each man taking his wife and going to a new place and that then they should people the earth as it was before the rain.

"So Balangao took his wife and traveled to a place which was named after him, but is now known as Lepanto, Hananga went to what is now called Mayoyao, Banol went to what is now called Banaue, and Etnig[9] traveled to Ilocos; and the offspring of these four brothers multiplied until they peopled the whole of northern Luzon.

"Uigan, on parting from his four sons and daughters, told them that they must remember at all times, whether good or bad, the brother whom they had killed."

Thus it is that up to the present time the Ifugao custom of taking heads and having *cañaos* in commemoration of the head of Igon taken by their forefathers continues, and the word Bunijon, which is commonly supposed to be the name of their God, is simply a word meant to include the three names Uigan, Bugan and Igon to whom they make their *cañaos.*

On the top of Mount *Amuyao* where Bugan lived, no one can pass, as people going up there have never been heard from again; and on Mount *Alauitan* where Bugan made the fire, fire is seen up to the present time, but when one draws near it disappears.

The Ifugao has an idea that bad crops, sickness and the like are caused by the spirits of the departed. Tangana, an Ifugao of Banaue, had a son who was sick and remained sick some weeks. He came and informed me that his father's head had been taken some years past by the people of Guinijon and that his death had never been avenged. Consequently, he was causing the boy to be sick as a sort of a reminder to the head of the family, so he requested that an expedition be made for the purpose of avenging his father's death. I suggested that probably the old man did not like the place where he was buried. Later on he took the body up and reburied it on a side hill behind his house. The sick boy improved somewhat, but still remained ill. The body was then taken up and with the usual *cañao* reburied beneath the house in a vault with the bodies of his ancestors. The boy recovered his health within a week and Tangana has decided that his father's spirit is satisfied.

I attended the burial of an old woman. It took place one evening just as the sun went down. A hole had been dug in the ground tapping a tunnel which ran to a vault under the house. Lighted torches were thrust into the tunnel after which the body, tied in a sitting posture and wrapped in a blanket, was carried in. On inquiry they told me that it was leaned up against the wall; then they all indulged in a good deal of shouting and informed me that they had told the old woman that they had used her well, given her a good *cañao,* kept a fire going constantly and done all that could be expected of them and asked her not to stay around but to go to the *rancherias* of their enemies.

[9] The Tingians commonly call themselves "*Etnig.*" (Dean C. Worcester.)

When an Ifugao dies, all those in the immediate vicinity set up a shouting to scare the spirit away.

When an Ifugao's wife dies he lets his hair grow. Until he cuts his hair he can not take another wife, and before cutting his hair he must take part in an expedition during which some of the enemy are killed, or a house is burned at least. He then goes home and kills a hog at the same time getting his hair cut and having a *cañao*. He may then take another wife.

The custom of smoking people after death does not hold among the Ifugaos of Nueva Vizcaya. The fact that a small fire is kept burning in front of the corpse evidently gives rise to this theory. On asking Ifugaos why they kept this fire burning I have been told: "Yes, when she goes up where the rest of the dead Ifugaos are and draws near the fire to cook her rice, and some one pushes her away and says 'Get away from here, you have no fire,' then she can say, 'Yes, I have a fire; look down there and see; there is my fire!' "

The Ifugaos, in order to keep their dead a number of days, will take a body after it has been dead about three days, and, with a cloth or some fiber, rub and press the flesh, squeezing out the blood. They also resort to salting the body. I once heard two Ifugaos disputing as to which was the richer. One said to the other "Oh yes, you are rich, you are, but when your mother died you did not put any salt on her as I did when mine died."

These customs differ greatly in the different rancherias. Especially do those on the Alimit River and its tributaries differ from those on the Ibilao and its tributaries.

There is generally much speculation as to the difference between the Banaue, Silipan and Quiangan Ifugaos.

The people living on the Ibilao River from the Lagaue gap through Lingay, Sapao and on up to its headwaters near Polis Pass and up to the heads of all its tributaries have the same customs and speech as those of Quiangan, as also have the people of Madanum, Ilamut and Antipolo.

Traveling from Banaue direct to the rancherias near Payauan (Silipan Ifugaos) the dialect seems to be altogether different, as do the people; but if one starts from Banaue and follows down the Alimit River gradually, or branches off at Dukligan, and travels through the rancherias over the mountains to Payauan he will not be aware of any difference whatever.

Now while there is a difference between the Quiangan and other Ifugaos, it is not great enough to justify their being considered as distinct from one another. Differences also exist between all of the various groups of Silipan Ifugaos (Banaue, Ayangan, Alimit, Mayoyao and Ilap); the farther apart they live the greater the difference.

This would tend to show that the Igorots who inhabit the northern part of Nueva Vizcaya are the same people; that in entering the mountains a party of them passed up through the Lagaue gap, settling at Lagaue; from which place, as they increased in numbers, they spread out peopling the valley of the Ibilao River up to its source, as well as along the streams that empty into it above Lagaue. Another party traveled down the Ibilao River, spreading out in the valleys of the small streams among the mountains, following the Magat River as far as the mouth of the Alimit; then on as far as the junction of the Alimit and Mayoyao Rivers and ever farther up, peopling all the land drained by these streams.

L. E. Case.

ILLUSTRATIONS.

PLATE IX.

FIG. 1. An Ifugao woman weaving. Quiangan. (Photo. by Martin.)

2. A stone "*pilapil*" or retaining wall showing projecting steps. The Ifugaos are particularly skillful in building these retaining walls of dry stone. (Photo. by Miller.)

PLATE X.

Wooden spoons. Also front and side views of an image of the goddess of plenty. Carved by Ifugaos of Banaue. Photos. by Worcester.)

PLATE XI.

Part of a circle of Ifugaos watching a dance. Quiangan. (Photo by Worcester.)

PLATE XII.

Ifugaos at Quiangan cutting down a *carabao* with their war knives. (Photo. by Worcester.)

PLATE XIII.

Ifugaos struggling for *carabao* meat. Magok. (Photo. by Martin.)

PLATE XIV.

A typical Ifugao man, showing war lance and shield; and a typical Ifugao woman, showing the dress of Ifugao women of the better class. Full length front views. (Photos. by Martin.)

PLATE XV.

FIG. 1. A typical Ifugao man, half length profile view, showing peculiar method of cutting hair which prevails generally among the Ifugaos. (Photo. by Martin.)

2. Young Ifugao woman of Quiangan, half front view, showing method of dressing the hair. (Photo. by Martin.)

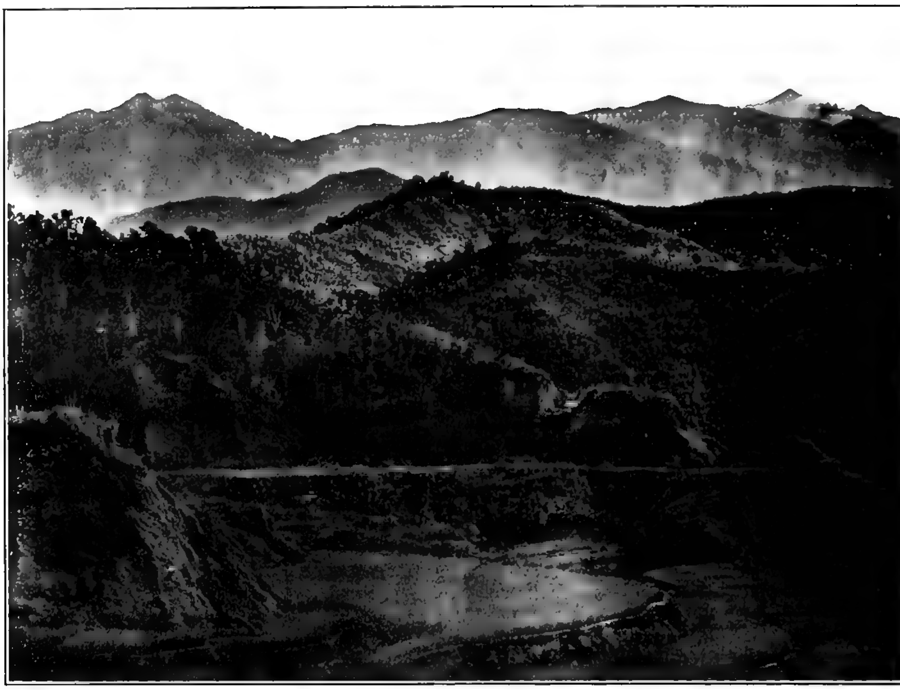


FIG. 1. MOUNT ALAUITAN TO THE LEFT, AND MOUNT AMUYAO TO THE RIGHT.

FIG. 3. THE HIGHEST PEAK OF THE MOUNT

P

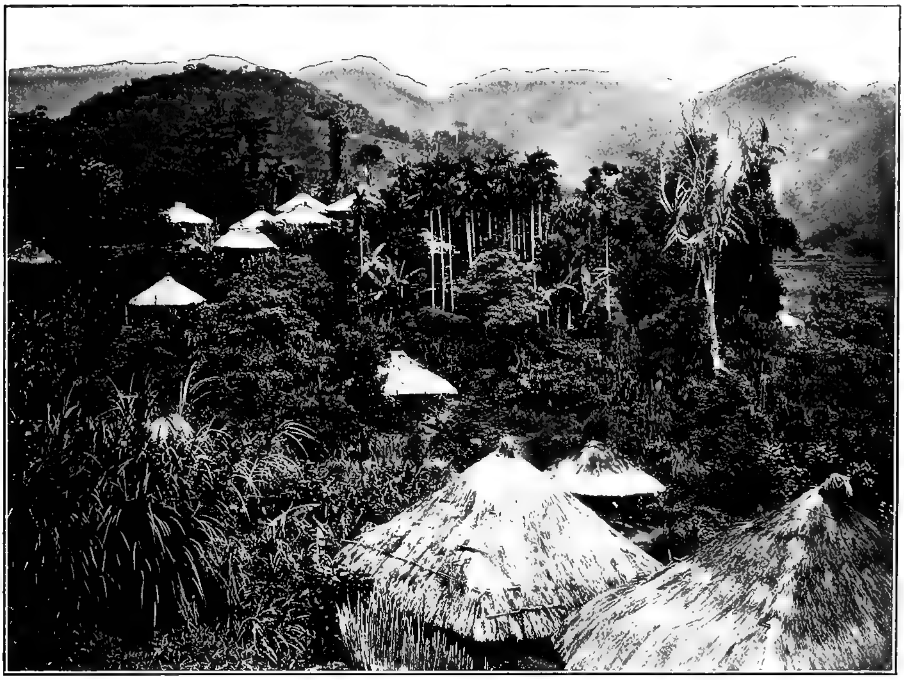


FIG. 2. IFUGAO SETTLEMENT, PART OF QUIANGAN.

RANGE, CALLED ALAUITAN BY SOME IFUGAOS.

E 1.

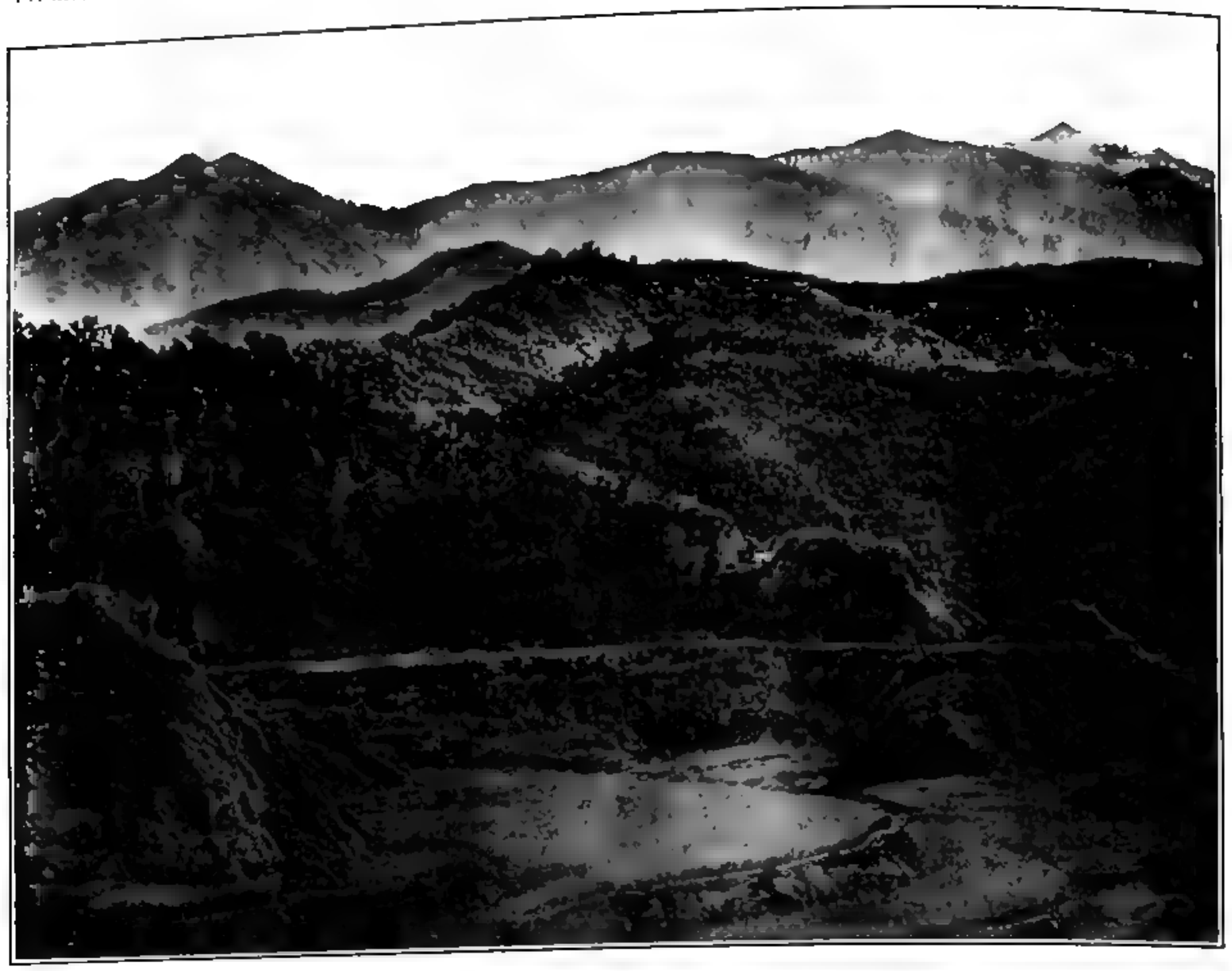


FIG. 1. MOUNT ALAUITAN TO THE LEFT, AND MOUNT AMUYAO TO THE RIGHT.

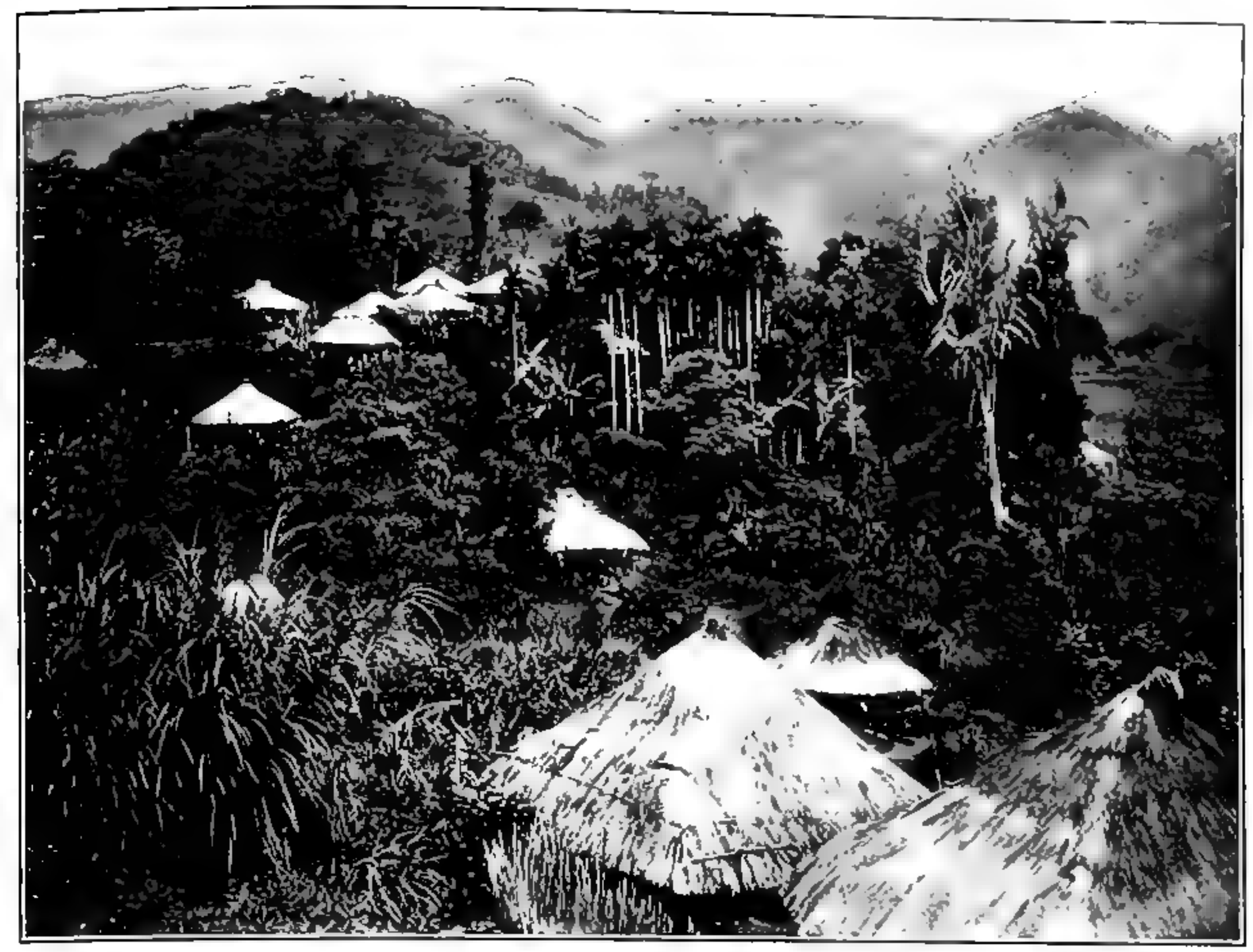


FIG. 2. IFUGAO SETTLEMENT, PART OF QUIANGAN.

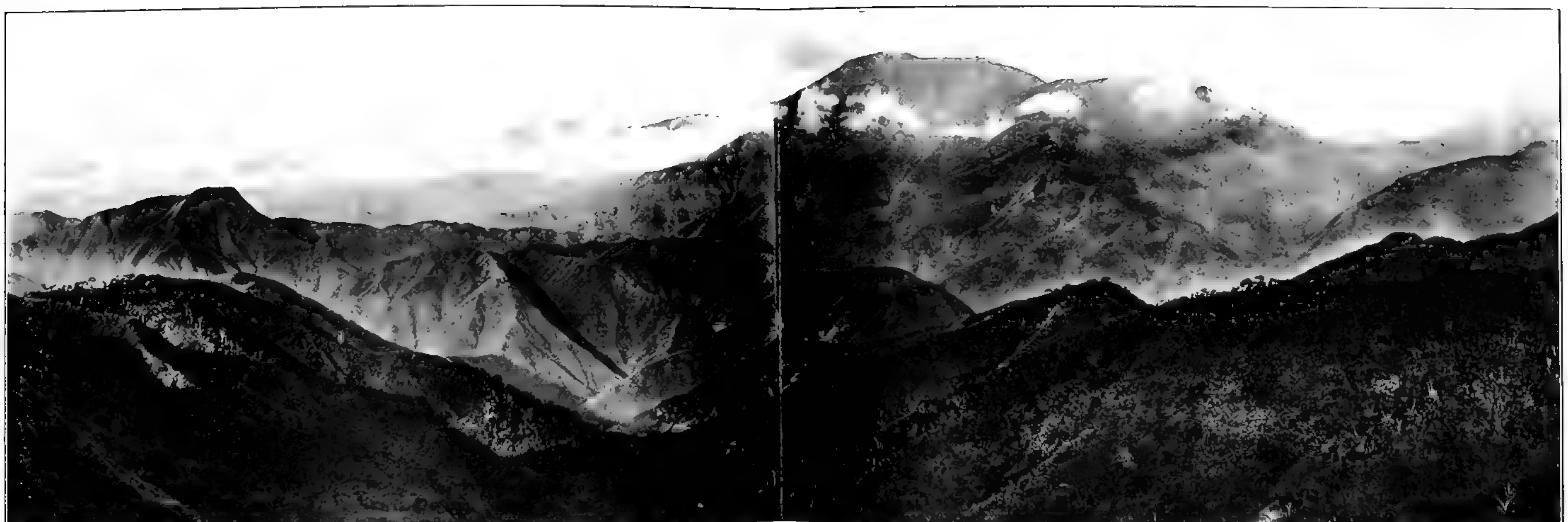


FIG. 3. THE HIGHEST PEAK OF THE MOUNT POLIS RANGE, CALLED ALAUITAN BY SOME IFUGAOS.

PLATE I.

COUNTRY OF THE IFUGAOS, LOOKING EAST FROM MOUNT POLIS.

PLATE II.

FIG. 1. TYPICAL IFUGAO HOUSE.

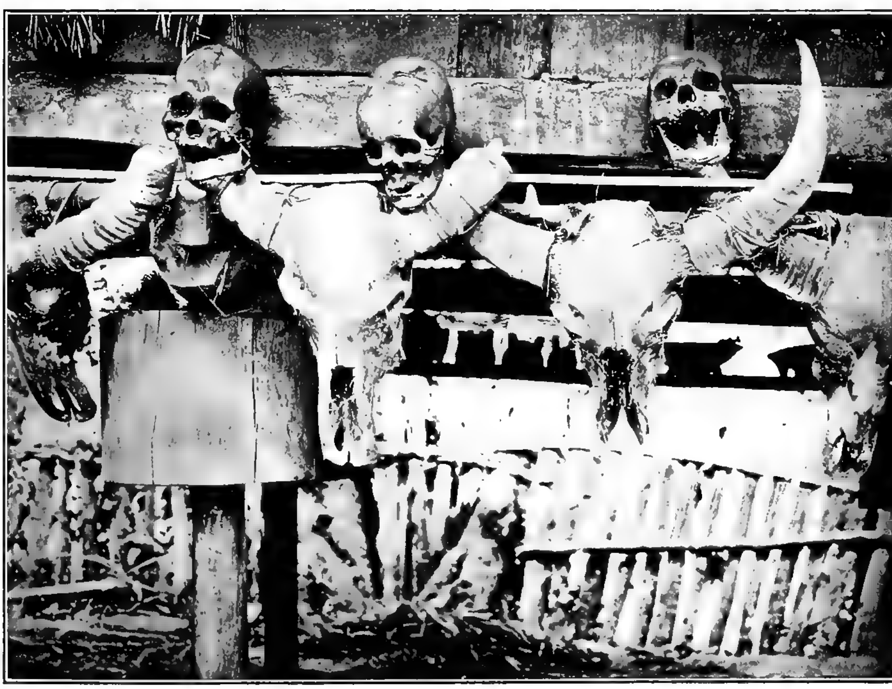
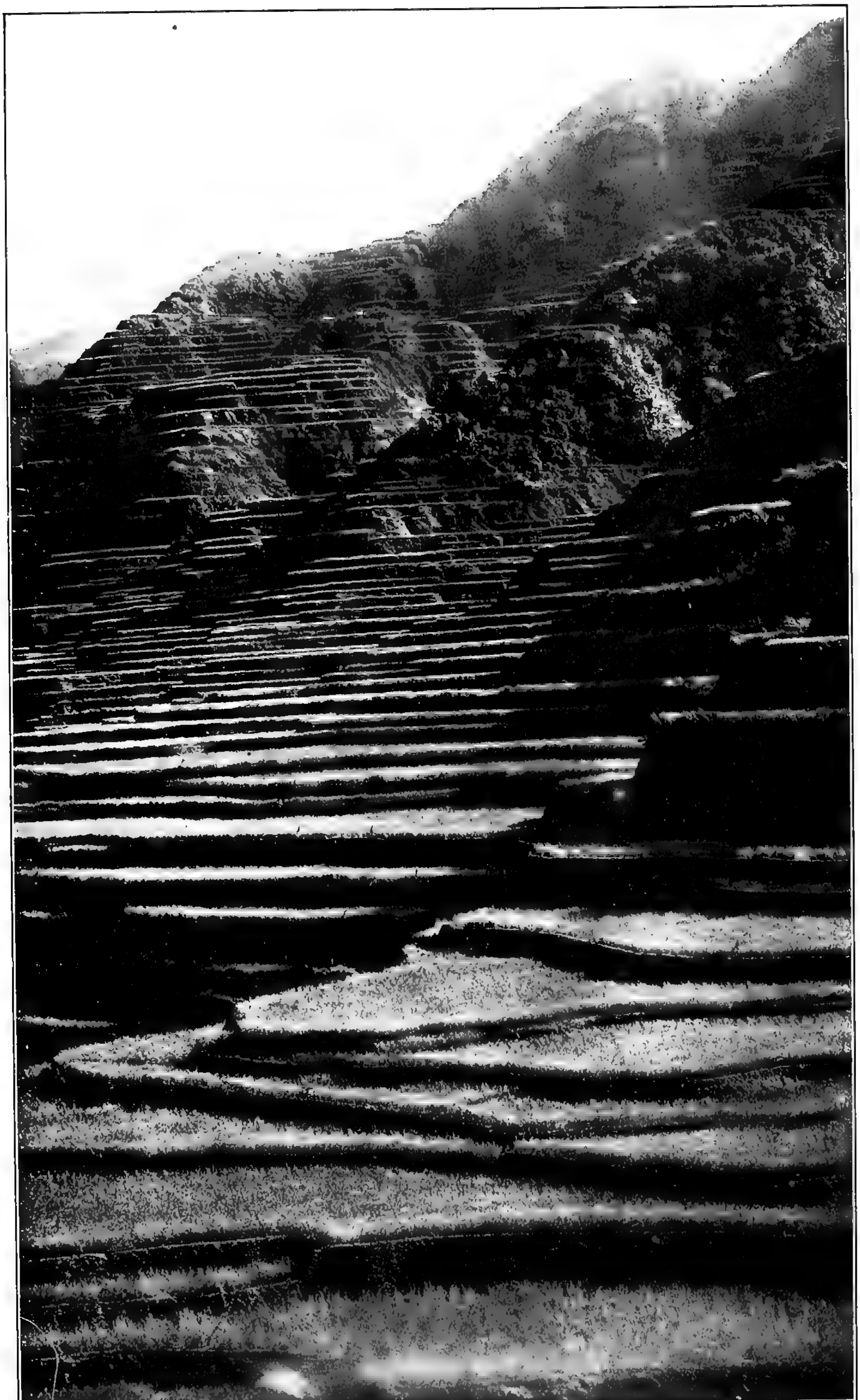


FIG. 2. PART OF AN IFUGAO HOUSE ORNAMENTED WITH SKULLS.

PLATE III.



IFUGAO RICE TERRACES WITH STONE RETAINING WALLS, BANAUE.

PLATE IV.

IFUGAO RICE TERRACES WITH STONE RETAINING WALLS.

PLATE V.

FIG. 1. IFUGAOS WITH WOODEN SHOVELS, BANAUE.

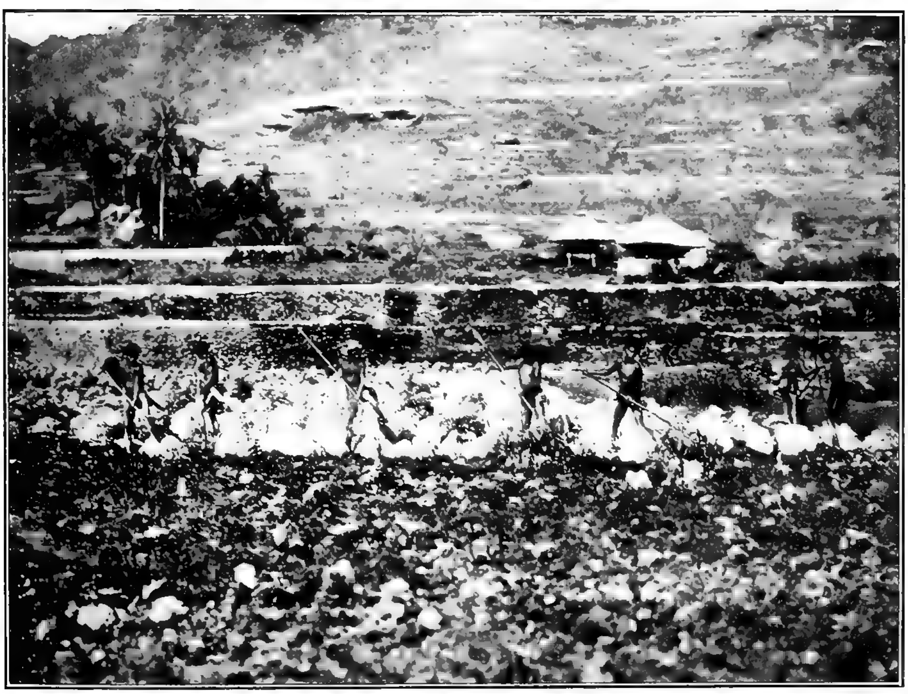


FIG. 2. IFUGAOS WORKING IN RICE TERRACES WITH WOODEN SHOVELS.

PLATE VI.

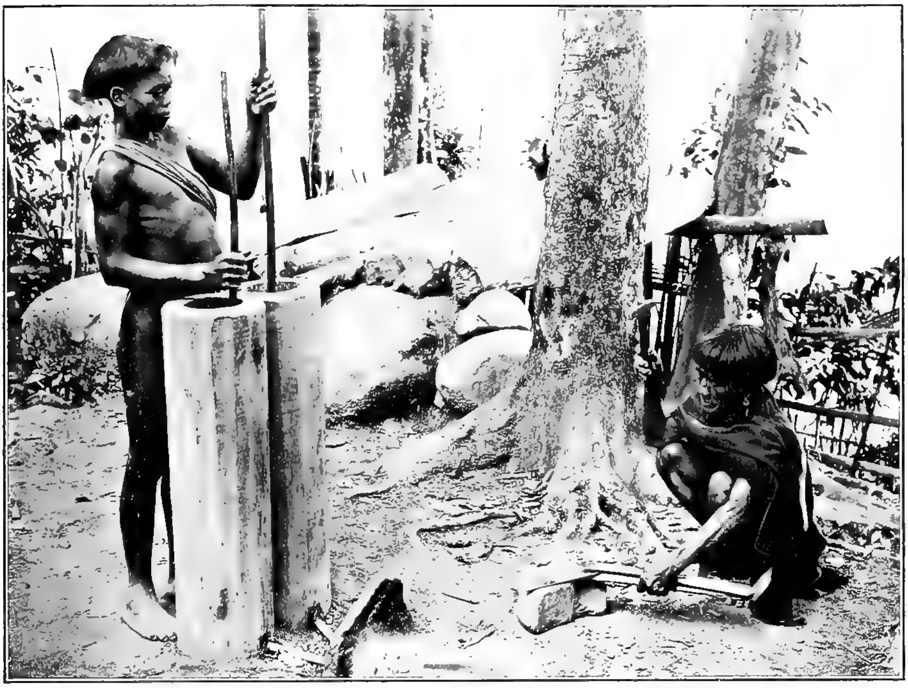


FIG. 1. IFUGAO BLACKSMITH'S SHOP, SAPAO.

FIG. 2. TYPICAL IMAGE, AND "TAGÁBI" OR CARVED SEAT.

PLATE VII.

FIG. 1. IFUGAOS DANCING, QUIANGAN.

FIG. 2. IFUGAO LANCES AND HATS, BANAUE.

PLATE VIII.

FIG. 1. IFUGAO WOMAN WEAVING.

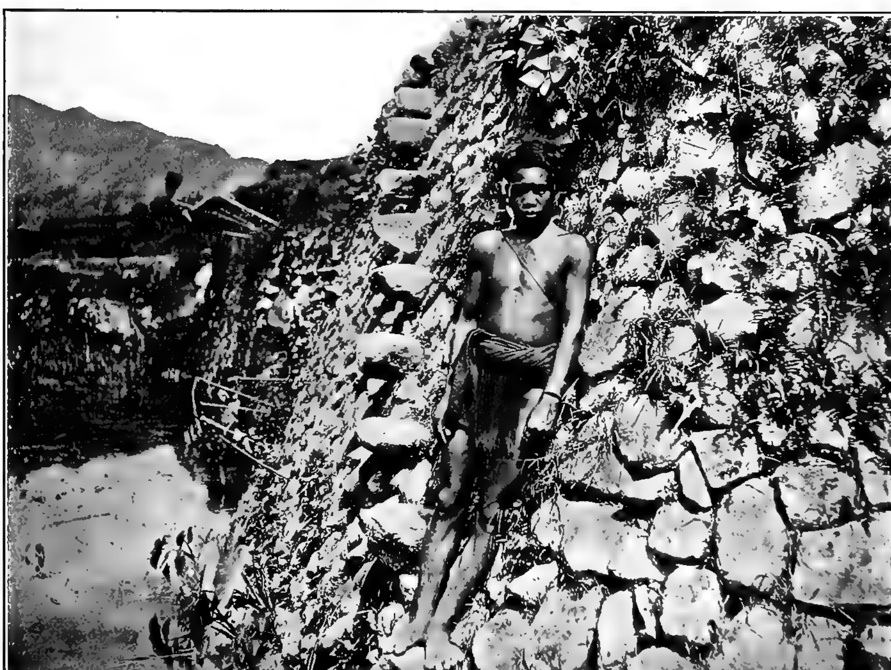
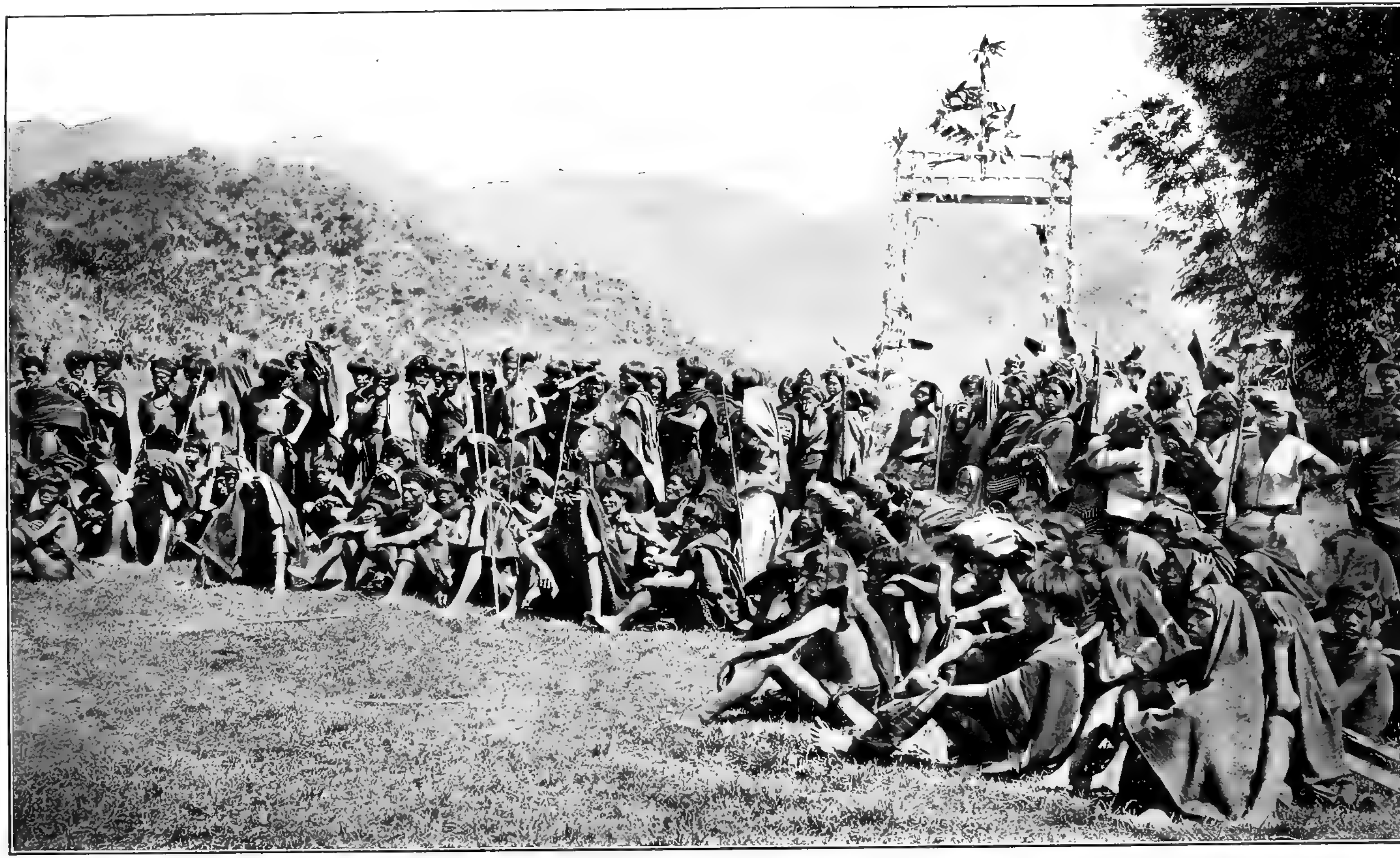


FIG. 2. STONE RETAINING WALL OR "PILAPIL" WITH PROJECTING STEPS.

PLATE IX.

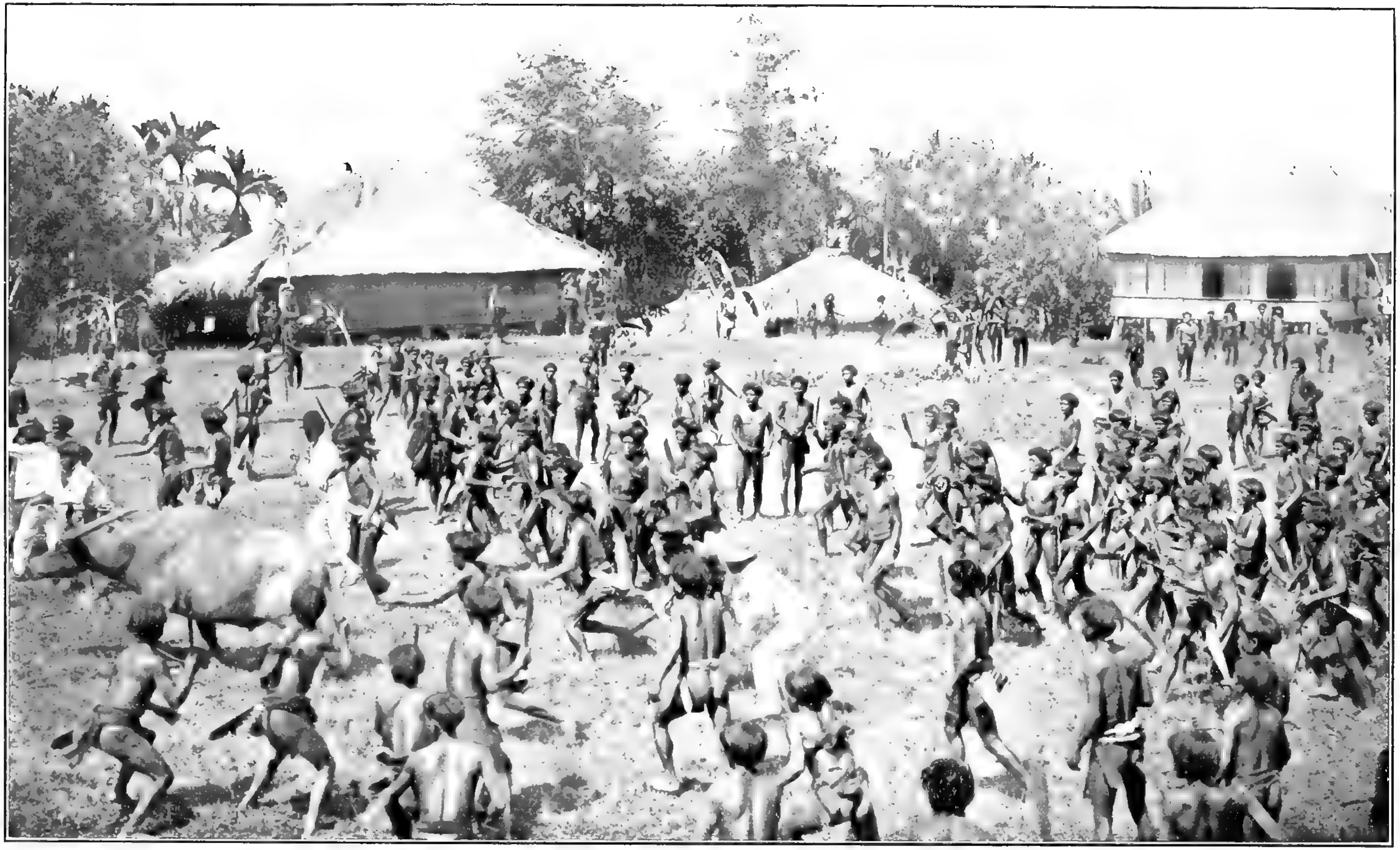
WOODEN SPOONS AND IMAGES.

PLATE X.



PART OF A CIRCLE OF IFUGAOS WATCHING A DANCE, QUIANGAN.

PLATE XI.



IFUGAOS CUTTING DOWN A CARABAO WITH WAR KNIVES.

PLATE XII.

IFUGAOS STRUGGLING FOR CARABAO MEAT.

PLATE XIII.

TYPICAL IFUGAO MAN AND WOMAN.

PLATE XIV.

FIG. 1.

FIG. 2.

TYPICAL IFUGAO MAN AND WOMAN.

PLATE XV.

I. FILIPINO TYPES: MANILA STUDENTS. AN ATTEMPT TO CLASSIFY THE LITTORAL POPULATION OF LUZON AND ADJACENT ISLANDS.

By Robert Bennett Bean.

(*From the Anatomical Laboratory, Philippine Medical School, Manila, P. I.*)

INTRODUCTION.

Previous attempts have been made to classify the Filipino peoples, but each has included only an incomplete survey of the population. It is hoped that by making a consecutive series of observations such as I have carried on covering the mountain districts, the lowlands, and the littoral population, and by taking a random sample from all the culture levels, a more complete analysis of the physical types that make up the population of the Philippine Islands may be made, the origin of the people discovered, present tendencies of amalgamation revealed, and future conditions predicted. I shall classify types by physical characteristics, and not alone by locality. The littoral population of the Philippines is one of the most mixed in the world, and the physical types are complex, but it is by means of this very complexity that obscure problems of heredity may be made clear. The types of man that have crossed are so dissimilar that characters may be traced more readily than if they were similar.

Worcester(30) writes with full knowledge at first hand of the non-Christian tribes of northern Luzon, and gives a classification that is valuable ethnologically and sociologically. Virchow(28) and Blumentritt(7) have written of the Filipinos from a distant point of view, in an attempt to classify the people physically, and A. B. Meyer(18,19,20) measured the Igorots and Negritos. Montano(21) and Folkmar(12) measured the living Filipinos and classified them in local groups.

Montano classifies the Filipinos by physical characters and locality into Negrito, Indonesian, and Malay: the Negrito occupying the mountain wilds of the Islands, the Indonesian the fertile interior, especially of Luzon and Mindanao, and the Malay occupying the coast lands. It is to be supposed that the littoral population is at present largely Malay, to which have been added Chinese and European elements, and in which still remains a remnant of Negrito and Indonesian. At present, American and Negro mestizos are springing up in almost every part of the Islands, making a rich field for the racial anatomist.

The Malays, according to Montano, are divided into local groups, such as Bicols, Visayans, Tagalogs, Ilocanos, etc., and as this classification is followed by Folkmar and others, I shall compare their measurements with mine in similar groups, by means of tables, at the end of this paper. (Tables 2, 3 and 4.) Montano and Folkmar confined their observations to types selected to represent the locality from which they came, whereas I have measured students as I could get them in the Philippine Normal School and the School of Arts and Trades; both of these institutions are located in Manila but receive students from all parts of the Archipelago.[1] Montano's and Folkmar's measurements were of the common people whereas mine are of students, presumably from the better classes, and some of them are mestizos; therefore foreign blood and nurture must be considered in a comparison of the measurements.

Only individuals 18 years old and upwards are included in this study and only the anthropomorphic characters are utilized here, the remainder being reserved for future publication as a comparative study of school children. My thanks are due to Mr. Beattie, principal of the Philippine Normal School, for his kindly coöperation in the work. It was undertaken primarily as a study of school children, hoping that a knowledge of the teeth, the physical condition, and other data would be of assistance in guiding those who are interested in the fundamental principles of sociology.

CARDINAL ANTHROPOMORPHIC CHARACTERS.

DISCUSSION OF THE OBSERVATIONS ON 377 STUDENTS.

The average stature of 377 students is 163.3 centimeters, the cephalic index 82.1 centimeters, the nasal index 82.55 centimeters, the head length 18.4 centimeters, the head width 15.1 centimeters, the nose length 4.56 centimeters, and the nose width 3.76 centimeters. The nose is wider, the head longer, and the stature greater than that of the Bilibid prisoners measured by Folkmar (12). The stature is greater, the nose is narrower, and the head is wider than that of the Igorots (2). The stature and cephalic index are about the same as the middle European or Alpine stock as represented by the people of central France (10,24).

The mestizos are separated from the Filipinos and curves of stature, cephalic index, and nasal index are constructed to represent the individual in the mass and to show the mode and the extremes. (Charts I, II, and III.) The curves may be interpreted to indicate by their summits the

[1] The measurements of a few natives of the littoral population made at Baguio and elsewhere are included in this study. For details as to method of measurements, see "The Benguet Igorots," *This Journal, Sec. A* (1908), **3**, No. 6, 413. The circumferences of the forehead, parietal, occipital, and frontal regions are all taken from the root of the zygomatic process and extend over the most prominent part of each region, that of the forehead passing above the brow ridges.

types that have mingled in the formation of the present population of the Islands. The curves for cephalic index show the majority of mestizos to be below 80 and the majority of the Filipinos to be above that number. The curves for stature show great homogeneity, especially for the Filipinos, but less for the mestizos, which is due to greater diversity of type among the mestizos, and to the fact that stature is more plastic than head form, more subject to selection and environment. The curve for nasal index with its Gothic spires and cathedral form has summits that are more distinct than those of the cephalic index. The majority of the Filipinos have a high index (wide noses), and the majority of the mestizos have a lower index.

Recent observations in the study of heredity indicate that, in some cases at least, heredity is neither exclusively alternate (Mendelian) nor exclusively blended, but may be neither (9) or both (2,16). In any study of heredity, at least two kinds of variation must be considered: The variation due to environment, and that due to crossing opposite extremes of the same character such as black and white color. When these two varieties of variation do not overlap there is no confusion, but when they do, endless confusion may result. With this in mind, we may consider the physical characteristics of the Filipinos in the light of the recent work of Spillman (27). Schull, in hybridizing corn, "looks upon a cornfield as simply a heterogeneous collection of elementary species and hybrids between them," and Spillman accounts for these elementary species on the "old Darwinian idea of gradual evolution" by a simple scheme shown by I, II, and III:

I.

1	2	3	4	5	6	7	8	9	10
A^1	A^2	A^3	A^4	A^5	A^6	A^7	A^8	A^9	A^{10}
B^1	B^2	B^3	B^4	B^5	B^6	B^7	B^8	B^9	B^{10}
C^1	C^2	C^3	C^4	C^5	C^6	C^7	C^8	C^9	C^{10}

II.

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A^1		A^5		A^1	A^1	A^1	A^1	A^5	A^5	A^5	A^5
B^3	+	B^8	=	B^3	B^3	B^8	B^8	B^3	B^3	B^8	B^8
C^2		C^6		C^2	C^6	C^2	C^6	C^2	C^6	C^2	C^6

III.

(1) + (1) =	A^1	A^1	B^3	B^3	C^2	C^2
(2) + (2) =	A^1	A^1	B^3	B^3	C^6	C^6
(3) + (3) =	A^1	A^1	B^8	B^8	C^2	C^2
(4) + (4) =	A^1	A^1	B^8	B^8	C^6	C^6
(5) + (5) =	A^5	A^5	B^3	B^3	C^2	C^2
(6) + (6) =	A^5	A^5	B^3	B^3	C^6	C^6
(7) + (7) =	A^5	A^5	B^8	B^8	C^2	C^2
(8) + (8) =	A^5	A^5	B^8	B^8	C^6	C^6

All types in III are derived from two types or elementary species, A^1 B^3 C^2 and A^5 B^8 C^6, A, B, and C being separable unit characters that obey Mendel's laws in cross mating.

Let A represent a Mendelian character that is variable and the differences of which are hereditary. Let B and C represent similar characters. The exponents represent the degree of difference between the characters, any two adjacent ones being so slightly different from each other as to appear to be exactly alike, but the difference between alternates is sufficient to be recognized and those that are far apart, as A^1 and A^{10}, are extremely different. Some of the intermediates may have disappeared leaving gaps not bridged over by living forms. The differences may have accumulated gradually throughout the time of the evolution of the structure and each one of the series now existing is fixed within the limits of environmental variation.

In order to illustrate the application of this scheme to the Filipinos under consideration, suppose that the three characters, stature, cephalic index, and nasal index are represented by A, B, and C, respectively. Let A^1 be a stature of 145 centimeters, and A^{10} a stature of 190 centimeters, with the other powers of A equivalent to the intervening statures at intervals of 5 centimeters for each power. Let B^1 represent a cephalic index of 72.5 and B^{10} one of 95.0, and C^1 represent a nasal index of 55 and C^{10} one of 100 with intervening indices accordingly, represented by the intervening powers of B and C. It will be seen that the exponents represent fairly well the summits of the curves of stature, cephalic index, and nasal index, therefore it may be inferred that the choice of values represented by the exponents is good, because they are actual points about which the characters fluctuate presumably by reason of enviroment. A hypothetical individual in which the gametic constitution is A^1 A^5 B^3 B^8 C^2 C^6, (the result of the marriage of two individuals with a gametic constitution of $2A^1$ B^3 C^2 and $2A^5$ B^8 C^6, respectively) when married to an individual of like gametic constitution, has the possibility of producing eight types that breed true and may be called elementary species (II and III). What really takes place among men remains to be determined, but if Mendelian characters in man follow the same course that they do among animals and plants in cross breeding, the above possibility becomes a strong probability.

We may now proceed to find what combinations of stature, cephalic index, and nasal index are found among the 377 Filipinos under consideration, and in this way select types that represent more or less homogeneous entities from which inferences may be drawn in confirmation of, or opposition to, Spillman's ideas regarding elementary species, especially in reference to man. These inferences can be firmly established only by measuring three or more generations in many families.

TYPES—INDIVIDUAL CHARACTERS.

The cephalic index is selected as the basis for the classification of types by individual characteristics, the nasal index is correlated with this and the stature is subordinated to the two in the following manner:

The group of cephalic indices as denoted by the curve (Chart II) at 74 to 78, 79 to 81, 82 to 84, 85 to 89, and 90 to 100, are segregated. It is found that the group at 74 to 78 may be subdivided by the nasal index into wide and narrow nosed types, and that the wide nosed type has a smaller stature than the narrow nosed type. The latter will be designated as modified Iberian because many mestizos are in the group, and the characteristics are similar to the Iberian type of Europe(10,25,26). The former will be designated as Australoid because it resembles a type similar to the Australian found among the Igorots(2). To this group also belong those individuals with cephalic index less than 83 and nasal index more than 12 above or below it.

The group 90 to 100 may also be subdivided by the nasal index into wide and narrow nosed types, and each of these may be divided into tall and small stature, the tall being largely mestizo and the small largely Filipino. The small are designated as Primitive, Modified Primitive, and Modified Alpine, the tall as Modified B. B. B. and Modified Adriatic. To this group also belong those individuals with cephalic index 83 and over and nasal index more than 12 greater or 12 less than the cephalic index.

The remainder with cephalic indices from 79 to 89 may be divided into three groups with mean cephalic indices of 80, 83, and 86 respectively and the nasal index of any individual less than 12 points above or below the cephalic index. The three groups are united to represent the fusing product of all types, or the average Filipino of the present, because of the homogeneity of the individuals and the large number in these groups.

MODIFIED IBERIAN TYPE.

There are 25 students of this type, of whom 16 are mestizos, and they come from the Provinces of Batangas, Bulacan, Rizal, Cavite, Mindoro, Zambales, Ilocos Norte, Pangasinan, Pampanga, Laguna, and the city of Manila. They are differentiated from other students primarily by stature, cephalic index, and nasal index, but a list of characteristics is presented that may also show differences. (Table I.)

This is one of the most distinct types and corresponds to the Mediterranean Race of Sergi(26), therefore it is taken as a standard with which to compare the remaining types. It is unlike the prehistoric Cro-Magnon of Europe(8) because of its smaller size and harmonic face, but the large occipital region and the relatively large face compared with the other types may indicate Cro-Magnon affinities. The Iberian and Cro-Magnon of Europe are related types, but the evidence here is very slight in confirmation of this relationship.

The stature is 1 centimeter more than that for the whole number of students, and the cephalic index and nasal index are each about 10 less. The morphologic face index is greater than that of the Igorots by 7, and the physiognomic face index is less by 2. The distance from chin to nasion is 8 millimeters more than for the Igorots, the distance from chin to hair line is 4 millimeters more, and the width of the face is 2 millimeters less. The head length is 4 millimeters more than for the Igorots, the head width is 1 millitemer less and the head height is 1 millimeter more. The average age is 7 years less than that of the Igorots.

In brief, this type is of medium height, with narrow head, nose, and face. The head and face are small and the individuals are thin. They are young and have bad teeth. Only one has hair that is not straight, and all have coarse, black hair except one that has fine brown hair.

AUSTRALOID TYPE.

Thirty students are of this type, and only 7 are mestizos. They are differentiated from other students in the same way as the Iberian type, and all the other types are differentiated in the same manner. The stature is below the medium height, the head is narrow, the nose and face are wide. Only one has wavy hair, the others have straight. The individuals are all young and thin. They come from Laguna, Samar, Bulacan, Rizal, Leyte, Pampanga, Albay, Cavite, Tayabas, and the city of Manila.

The characteristics of this type may be emphasized by contrast with the Iberian which it resembles in head shape and stature, although it is not quite so tall and dolichocephalic. (Table 1.) The nasal index of the Australoid is almost 20 higher than that of the Iberian, the morphologic face index is 5.3 higher, and the number of decayed teeth is 20 per cent less than with the Iberian type, and there are twice the number of individuals who have no decayed teeth; in other characteristics the two resemble each other closely.

Were it not that a type almost exactly the same as the Australoid was found among the Igorots and in about the same proportion to the whole number examined, it would seem that this is the result of the crossed Iberian and Primitive type of the Spanish and Filipino people, respectively, but among the Igorots there are no recent Iberians nor is there evidence of any that have recently come into contact with the Igorots. Therefore, I believe as stated in my recent work on the Igorots(2), that this type forms one of the primitive elements of the Filipinos. A comparison of the students of this type with the Igorots of the same type and with the Iberian as given in the following table may be of interest:

	Cephalic index.	Nasal index.	Stature.
Igorot	75.1	97.7	146.6
Student	76.8	92.7	161.0
Iberian	75.2	73.9	164.3

The stature of the Igorot is less than that of the student, but the cephalic index and nasal index are almost the same. The cephalic index of the student is slightly greater than either that of the Igorot or of the Iberian, which may be due to the influence of the Primitive type. The nasal index is less than the others, and may be due to the same influence coupled with that of the Iberian, and like influences may have altered the stature.

The disharmonic physiognomy suggests the Cro-Magnon of prehistoric Europe (8), but the small size of the individuals in every dimension almost precludes any relationship, unless environment accounts for the differences. The Cro-Magnon of Europe was noted for great height; long, high, narrow head; prominent occipital region; and large, square face. If the Australoid type is a remnant of the Cro-Magnon, great changes have taken place.

In conclusion then, the Australoid type among the students resembles the same type among the Igorots in cephalic index, nasal index, and physiognomic face index, and it differs from the Iberian in nasal index, morphologic face index, and number of decayed teeth, in which characters it resembles the following type.

PRIMITIVE TYPE.

Only nine students of this type occur in 377, a comparatively small number, but the type justifies itself because of its distinctive characters. (Table 1.) The head is wide, the nose and face are wide, and the stature is small. Two of the nine have wavy hair; 40 per cent have no decayed teeth and the average number of decayed teeth is 3 less than the Iberian and 2 less than the Australoid; there are no mestizos among them; they come from the Provinces of Rizal, Bulacan, Ilocos Sur, Cavite, Pangasinan, Leyte, and Union.

The cephalic index of this type is about 10 higher than the Iberian, the nasal index is 12.6 higher, and the stature is 13.5 centimeters lower. The head length is 1.3 centimeters less than the Iberian, the head width is 8 millimeters greater, the nose is 9 millimeters shorter, and 1 millimeter wider, and the face is 1 centimeter shorter and 3 millimeters wider. The parietal circumference is 1.2 centimeters more than the Iberian, the occipital circumference is 9 millimeters less, but the other circumferences are not so different. However, the fronto-parietal index is 2 less than the Iberian, the forehead-occipital is 1.4 more, the forehead-parietal is 3.5 less and the occipito-parietal is 1.7 less. This means that the parietal region is well developed and the occipital region is poorly developed in relation to the Iberian type, or the converse, the parietal region is poorly developed and the occipital region is well developed in the Iberian in relation to this type.

The teeth are notably free from cavities or any irregularities, and are the best teeth of all examined among the 377 students. The age is a little more than that of the Iberian, therefore the differences are not due to less maturity. This type is believed to be a primitive precursor of the Filipino, but whether Negrito or some other it is difficult to decide.

MODIFIED PRIMITIVE TYPE.

Forty-six individuals of this type appear of whom none are mestizos and 7 have wavy or curly hair. They come from Laguna, Ilocos Sur, Bulacan, Pangasinan, Nueva Viscaya, Cavite, Cagayan, Pampanga, Nueva Ecija, Ilocos Norte, Batangas, Union, Negros, Rizal, Capiz, Masbate, Tayabas, Iloilo, Romblon, Zambales, Bataan, and two from the city of Manila.

This type is below the average stature, very broad headed and broad nosed, and has a short, wide face. The frontal and parietal regions are relatively well developed, and the occipital region is poorly developed. In addition, the teeth are sound, the individuals are further advanced in age, and the weight is a little greater in proportion to stature than the average. (Table 1.)

Compared with the Iberian type the cephalic index is 10.4 greater, the nasal index is 19 greater, the stature is 4.2 centimeters less, the morphologic face index is 6.9 less, and the physiognomic face index is 3.9 greater. The head length is 1.2 centimeters less, the head width is 9 millimeters more, and the head height is 1 millimeter more. The nose length is 7 millimeters less and the nose width is 3 millimeters more. The lower face height is 6 millimeters less, the upper face height is 4 millimeters less, and the bizygomatic width is 4 millimeters more. The frontal circumference is 8 millimeters more, the parietal circumference is 4.5 millimeters more, the forehead circumference is 1 millimeter more, and the occipital circumference is 15 millimeters less.

This type is similar to the Primitive except in stature, in which it is not only about 10 centimeters greater, but in which there is no overlapping of the extremes between the two. The wavy hair and the broad nose indicate Negrito affinities. The type is probably the Primitive modified by European types and mixed with some Negrito blood. The head, nose, and face are wider than the people of the Malay peninsula (17) and the stature is higher.

MODIFIED ALPINE TYPE.

There are 30 students of this type of whom 8 are mestizos. They come from Ilocos Sur, Rizal, Union, Nueva Ecija, Bulacan, Leyte, Iloilo, Laguna, Tayabas, Batangas, Mindanao, Zambales, Ilocos Norte, Cavite, Marinduque, Lubang Islands, Capiz, Pampanga, Batangas, Isabela, Negros, Pangasinan, the city of Manila, and the father of one is from Spain.

This type is below the average stature, very broad headed, very narrow nosed, and it has a face intermediate between the Iberian and Primitive. The head size is like that of the Iberian except in the occipital region where it is like the Primitive. In addition, this type has very good teeth and is not fat. No wavy hair is found. (Table 1.)

Compared with the Iberian, this type has the cephalic index 11.7 greater, the nasal index 1 less, the stature 4.1 centimeters less, the morphologic face index 3.6 less, and the physiognomic face index 2.9 greater. The head length is 1.5 centimeters less, the head width is 8 millimeters more, and the head height is 0.6 millimeter less. The nose length is 0.7 millimeter less, that nose width is 0.8 millimeter less. The lower face height is 2.5 millimeters less, the total face height is 3.3 millimeters less, and the bizygomatic width is 2.8 millimeters more. The frontal and parietal circumferences are the same, the forehead circumference is 3 millimeters less, and the occipital circumference is 1.3 centimeters less.

The nearest living related people are the Alpine of middle Europe (10, 25) who are represented to some extent among the Spaniards. The type is therefore called modified Alpine, and represents a blend of Spanish and Filipino. Some Chinese may be present because three individuals are noted as resembling Chinese, and the Alpine Chinaman is a type often seen in Manila (4).

MODIFIED B. B. B. TYPE.

The 21 students of this type have indications of both Spanish and Chinese characteristics. Five are mestizos, 10 resemble Chinese, and 1 has wavy hair. They come from the Provinces of Pampanga, Bulacan, Batangas, Cavite, Nueva Viscaya, Nueva Ecija, Rizal, Zambales, and the city of Manila, all from the Island of Luzon.

The chief characteristics of this type are stature above the average, very wide head, but comparatively narrow face and very narrow nose. The number of decayed teeth is large and the age is above the average. (Table 1.)

Compared with the Iberian this type has the cephalic index 11 greater, the nasal index 1.9 less, the stature 4.5 centimeters greater, the morphologic face index 3.7 less, and the physiognomic face index 2.9 greater. The head length is 1.1 centimeters less, the head width is 1.1 centimeters more, and the head height is 1 millimeter more. The nose length is 1 millimeter more, and the nose width is exactly the same. The lower face height is the same, the total face height is 1 millimeter more, and the bizygomatic width is 6 millimeters more. The frontal circumference is 8 millimeters more, the parietal circumference is 5 millimeters more, the forehead circumference is 4 millimeters more, and the occipital circumference is 9 millimeters less. The size of the regions of the head is almost identical with the Primitive type, but the stature is 8.7 centimeters more, and the nasal index is 20.9 less.

This type represents the blending B. B. B. of the Spanish and Chinese population with the Primitive type of the Filipino people. The B. B. B. is the big cerebellumed, box-headed Bavarian of Ranke, so-called by Beddoe(5), and the type is a prevailing one among the Spaniards of the Philippines. I believe the B. B. B. type is a blend of the Alpine and Iberian of middle and southern Europe, with possibly an infusion of Cro-Magnon and Adriatic, the last two probably related to the Iberian and Alpine respectively as progenitors or offshoots.

The broad head of the Primitive type is combined with the narrow nose of the B. B. B. and the face is a blend of the two types. This is the reverse of the condition found in the Australoid type, where the long head of the Iberian has combined with the broad nose of the Primitive. These two types may, however, represent a recombination in different ways of characters belonging to only two types, one European, the other Eastern; one with long head, long nose, long face, and tall stature, the other with broad head, broad nose, broad face, and small stature. If this be true, it indicates Mendelian tendencies for the four characters mentioned, and there should be found in the total population as many types as the possible combinations of four characters in unit pairs permit, which is 16. There are, however, only 8 types, which is the proper number for three Mendelian characters, stature, cephalic index, and nasal index, by which these types are selected. There is evidence of blending in all, as well as the evidence of Mendelian tendencies, therefore my supplementary theory of heredity fits the conditions(2). The students are probably in an earlier stage of blending than the Igorots, and may be represented by Spurious Mendelism at B^1 and nearer 2 than 3, whereas the Igorots are in the stage of No Mendelism at B 2 near 3.

MODIFIED ADRIATIC TYPE.

There are 24 individuals of this type, of whom 6 show evidences of European characters, 1 is a Chinese mestizo, and 3 others resemble the Chinese. Two have curly hair. The characteristics of the type are stature above the average, very wide head, wide nose, moderately wide face, and well developed frontal region, but poorly developed parietal and occipital regions. A large number have no decayed teeth, but as many have bad teeth, which accounts for the high average number of decayed teeth. The age is above the average. (Table 1.) The individuals come from Union, Bohol, Bulacan, Pampanga, Capiz, Pangasinan, Tayabas, Iloilo, Negros, Rizal, Zambales, Bataan, Laguna, and the city of Manila.

Compared with the Iberian, this type has the cephalic index 12.8 greater, the nasal index 19 greater, the stature 4.3 centimeters greater, the morphologic face index 8.4 less, and the physiognomic face index 4.3 centimeters greater, the head length is 1.4 centimeters less, the head width is 1.1 centimeters more, and the head height is exactly the same. The nose length is 7 millimeters less, and the nose width is 3 millimeters more. The lower face height is 7 millimeters less, the total face height is 4 millimeters less, and the bizygomatic width is 5 millimeters more. The frontal circumference is 5 millimeters more, the parietal circumference is 1 millimeter less, the forehead circumference is 2 millimeters less, and the occipital circumference is 3 millimeters less.

The notable characteristics of this type are the great height, 2 centimeters less than the average for the white race in Europe and America(10), the wide, short head, the wide nose, the short, narrow face, and the well developed frontal region of the head. The nearest related living people are the Adriatic described by Deniker(10) and located on the northern shores of the Adriatic Sea. Except for the stature and the nasal index, both of which are too high, it resembles the Alpine or middle European. The stature is not so great as that of the Adriatic and the nasal index is greater, these differences being caused by the Filipino element. The Chinese influence is evident in the stature, nasal index, and cephalic index.

BLENDING TYPE.

This group of Filipinos with cephalic index ranging from 79 to 89, nasal index from 72 to 93, and stature from 146 centimeters to 180 centimeters, is composed of characters belonging to several types, and an effert will be made to discover what may have been the characteristics of these types. The European, the Primitive, and the Negrito undoubtedly enter into the composition of the Filipino people, but to what extent is each a factor and are the three represented in this group of average Filipino students? In order to answer these questions the group is analyzed as follows:

The cephalic index is first divided into three groups about 80, 83, and 86.

Cephalic index by groups—males—blending type.

Cephalic index.	77.	78.	79.	80.	81.	82.	83.	84.	85.	86.	87.	88.	Total.
About 80	3	16	21	23	19	8	------	------	------	------	------	------	90
About 83	------	------	------	------	------	16	22	19	4	------	------	------	61
About 86	------	------	------	------	------	------	------	------	10	14	6	6	36
Total	3	16	21	23	19	24	22	19	14	14	6	6	187

The divisions between the groups are made by using the nasal index as a differentiating factor. Those with a cephalic index of 82 and a nasal index below 80 are put into the group "about 80," whereas those with a cephalic index of 82 and a nasal index above 80 are put into the group "about 83." Likewise those with a cephalic index of 85 and a nasal index below 80 are put into the group "about 83," whereas those with a cephalic index of 85 and a nasal index above 80 are put into the group "about 86." This is a somewhat arbitrary method but I believe it represents a real natural grouping.

Using the cephalic index as grouped, the nasal index is compared with it.

Nasal index by groups—males—blending type.

Nasal index.	70.	72.	74.	76.	78.	80.	82.	84.	86.	88.	90.	92.	Total.
Cephalic index about 80		3	13	8	12	17	9	7	8	5	7	1	90
About 83			7	6	14	14	3	8	4	2	1	2	61
About 86			1	1	2	9	7	7	8	0	1		36
Total		3	21	15	28	40	19	22	20	7	9	3	187

In this table four groups of nasal indices are apparent but to show the relation of nasal index to the three groups of cephalic index the table may be simplified by condensed grouping in percentages.

Nasal index by groups—males—blending type—percentages.

Cephalic index.	Nasal index.			
	72 to 77.	78 to 83.	84 to 89.	90 to 93.
About 80	27	42	22	9
About 83	21	51	23	5
About 86	6	50	41	3
Total	54	143	86	17

A glance at this table will show that the nasal index varies slightly with the three groups of cephalic index, the percentage of extremes constantly decreasing with increase of cephalic index, whereas the percentage of intermediate nasal indices increases with increase of cephalic index. The correlation of nasal index and cephalic index is closer in the group with cephalic index "about 86" than in the other groups, there is less "spread" of nasal index, and the average or mean is higher. This indicates that the group about 86 is more homogeneous than the other two in the relation of cephalic index to nasal index, and this group may be segregated as a type whereas the other two are so heterogenous as to be considered only a group of blends.

The stature adds confirmation to the justice of this separation and approves the type as a reality.

Stature by groups—males—blending type.

Cephalic index.	Stature.																		
	146.	148.	150.	152.	154.	156.	158.	160.	162.	164.	166.	168.	170.	172.	174.	176.	178.	180.	Total.
About 80	----	----	----	----	2	4	5	16	17	13	10	9	6	2	2	3	0	1	90
About 83	1	0	0	3	2	2	5	8	8	6	7	8	6	3	2	----	----	----	61
About 86	----	----	1	2	2	4	6	5	1	3	4	3	2	0	2	0	1	----	35

This table may be simplified by condensed grouping in percentages.

Stature by groups—males—blending types—percentages.

Cephalic index.	Stature.		
	Below 160 centimeters.	160 to 165 centimeters.	Above 165 centimeters.
About 80	12	51	37
About 83	21	37	42
About 86	25	33	42

A glance at this table shows that the number of individuals with both small and large stature increases with increase of the cephalic index, and the group with a cephalic index about 86 has a greater percentage of large than of small stature. In the latter respect the group about 83 is similar, whereas the group about 80 is different, and it is also more homogeneous than the other groups. When the ratio of nasal index to cephalic index is compared with the stature above 165 centimeters and the stature below 165 centimeters, the difference in stature bears a constant relation to this ratio in the group "about 86," whereas it is different in the other groups as the following table indicates:

Relation of the ratio of cephalic index and nasal index to stature—blending type—percentages.

	Stature below 16 centimeters.			Stature above 165 centimeters.		
Ratio	−2 to −12	1 to −1	2 to 12	−2 to −12	1 to −1	2 to 12
Cephalic index:						
About 80	13	20	27	12	14	12
About 83	24	16	13	33	10	5
About 86	31	28	0	25	14	3

The ratio of the nasal index to the cephalic index is the difference between the two in any individual and it is represented by the number of points that the nasal index is above (+) or below (—) the cephalic index. For instance, if the cephalic index is 81 and the nasal index is

78, the individual is in the group about 80 under "—2 to —12" and depending upon stature is above 165 centimeters or below 165 centimeters.

One notable fact presented by this table is that, regardless of stature, the group about 86 has nasal indices less than the cephalic, whereas the group about 80 has nasal indices more than the cephalic indices. The group "about 83" is intermediate, especially those with stature below 165 centimeters. The group about 80 is the only one in which the stature apparently alters the ratio. Here those with tall stature have an equal number of nasal indices above and below the cephalic, whereas those with small stature have a greater number with nasal indices above than below the cephalic indices. This represents a tall element with mesocephalic heads and relatively narrow noses, which is probably the Iberian and Cro-Magnon mixed with the Filipino. At the other extreme an element is found with small stature, brachycephalic heads and relatively narrow noses, which is probably the Alpine mixed with the Filipino. There is also an element with low stature, mesocephalic heads, and broad noses which is not of European origin, but mixed Australoid and Primitive, and another element with tall stature, moderately brachycephalic heads, and relatively narrow noses, which is probably the B. B. B. and Adriatic mixed with the Filipino. There is also a large element with intermediate stature, moderately brachycephalic heads and relatively small noses which is probably the ultimate blend of the other types and represents the Filipino of the future. Chinese elements which are similar to the Filipino and European types previously described enter into this blending type(4). Negrito elements are present as indicated by the curly hair, of which 2 per cent are found in the group with cephalic index about 80, 10 per cent in the group with cephalic index about 83, and 9 per cent in the group with cephalic index about 86. The increased percentage of curly hair with increase of cephalic index points to Negrito rather than European influence, although the latter can not be excluded in accounting for the curly hair or broad head.

The remaining characteristics of the blending type are presented in detail in Table 1.

Only 30 mestizos belong to this type and of these 13 are found among the 35 tall, mesocephalic individuals with narrow noses that belong to the Iberian-Cro-Magnon group mentioned above on this page. Other indications that the Cro-Magnon influence is expressed in this group are that the sitting height is 1 centimeter more than the total of the blending type, the head length is 5 millimeters more, the total face height is 5 millimeters more, the bizygomatic width is 2 millimeters more, and each head circumference is 4 millimeters more, all of which brings this group nearer to the dimensions of the prehistoric Cro-Magnon than is any other type of Filipino(8).

Compared with the Iberian the blending type has the morphologic face index 4.2 less, and the physiognomic face index 2.4 greater. The head length is 1 centimeter less, the head width is 5 millimeters more, the head height is 1 millimeter more. The nose length is 3 millimeters less, and the nose width is 3 millimeters more. The lower face height is 4 millimeters less, the total face height is 3 millimeters less, and the bizygomatic width is 2 millimeters more. The frontal circumference is 2 millimeters more, the parietal circumference is 1 millimeter more, the forehead circumference is 2 millimeters less, and the occipital circumference is 9 millimeters less. The number of decayed teeth is 2.1 less, and the age is 1.3 years more. The cephalic index is 7.2 more, the nasal index is 10.9 more, and the stature is 5 millimeters less.

The blending type is below the average European stature(10), and would be considered small in comparison, the head is moderately brachycephalic, and the nose is mesorhinian. The face is wide and short. The type which is nearest this one in all dimensions should be the one which has exerted the greatest influence in molding the blend. A survey of the types in the following table reveals the differences:

Differences between the blending type and the other types.

Type.	Standing Stature.	Cephalic index.	Nasal index.	Morphologic face index.	Physiognomic face index.	Stature sitting.	Weight.	Decayed teeth.
Modified Iberian	0.5	7.2	10.9	4.2	2.4	0.6	0.3	2.1
Australoid	16.8	5.6	7.9	1.1	0.7	1.8	1.3	1.1
Primitive	13.0	3.1	1.7	3.6	3.6	4.6	5.2	0.8
Modified Primitive	3.7	3.2	8.1	2.7	1.5	2.5	1.3	0.3
Modified Alpine	3.6	4.5	11.9	0.6	0.5	2.0	3.1	0.3
Modified B. B. B.	5.0	3.8	12.8	0.5	0.5	1.9	2.6	1.3
Modified Adriatic	4.8	5.6	8.1	4.0	1.9	1.1	2.5	0.0

The blending type is nearer the modified Iberian in standing stature, sitting stature, and weight; it is nearer the Primitive in cephalic index and nasal index; it is nearer the modified B. B. B. in morphologic face index and physiognomic face index; it is nearer the modified Adriatic in the number of decayed teeth, but the modified Alpine is as near as the modied B. B. B. in physiognomic face index. The Australoid is very near in the two facial indices, the modified Alpine is near in standing stature and the modified B. B. B. is near in sitting stature. The Blending type seems to be molded in body more by the European types, and in head form and nose form by the Eastern types. The face form is also probably molded more by the Eastern types, because it is similar to the Alpine, B. B. B., and Adriatic, and the Alpine is believed to be Asiatic in origin and the Adriatic and B. B. B. are related to the Alpine. The Iberian, then, is the only distinct European type, and the notable differences between this type and the others lie in head form, nose form, face form, and number of decayed teeth.

DISCUSSION.

The Iberian, Alpine, and Adriatic of Europe(10) should be compared with modified types of like nature in the United States(3) and with similar types among the Filipinos in order to establish relationships and differences and, if possible, to determine the trend of development.

	Iberian.			Alpine.			Adriatic.		
	Filipino.	Europe.	United States.	Filipino.	Europe.	United States.	Filipino.	Europe.	United States.
Stature	164.3	161–162	170.8	160.2	163–164	169.4	168.6	168–172	175.0
Cephalic index	75.2	73–76	76.8	86.9	85–87	81.4	88.0	85–86	81.6

The stature of each type is greater in America than in Europe, and greater in Europe than in the Philippines, except the Iberian, which is greater in the Philippines. The Filipino Iberian has Cro-Magnon elements which may account for his greater stature. The cephalic index is more mesocephalic in America and more brachycephalic in the Philippines, except again in the Filipino-Iberian type, which is more dolichocephalic than the American Iberian, but more mesocephalic than the European Iberian. Here again, the influence of the long headed Cro-Magnon as well as the broad headed Primitive explains the difference. The nose of the Filipino is notably wider than that of the European.

The tendency in the Philippines seems to be toward reduced stature, wide heads and noses in so far as the European types are concerned, although the Iberian is only slightly modified. This may be because the Iberian is a purer or an older type than the Alpine, Adriatic, B. B. B. or Cro-Magnon, or because it is more unlike the Filipino types than are the other European ones, and, in spite of crossing with the Filipino, it does not blend. The Iberians may be dominant and the other types recessive or *vice versâ* in cross breeding.

On the other hand, the Filipino types are themselves becoming altered through the influence of the European and in the opposite direction; they are becoming taller, more mesocephalic and less wide nosed. This is evident in the Modified Primitive type, and in the Australoid as compared with the Australoid of the Igorots, as well as in the Blending type as compared with the Primitive and Australoid. The American white and the American negro will in time intensify the increasing stature and decreasing cephalic index, but the nose may continue to be as wide as at present.

It can not be overlooked that the Primitive, the Alpine, and the Adriatic as well as the B. B. B., are related to each other, and are separated only by relative factors such as slight differences in stature, cephalic, nasal, and face indices. This may lead to one of two conclusions: Either the Primitive type represents the fundamental one and the others are products of evolution from it, or the Primitive is a product of the other types as a result of nurture, degeneration, etc., or otherwise the types are different in origin and formation. It is more than probable that the Primitive represents one of the elements of the ground work of the East, and it may be that modified representatives of this type have influenced western Asia and Europe, and it is also more than probable that European elements have migrated eastward and formed the modified types.

The question arises, are the modified European types the result of recent or remote amalgamation? Are they the product of prehistoric or recent European mixtures?

A recent cross will not be so much blended as a remote one in which amalgamation has been continuous(2), unless the types that cross resemble each other closely, in which case amalgamation takes place rapidly. Therefore the Iberian, at least, represents a recent cross, as is probably true of the Alpine, B. B. B., and Adriatic as well. The Cro-Magnon, however, represents an ancient element and belongs to pre-Spanish as well as Spanish times. If the Australoid type is the product of Iberian and Negrito, or Iberian and Primitive, then the Iberian must have been an ancient as well as a modern type to have become blended even in a disharmonic manner, as is the case among the Igorots. The ancient type must have come at an early period in world-time in order to have amalgamated so completely with the others, or else our ideas of the time necessary for complete amalgamation need revision; it must be shorter than has been supposed, and new types are produced in man in a few hundreds of years instead of thousands. It may be that amalgamation is more rapid where early marriages are contracted, promiscuity is practiced, and under certain climatic conditions, where rapid development is the rule. If these three conditions have prevailed in the Philippines, it is possible that diverse types have become blended or amalgamated in short periods of time. However, it is probable that European types entered into the composition of the Filipino people before the Igorots reached the Islands, and it may be that these were the early prehistoric types of Europe, or products of such types as the Cro-Magnon, Laugerie-Chancelede, and Iberian, with also those resembling the Alpine, B. B. B., and Adriatic, such as have entered into the population of the Pacific Islands as far east as Hawaii, and to-day are represented by a remnant in Japan, namely the Aino(1,21,22,28). It is probable that the European types had become diversified before leaving their homes in Europe, or else those represented in the East would all be alike, whereas there are at least two diverse elements, one of which is long headed, long faced, and narrow nosed, and the other wide headed, with moderately narrow face and nose. Further investigations are necessary to determine these questions. At present we can say that at least traces of the Cro-Magnon are found among the Filipinos, the Iberian is present in comparative purity, and the Alpine with its affiliated types, the B. B. B. and Adriatic, are represented to some extent. The blending of all types except the Iberian has progressed a long way toward complete amalgamation, and the resulting product is below the average stature, slightly brachycephalic and moderately wide nosed. Of course this applies mainly to the better classes of the littoral population, and not to the Filipino of the rural districts, or to the non-Christian tribes of the interior of the Islands. At least two types, the Australoid and the Primitive, and probably a third, the Modified Primitive, constitute elements of the littoral population which are other than European in origin, although primitive European elements can not be excluded from the Australoid and the Modified Primitive types.

I have purposely avoided the use of the word Malay because I have been unable to decide to my own satisfaction what type is Malay, if there be such a type. For the same reason I have used the word Negrito sparingly. Judging by the usually accepted knowledge of these two races, the Negrito and the Primitive are alike except in hair texture, and the Malay and the Modified Primitive are alike throughout.

The Primitive type is almost identical with the type N of the Igorots. The following differences are found:

	Stature.	Cephalic index.	Nasal index.	Number.
Primitive	150.8	85.5	86.5	9 in 377
Igorot type N	150.3	84.3	89.4	8 in 104

It is evident that these are the same type, and that it is rarer among the students than among the Igorots. The finding of two types, the Australoid and the Primitive, among the Igorots and among the littoral people of the Philippines is indicative of a similar origin for a part of the two peoples. However, there is a difference between the two peoples in the remainder of the population. No type among the littorals corresponds to type M of the Igorots unless it be the Cro-Magnon, although the B. B. B. is similar in stature and nasal index, but not in cephalic index. The above corroborates my supposition stated in the discussion in the Igorots. The Australoid and Primitive had been mixed with type M before the entrance of the Igorots into the Philippines. These three types constitute the so-called Proto-Malays or Primitive Malays. That two of the types of the Proto-Malays remain in the littoral population may be due to a residue of these people who remained when the Neo-Malays took possession of the lowlands, or it may be because of the fact that the Neo-Malays contained these two types in their composition. The nonappearance of type M in the littoral population may be explained by its absorption or modification by the Neo-Malays, the type not having constituted a part of the latter, which is most probable. The distinctive difference between the Igorots and the littoral population is in the presence of type M among the Igorots and its absence among the littoral population, as well as the presence in the latter of recent European types with greater stature and greater brachycephaly.

M. Moszkowski(22) investigated the natives of east Sumatra (not Malays) and reports two peoples, the Orang Akett and the Orang Sakei, who correspond in physical measurements with the Primitive and the Australoid, as may be seen in the following table:

	Number.	Stature.	Cephalic index.	Morphologic face index.
Orang Akett (Moszkowski)	13	151.88	84.3	193.7?
Primitive (Bean)	9	150.80	85.5	78.8
Orang Sakei (Moszkowski)	117	154.74 to 156.17	73.8 to 75.9	94.8 to 99
Orang Sakei (Pinger)	19	156.16	75.45	96.6
Australoid (Bean)	30	161.00	76.8	89.3

Except for differences in the face index the types are practically the same. The Orang Akett have wooly hair and resemble the Negritos, and the Orang Sakei have wavy hair and resemble the Veddahs and the Senoi of Martin. In spite of the lack of wooly or wavy hair among the Australoid and Primitive, I am convinced that these types are of the same stock as those of the Malay Peninsula(17), of east Sumatra(21), and of Ceylon (Sarasin), as well as other parts of the East(6,15) (Negrito). In the last named places the Negrito element has remained more or less predominant, whereas in the Philippines it has become swamped in the waves of immigration, with consequent loss of the characteristic curly or kinky hair which occurs only rarely.

FORECAST.

If the Australoid and the Primitive types represent the original elements of the Filipinos, and the other types represent modifications caused by Europeans and Chinese, recent and remote, then the individuals of the present population are larger than the original in all physical measurements. Continued immigration of Americans and Chinese will result by interbreeding in further increase of size. With increase of size go increase in bodily and mental vigor. Advance on the part of the Filipinos will be coincident with and incident to the continuation of the amalgamation of the races, although better nutrition, fewer animal parasites, and altered hygiene may assist in the advance.

In future papers I hope to be able to demonstrate the prevalence of certain diseases in definite morphologic types of men in the Philippines, which may indicate the types that fare well in the Tropics, as well as those that do not.

Mention was made in the beginning of the present work, of the summits of the curves of stature, cephalic index, and nasal index which suggested the cornfield of Schull with its "heterogeneous collection of elementary species and hybrids between them," and Spillman's explanation of the elementary species on the "old Darwinian idea of gradual evolution" as represented by a simple scheme which was delineated. The above selection of types is not an attempt to prove or disprove the application of this scheme to man, but is an earnest effort to find the exact composition of a mixed population. That the types fall somewhat into Spillman's scheme goes without saying, and that the summits of the curves correspond to different elements of the character represented by them is also true to some extent. The summit of the cephalic index (Chart II) at 76, represents the Iberian; at 78, the Australoid; at 80 and 83, as well as part of 86, the Blending type; at 86, the Primitive, Modified Primitive, and the B. B. B.; at 88, the Alpine and Adriatic; and at 92 some individuals of the Primitive, Modified Primitive, Alpine, B. B. B., and Adriatic. The summits of nasal index and stature are less exact than those of the cephalic index.

The gametic constitution of the types is as follows, in fulfilment of Spillman's scheme:

Iberian	A^5 B^2 C^5
Australoid	A^4 B^3 C^9
Primitive	A^2 B^6 C^7
Modified Primitive	A^4 B^6 C^9
Modified Alpine	A^4 B^7 C^5
Modified B. B. B.	A^6 B^6 C^4
Modified Adriatic	A^6 B^7 C^9
Blending type	A^5 B^5 C^7

A, in this scheme, represents stature, B, cephalic index, and C, nasal index, with equivalents as mentioned on page 266. Many possible forms are missing and those present are near the median or below, except in the nasal index, where the highest extreme is almost reached. Individual forms probably bridge the majority of the gaps, and a perfect series could be constructed from them.

If plants and animals may be designated as elementary species by Spillman's scheme, on the "old Darwinian idea of gradual evolution," with equal propriety and verity that scheme may apply to man, and types selected above represent elementary species of men who have been formed by the blending of diverse types, as well as by gradual evolution.

MENDELISM AND STUDENT TYPES.

When the types of Manila Students are compared with the polyhybrids resulting from the crossing of two unlike tomato plants, great similarity in the number of polyhybrids and in their relative proportions is found.

Price and Drinkard (24) obtained eight forms of tomato plants upon crossing the Yellow Pear which is "characterized by pyriform shape and yellow color of fruit and green foliage" with the Honor Bright which "possesses the three opposite attributes of round or spherical fruit shape, red fruit color, and yellow foliage color." "In this cross there was noted complete dominance of green foliage color, red fruit color, and round fruit shape."

Suppose the green foliage color represents small stature, the red fruit color represents the round head, and the round fruit shape represents the broad nose; then the three characters combined represent the Primitive and Modified Primitive types. The three opposite characters, tall stature, long head, and narrow nose, represent a hypothetical type not present among the Filipino Students, but which conforms to the Nordic type of Deniker in Europe.

If two such types have crossed to produce the Filipino, then all possible combinations of the characters constituting the two types should be found according to Mendel's law of polyhybrids as formulated by Price and Drinkard:

"When parents differing with respect to more than one pair of characters are crossed all possible combinations of these characters will be found in the F^2 generation and these combinations will occur in a definite numerical proportion." The following table shows the theoretical requirements for a Mendelian trihybrid, the actual proportions secured from 40 plants of the tomato as a result of the cross of the Yellow Pear and Honor Bright by Price and Drinkard, and the proportion of each type found among 377 students of the Trade and Normal Schools at Manila.

Mendelism and Student Types.

Theoretical result for 64 individuals.	Tomato hybrids, 40 plants.	
Per cent.		*Per cent.*
42	Green foliage, red and round fruit	37.5
14	Green foliage, red and pear fruit	7.5
14	Green foliage, yellow and round fruit	25.0
14	Yellow foliage, red and pear fruit	17.5
5	Green foliage, yellow and pear fruit	2.5
5	Yellow foliage, red and pear fruit	2.5
5	Yellow foliage, yellow and round fruit	5.0
1	Yellow foliage, yellow and pear fruit	2.5

377 individuals—Filipino types—Manila Students.

		Per cent.
Small stature, round head, broad nose.	Primitive and Modified Primitive	14.6
Small stature, round head, narrow nose	Alpine	8.0
Small stature, long head, broad nose	Australoid	8.0
Tall stature, round head, narrow nose	Adriatic	6.4
Small stature, long head, narrow nose	Iberian	6.6
Tall stature, round head, narrow nose	B. B. B.	5.6
Tall stature, long head, broad nose	Cro-Magnon	?
Tall stature, long head, narrow nose	?	....

According to this classification the two types corresponding to the Yellow Pear and Honor Bright tomato are the Adriatic and Iberian, but no doubt the crossing of two other varieties of tomato among the eight would produce a similar series to that in the table, therefore the Adriatic and Iberian were not necessarily the progenitors of the Filipino although they may have been.

We can conceive that the pure dominant, the Primitive, and the pure recessive, the Nordic, may have crossed to produce the eight types. The Primitive, being dominant, has persisted, and appears in a greater percentage than the other types; the Nordic, being recessive, has disappeared. The other types appear in proportions not unlike the theoretical expectancy, although the percentage is low except that of the Iberian and B. B. B. The high percentage of these may be due to recent Spanish infusion of the two types, which are characteristic of the Spanish population of the Philippines (Ears). The low percentage of the other types is due to the progressive increase of blends, which now amount to one-half the population. The *scheme for heredity* which explains the amalgamated condition of the Igorots(2) will assist in the understanding of the student types. If the Nordic type represents the European and the Primitive represents the Eastern, then the existing types may be readily accounted for by the action of Mendelism as indicated above, but there have been many types of Europeans and probably more than one type of the Eastern which have fused to form the present Filipino population. However, if we may suppose that two types similar to the Nordic and Primitive united to form the European populations (a fact that is not improbable), resulting in eight forms similar to the eight Filipino types presented in the table above, and if these eight forms have projected themselves through the East, uniting with the Primitive wherever encountered, then the eight types of Filipinos represent the remains of a departing Mendelism which is being swallowed up by amalgamation in the blend—the Filipino of the future.

The eight European forms may not all have penetrated the East, but, having been segregated in Europe, only a few of the forms need have come into contact with the Primitive to produce the eight Filipino types, because the eight forms could be present in two types.

The scheme used as a *supplementary theory of heredity*(2) may be used to present the conditions found among the Filipino students. The process of amalgamation is more complex than among the Igorots because there are more types, the types show greater differences, and the minglings have been more frequent. The littoral people have recent European and Chinese elements besides the primary types, which make recent as well as remote blends. The recent blends probably exhibit Mendelian effects in crossing, especially the European with the primary types. The Chinese having reached a condition of Spurious Mendelism at least, as indicated by a study of their ears(4), are blending with the primary types on the one hand and the European on the other, each of which is in a condition of No Mendelism or Spurious Mendelism, thus producing a variable blend without True Mendelian effects. The total population is thus thrown into a condition of Spurious Mendelism. Some elements which are already perfect blends, such as the Primitive, Australoid, and Iberian, when crossed with their own kind, should reproduce true to type, whereas others, which are extremely opposite, such as the Iberian and Primitive, probably exhibit True Mendelism, at least in some characters, when crossed.

Finally, it is evident that the presence of the types described in this paper corroborates to some extent the existence of similar types delineated in a study of Filipino ears(4). The definiteness of a few types and the blended condition of others, upholds the theory of heredity and the supplementary theory of heredity presented in previous papers.

BIBLIOGRAPHY.

(1) BAELZ, E. Zur Vor- und Urgeschichte Japans. *Ztschr. f. Ethnol.* (1907), **39**, 281–310.

(2) BEAN, ROBERT BENNETT. The Benguet Igorots. *This Journal, Sec. A.* (1908), **3**, 413.

(3) *Idem.* A Preliminary Report on the Measurements of about 1,000 Students at Ann Arbor, Michigan. *The Anatomical Record* (1908), **1**, No. 3, 67–68.

(4) *Idem.* Filipino Ears. *This Journal, Sec. A.* (1909), **4**, 27.

(5) BEDDOE, J. A Method of Estimating Skull-Capacity from Peripheral Measures. *Journ. of Anthrop. Inst. of Great Britain and Ireland* (1904), **34**, 268.

(6) BLOCH. A quelques remarques d' anthropologie sur les Cambodgiens actuellement a Paris. *Bull. Soc. Anthrop. Paris* (1906), **7**, 354–365.

(7) BLUMENTRITT, F. Alphabetisches Verzeichnis der Eingeborenen Stämme der Philippinen und der von ihren gesprochenen Sprachen (1890), 20.

(8) BROCA, PAUL. Sur les cranes et ossements des Eyzies. *Bull. Soc. Anthrop. Paris* (1868) **3**, No. 2, 350–392.

(9) CASTLE. *Carnegie Publications* (1906), No. 49.

(10) DENIKER, J. The Races of Man. London and New York (1906), 325–334.

(11) *Idem. Bull. Soc. Anthrop.* (1897), 189–291.

(12) FOLKMAR, DANIEL. Album of Philippine Types: Christians and Moros. Manila (1904).

(13) FRITSCH, G. Ueber die Verbreitung der östlichen Urbevolkerungen und ihre Beziehung zu den Wandervolkern, Globus, Braunschweig. (1907), **91**, 8–14, 21–26, and 37–44.

(14) JAGOR, F. Reisen in den Philippinen. Berlin (1875), XVI+381.

(15) KEANE, A. H. The Cochin tribes and castes, *Man.* London (1907), **7**, 41–42.

(16) LUTZ, FRANK E. *Science,* N. S. (1908), **27**, No. 714.

(17) MARTIN, RUDOLH. Die Inlandstämme der Malayischen Halbinsel. (1905), 1–1062.

(18) MEYER, ADOLPH BERNARD. Ueber die Negritos oder Aetas der Philippinen.

(19) *Idem* and SCHADENBERG, A. Die Philippinen. I Nord Luzon: Tingianen, Banaos, Gianganen, Igorotten, Irayas und Ilocanen. Dresden, (1890). Publicationen aus dem Königlichen-ethnographischen Museum zu Dresden, VIII.

(20) MEYER, ADOLPH BERNARD. Die Philippinen, II: Negritos. Dresden, 1893. Ibid, I.

(21) MONTANO, J. Rapport a M. le ministre de l'instruction publique sur une Mission aux Iles Philippines et en Malaisie. (1879–1881), Paris. Imprimerie National, 1885.

(22) MOSZKOWSKI, M. Ueber zwei nicht-malayische Stämme von Ost-Sumatra. *Ztschr. f. Ethnol.* (1908), **40**, 229–239.

(23) MÜNSTERBERG, O. Einflus Westasiens auf Ostasiatische Kunst in vorchristlicher Zeit. *Ibid,* 257–262.

(24) PRICE, H. L. and DRINKARD, A. W., Jr. *Bull. Virg. Expr. Sta.* (1908), **177**, 47.

(25) RIPLEY. The Races of Europe with Bibliography. New York (1899), XXXI–624.

(26) SERGI, G. The Mediterranean Race: A study of the Origin of European Peoples. London (1901), 1–320.

(27) SPILLMAN, W. J. *Science,* N. S. (1908), **27**, No. 701.

(28) VIRCHOW, R. Ueber Negrito-und Igorroten-Schadel von den Philippinen. *Ztschr. f. Ethnol., Verhandlungen.*

(29) VOLZ, W. Beiträge zur Anthropologie und Ethnographie von Indonesien. *Arch. f. Anthrop.* (1908), **7**, 89.

(30) WORCESTER, DEAN C. The Non-Christian Tribes of Northern Luzon. *This Journal* (1906), **8**, 791.

ILLUSTRATIONS.

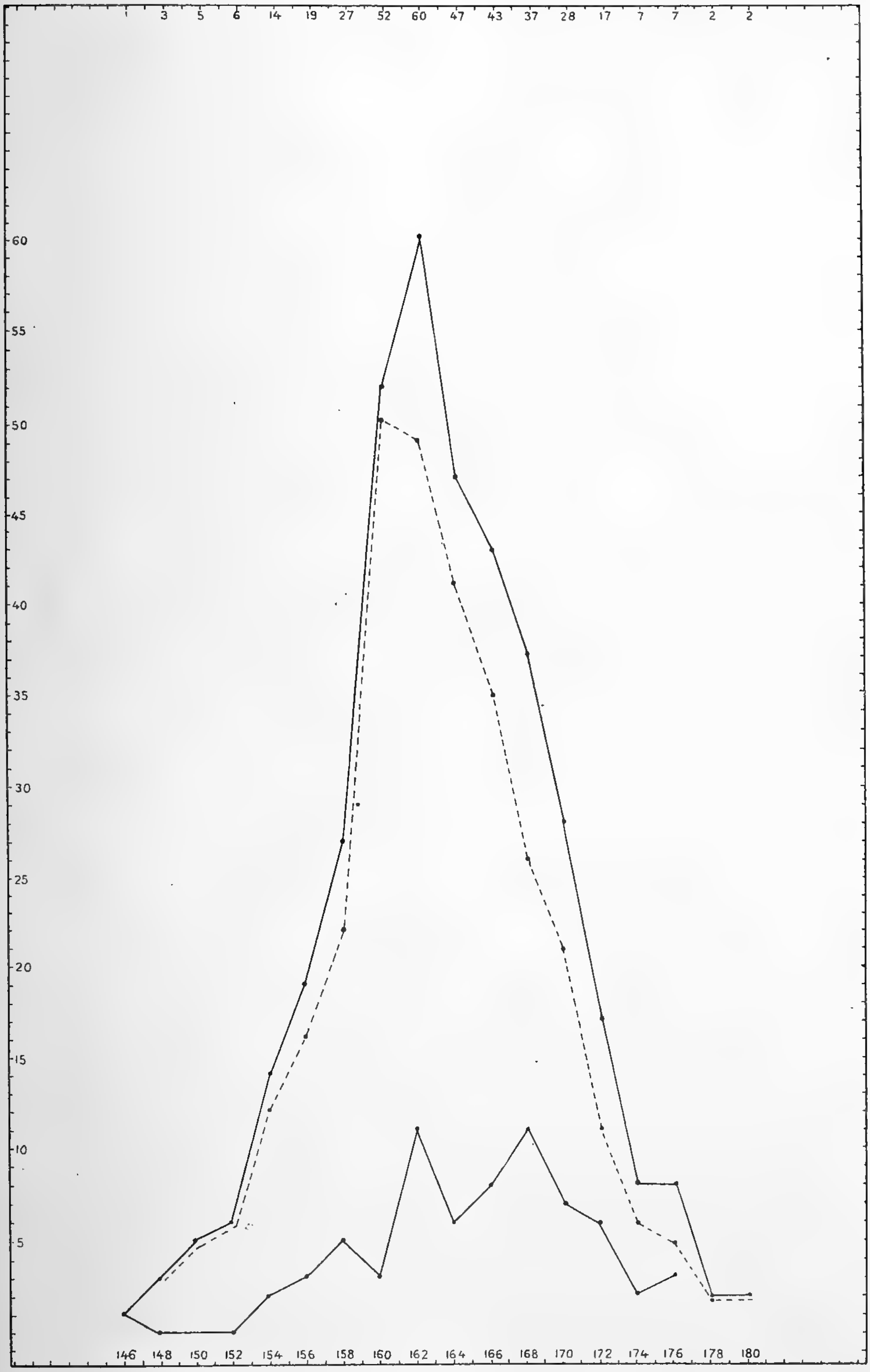

1 3 5 6 14 19 27 52 60 47 43 37 28 17 7 7 2 2
60
55
50
45
40
35
30
25
20
15
10
5
146 148 150 152 154 156 158 160 162 164 166 168 170 172 174 176 178 180

CHART I.

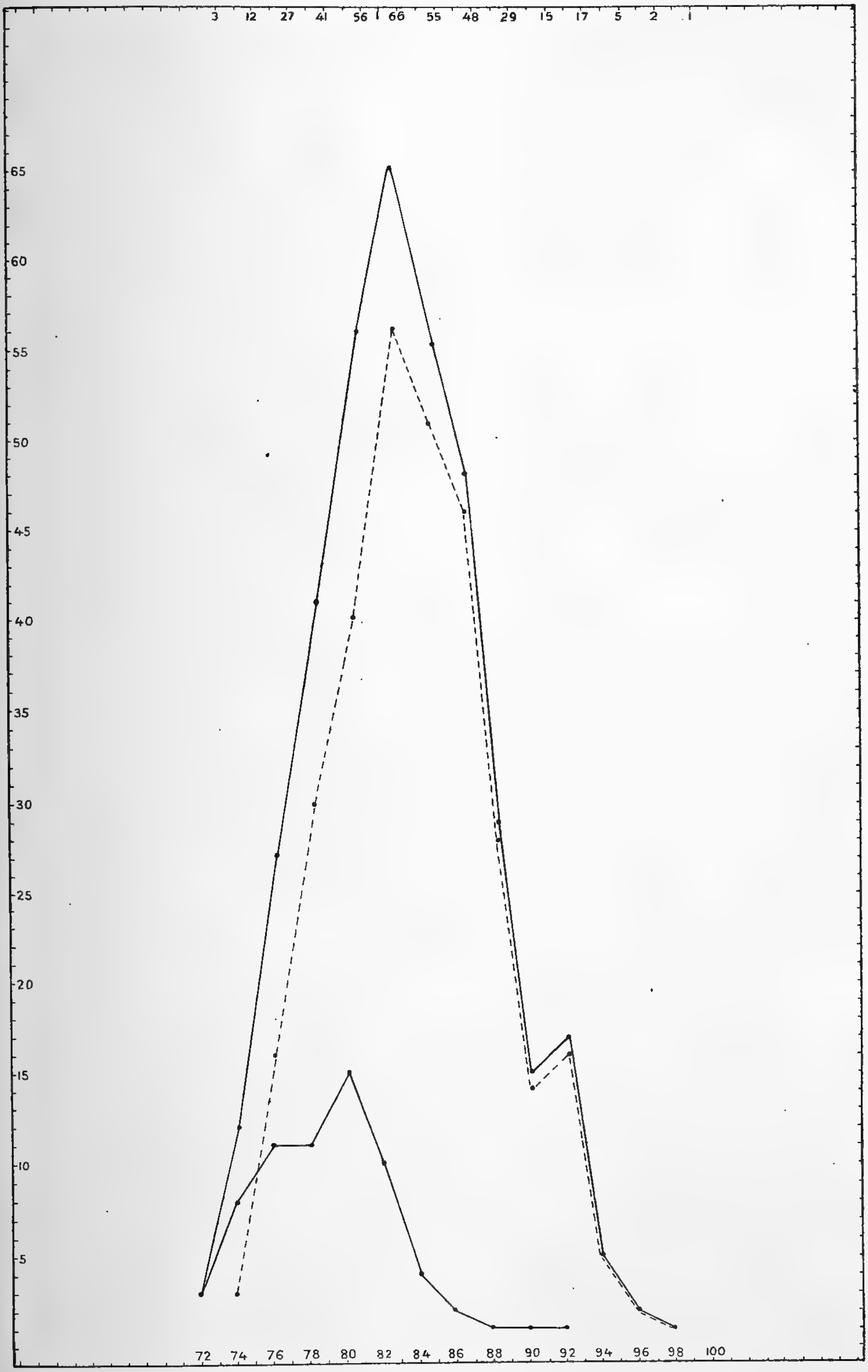

3 12 27 41 56 66 55 48 29 15 17 5 2 1
65
60
55
50
45
40
35
30
25
20
15
10
5
72 74 76 78 80 82 84 86 88 90 92 94 96 98 100

CHART II.

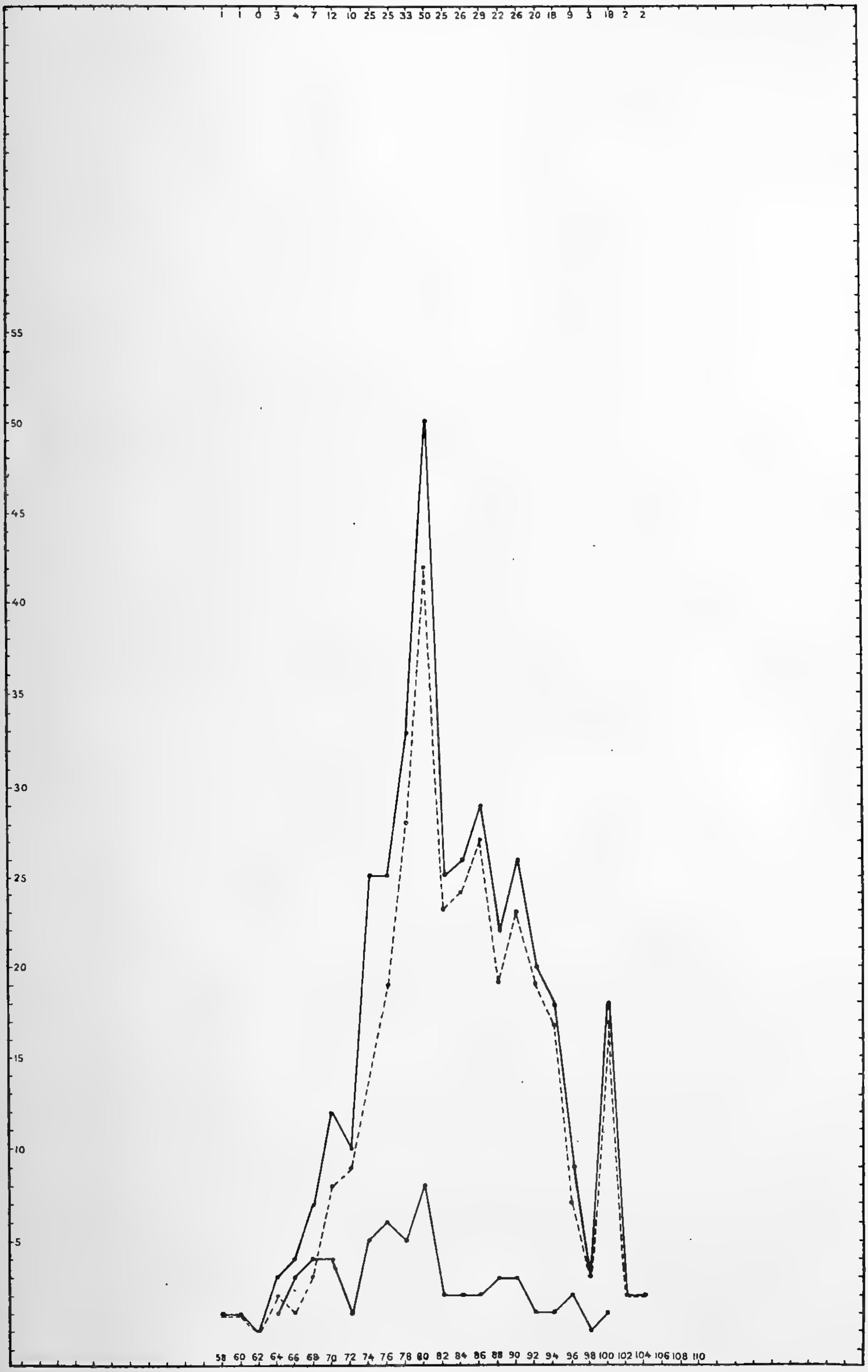

1 1 0 3 4 7 12 10 25 25 33 50 25 26 29 22 26 20 18 9 3 18 2 2
55
50
45
40
35
30
25
20
15
10
5
58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106 108 110

CHART III.

TABLE 1.—*Types—adult male Filipinos.*

Character.	Modified Iberian, 25.			Australoid, 30.			Primitive, 9.			Modified Primitive, 46.			Modified Alpine, 30.			Modified B. B. B., 21.			Modified Adriatic, 24.			Blending, 187.		
	Maxi-mum.	Mean.	Mini-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.	Mini-mum.	Mean.	Maxi-mum.
Cephalic index	72.0	75.2	78.0	74.0	76.8	82.0	80.0	85.5	93.0	80.0	85.6	92.0	80.0	86.9	98.0	78.0	86.2	93.0	80.0	88.0	97.0	77.0	82.4	88.0
Nasal index	60.0	73.9	80.0	83.0	92.7	102.0	85.0	86.5	100.0	81.0	92.9	105.0	60.0	72.9	89.0	58.0	72.0	81.0	84.0	92.9	105.0	72.0	84.8	92.0
Stature standing	154.0	164.3	172.0	147.0	161.0	173.0	148.3	150.8	154.6	156.0	160.1	164.9	152.0	160.2	164.5	165.6	168.8	172.9	165.0	168.6	177.0	146.0	163.8	180.0
Stature sitting	81.0	86.1	92.0	78.0	83.7	90.0	77.5	80.9	83.0	79.0	83.0	86.6	78.1	83.5	96.7	83.3	87.4	92.0	81.5	86.6	92.5	73.7	85.5	97.0
Morphologic face index	81.0	86.6	94.0	74.1	81.3	89.0	72.4	78.8	80.6	72.2	79.7	89.0	73.0	83.0	98.0	76.0	82.9	90.4	70.9	78.4	90.0	69.0	82.4	95.2
Physiognomic face index	69.0	73.2	84.7	70.9	74.9	82.5	72.8	79.2	84.8	67.5	77.1	84.5	66.0	76.1	81.8	70.0	76.1	93.3?	73.7	77.5	82.5	63.9	75.6	87.6
Head length	18.0	19.2	20.5	17.6	18.9	19.6	17.0	17.9	19.1	16.7	18.0	19.3	16.4	17.66	18.8	16.8	18.1	19.4	16.3	17.8	19.0	16.7	18.2	19.6
Head width	13.8	14.5	15.3	13.5	14.6	15.7	15.0	15.3	16.0	14.3	15.4	16.6	14.2	15.34	16.4	14.8	15.6	16.9	14.4	15.6	16.8	14.0	15.0	16.4
Head height	12.3	13.0	13.5	12.5	13.1	13.7	12.7	13.1	13.4	12.3	13.1	13.5	12.2	12.94	13.9	12.3	13.1	13.8	12.3	13.0	13.5	12.1	13.1	13.8
Nose length	4.1	4.9	5.8	3.6	4.15	4.6	3.7	4.03	4.5	3.8	4.2	4.7	4.0	4.83	5.30	4.3	5.0	5.4	3.8	4.2	4.9	4.0	4.6	5.4
Nose width	3.2	3.6	4.0	3.5	3.8	4.5	3.4	3.68	4.0	3.5	3.9	4.4	2.9	3.52	4.30	3.0	3.6	4.0	3.4	3.9	4.5	3.2	3.9	4.3
Chin to nasion	10.7	11.6	12.7	10.0	10.9	12.3	10.2	10.8	11.2	10.2	11.0	12.0	10.3	11.35	12.50	10.8	11.6	12.5	10.0	10.9	12.0	9.7	11.2	12.6
Chin to hair line	16.4	18.3	20.5	16.7	17.9	19.6	16.3	17.3	18.8	16.5	17.9	20.0	16.7	17.97	19.4	15.0?	18.4	19.7	17.0	17.9	19.4	15.7	18.0	21.6
Bizygomatic width	12.1	13.4	14.3	12.7	13.4	14.3	13.0	13.7	14.1	12.7	13.8	15.1	12.3	13.68	14.8	13.4	14.0	14.8	12.8	13.9	14.8	12.5	13.6	14.8
Frontal circumference	27.3	30.2	33.0	27.5	30.5	33.1	28.7	30.5	32.5	29.5	31.0	32.7	27.8	30.20	32.4	28.6	31.0	33.2	28.8	30.7	34.5	27.5	30.4	33.6
Parietal circumference	33.0	36.0	38.0	33.8	35.8	38.0	35.9	37.2	38.4	34.3	36.45	38.7	32.0	36.00	38.2	29.0	36.5	38.6	33.2	35.9	38.0	29.2	36.1	39.8
Forehead circumference	25.4	27.2	29.5	25.6	26.4	29.0	26.0	26.8	27.8	25.5	27.3	30.0	25.2	26.90	29.3	25.6	27.6	29.7	25.2	27.0	29.0	24.7	27.0	28.7
Occipital circumference	27.6	30.2	33.5	27.2	29.7	32.0	27.0	29.3	31.0	27.4	28.7	32.3	26.0	28.90	31.5	27.0	29.3	31.5	26.4	29.1	31.0	27.0	29.3	33.5
Fronto-parietal index	79.0	84.0	92.0	77.9	85.2	94.3	74.7	82.0	90.8	80.0	85.0	92.0												
Forehead occipital index	80.0	90.0	104.0	83.9	88.9	100.0	85.8	91.4	97.0		95.1													
Fronto-occipital index		100.0								98.4	108.0	114.5												
Forehead parietal index		75.5			73.7		70.0	72.0	76.0		74.9													
Occipito-parietal index											78.7													
Weight	39.2	50.0	63.2	40.5	49.0	68.3	38.2	45.1	51.5	41.5	49.0	60.8	38.6	47.16	53.5	49.8	52.9	69.6	40.0	52.8	64.0	33.6	50.3	71.0
Decayed teeth	[a]0.0	4.8	22.0	[b]0.0	3.8	19.0	[a]0.0	1.9	5.0	[c]0.0	2.0	13.0	[d]0.0	2.40	8.0	[a]0.0	4.0	15.0	[e]0.0	2.7	10.0	[f]0.0	2.7	20.0
Age	18.0	19.0	22.0	18.0	19.0	25.0	18.0	19.7	26.0	18.0	21.3	26.0	18.0	19.6	22.0	18.0	20.6	29.0	18.0	20.4	28.0	18.0	20.3	31.0

[a] 4 students of this type have no decayed teeth.
[b] 8 students of this type have no decayed teeth.
[c] 20 students of this type have no decayed teeth.
[d] 14 students of this type have no decayed teeth.
[e] 9 individuals of this type have no decayed teeth.
[f] 59 students of a possible 187 have no decayed teeth, exactly one-third.

TABLE 2.—*Measurements classified by locality.*

Locality.	Number.	Stature.	Cephalic index.	Nasal index.	Head length.	Head breadth.	Nose length.	Nose breadth.
City of Manila:								
Filipinos—								
Average	40	163.8	82.3	83.8	18.1	14.9	4.39	3.69
Maximum		179.3	90.0	102.0	19.6	15.5	5.10	4.30
Minimum		151.8	76.0	68.0	16.7	13.8	3.70	3.20
Mestizos—								
Average	23	163.1	77.2	78.9	18.9	14.6	4.65	3.67
Maximum		176.5	72.0	95.0	20.5	15.5	5.40	4.30
Minimum		146.1	84.0	66.0	17.8	14.0	4.00	3.20
Rizal Province:								
Filipinos—								
Average	31	162.8	83.4	83.2	18.1	15.1	4.47	3.72
Maximum		172.0	92.0	105.0	19.4	16.2	5.10	4.20
Minimum		148.8	74.0	64.0	16.3	13.5	3.80	3.30
Mestizos—								
Average	7	166.3	78.4	79.8	19.0	14.9	4.71	3.76
Maximum		169.5	84.0	84.0	19.8	15.3	5.00	4.20
Minimum		160.5	75.0	72.0	18.0	14.2	4.40	3.30
Laguna Province:								
Filipinos—								
Average	14	162.6	81.3	84.3	18.2	14.8	4.39	3.70
Maximum		173.5	91.0	100.0	19.1	16.4	4.90	4.40
Minimum		153.7	75.0	70.0	17.7	14.0	3.70	3.20
Mestizos—								
Average	6	162.7	78.5	80.3	18.6	14.6	4.56	3.66
Maximum		167.0	82.0	100.0	19.6	15.2	5.30	3.90
Minimum		156.6	74.0	64.0	18.0	13.7	3.70	3.30
Cavite Province:								
Filipinos—								
Average	10	166.7	82.9	81.0	18.5	15.4	4.64	3.76
Maximum		175.8	93.0	95.0	19.3	16.4	5.00	4.20
Minimum		154.6	75.0	68.0	17.6	14.3	4.30	3.40
ADULT MALES—NO MESTIZOS.								
Batangas Province:								
Average	12	164.2	83.7	79.8	18.2	15.2	4.7	3.8
Maximum		170.6	92.5	88.9	18.8	16.1	5.3	4.0
Minimum		156.6	76.9	72.0	17.1	14.3	4.0	3.4
Bulacan Province:								
Average	26	163.6	84.2	83.2	18.1	15.2	4.5	3.7
Maximum		173.5	90.1	97.3	19.0	16.9	5.3	4.1
Minimum		152.9	77.3	57.7	17.0	14.3	3.8	3.0
Tayabas Province:								
Average	15	160.6	83.3	83.3	18.0	15.0	4.6	3.8
Maximum		171.5	90.9	100.0	19.4	15.9	5.0	4.1
Minimum		149.7	77.0	75.0	16.9	14.3	4.0	2.9
Zambales Province:								
Average	9	165.1	84.1	79.2	18.3	15.6	4.8	3.8
Maximum		173.4	91.2	91.3	19.5	16.6	5.1	4.3
Minimum		159.5	80.0	72.0	17.3	15.1	4.6	3.5
Pampanga Province:								
Average	22	163.5	81.3	87.6	18.5	15.0	4.4	3.8
Maximum		172.2	90.5	100.0	19.6	15.7	5.0	4.5
Minimum		158.7	76.5	72.0	16.8	14.2	3.8	3.3

TABLE 2.—*Measurements classified by locality*—Continued.

Locality.	Number.	Stature.	Cephalic index.	Nasal index.	Head length.	Head breadth.	Nose length.	Nose breadth.
Pangasinan Province:								
Average	18	161.0	84.7	85.0	18.1	15.3	4.5	3.8
Maximum		170.0	93.1	100.0	19.2	16.1	5.4	4.1
Minimum		151.3	80.0	74.1	16.9	14.5	3.7	3.3
Nueva Ecija and Nueva Vizcaya Provinces:								
Average	17	166.1	83.6	80.0	18.3	15.3	4.8	3.9
Maximum		175.7	95.3	90.9	19.5	16.4	5.3	4.2
Minimum		158.1	79.0	69.8	17.2	14.4	4.2	3.6

TABLE 3.—*Comparison of measurements by groups.*

Authority.	Number.	Stature.	Cephalic index.	Nasal index.	Head length.	Head width.	Nose length.	Nose width.
Tagalogs—Adult male—averages:								
Montano	4	158.0	83.69	82.52				
Folkmar	169	159.6	83.09	79.69	18.0	15.0	5.1	4.1
Bean—								
Filipinos	219	163.4	83.80	82.80	18.2	15.1	4.53	3.75
Mestizos	64	164.9	78.70	77.9	18.8	14.8	4.75	3.70
Total	283	163.8	82.20	81.9	18.3	15.1	4.58	3.75
Averages—adult males—no mestizos:								
Ilocanos—								
Montano	3	161.9	86.8	86.7				
Folkmar	193	160.2	84.8	75.4	17.8	15.1	5.20	4.00
Bean	48	161.5	83.5	81.8	18.2	15.2	4.30	3.65
Bicols—								
Montano	6	158.3	86.6	86.5				
Folkmar	63	159.2	83.2	81.5	18.0	15.0	5.0	4.1
Bean	14	163.2	83.5	86.3	18.2	15.2	4.5	3.9
Bisayans or Visayans—								
Montano	2	150.1	87.5	71.3				
Folkmar	259	158.7	84.4	81.7	17.9	15.1	4.9	4.0
Bean	23	160.7	84.3	87.3	18.2	15.4	4.4	3.8
Moros of Mindanao—								
Montano	5	157.4	81.9	84.6				
Folkmar	6	161.3	80.8	81.0	18.7	15.1	5.00	4.10
Bean	2	163.0	88.8	87.4	17.9	15.85	4.75	4.25
Cagayanes—								
Folkmar	15	162.2	80.8	80.4	18.4	14.9	5.1	4.1
Bean	3	165.6	83.6	80.9	17.7	14.8	4.7	3.8

The Tagalogs include all those enumerated in Table 2; the Ilocanos are those from Ilocos Norte, Ilocos Sur, and Union; the Bicols are from Camarines, Albay, Sorsogon, Romblon, and Masbate; the Visayans are from Iloilo, Capiz, Antique, Negros, Bohol, Leyte, and Samar.

TABLE 4.

[Montano, J. Rapport a M. le ministre de l'instruction publique sur une mission aux isles Philippines et en Malaisie 1879–1881 p. 354–360.]

	Indices.				Absolute stature.
	Cephalic.	Facial.	Frontal.	Nasal.	
Negritos—18 males—Mariveles and Batan:					
Mean	84.66	56.24	69.31	94.67	148.53
Maximum	89.19	61.64	74.65	122.80	157.50
Minimum	77.09	51.43	61.31	82.00	142.50
Negritos—12 females—Mariveles and Batan:					
Mean	86.95	55.93	72.64	96.62	143.16
Maximum	96.86	60.92	95.07	105.40	148.50
Minimum	80.56	53.03	66.90	88.09	135.00
Manthus—7 males—Malacca:					
Mean	80.01				148.87
Maximum	82.38				158.00
Minimum	76.66				139.00
Manthus—5 females—Malacca:					
Mean	81.40				142.38
Maximum	85.52				149.00
Minimum	76.70				133.00
Aetas—2 males—Camarines Sur, Lucon:					
Mean	81.29	60.73	71.39	93.97	155.00
Bicols—6 males:					
Mean	86.63	56.79	71.96	86.51	158.33
Maximum	92.94	62.31	73.94	100.00	165.50
Minimum	81.14	56.05	67.74	79.59	147.20
Bicols—10 females:					
Mean	86.60	60.09	69.89	86.38	150.58
Maximum	91.18	66.67	72.41	94.74	161.00
Minimum	82.35	55.00	67.74	77.55	141.50
Tagalogs—4 males:					
Mean	83.69	59.70	68.06	82.52	158.00
Maximum	89.63	64.88	74.28	88.37	165.50
Minimum	80.55	57.04	61.29	60.00	150.50
Visayans—2 males:					
Mean	87.54			71.30	150.10
Maximum	89.63	64.88	68.02	82.61	151.20
Minimum	85.46	59.84	65.30	60.00	149.00
1 13 years old	82.35	62.40	74.28	85.00	133.80
1 male—Pangasinan	83.78	60.69	67.74	75.00	165.00
1 male—Pampanga	77.29	59.44	76.92	82.22	163.90
Ilocanos—3 males:					
Mean	86.78	63.95	71.26	86.71	161.90
Maximum	89.41	65.38	76.66	91.10	168.50
Minimum	85.22	61.31	65.79	80.42	158.20
Sulus—6 males:					
Mean	84.67	62.47	73.65	86.60	152.60
Maximum	87.88	74.59	78.77	95.24	159.20
Minimum	78.89	56.64	71.23	76.60	148.80
Sulus—4 females:					
Mean	86.72	54.31	69.96	85.05	143.03
Maximum	93.83	58.33	77.93	91.43	146.50
Minimum	77.14	50.41	60.53	73.91	139.80
Davao Moros—5 males:					
Mean	81.94	56.11	73.45	84.56	157.36
Maximum	87.11	62.96	78.57	95.35	162.50
Minimum	75.27	55.86	63.02	75.47	150.90
Halagan—1 male	79.46	54.80	76.19	102.50	166.50

APPENDIX.

STUDENTS' CLASS STANDING BY TYPE.

Since compiling the present work, the class standing of the students measured has been obtained from the Philippine Normal School and the Philippine School of Arts and Trades, through the kindness of Mr. Beattie, and with the assistance of Teodorico Planta, a student in the Philippine Medical School who copied the grades from the records of the two schools. Only the class standing for the year in which the students were measured was obtained. This is classified according to the type of student into three groups: literature, mathematics, and science. Literature includes history, geography, languages and such general subjects; mathematics includes of course arithmetic, algebra, geometry, etc.; and science includes physics, chemistry, botany, zoölogy, and practical courses necessitating handiwork.

The grades under each of the three classes are treated in three ways: first, the average is obtained, then the high grade and low grade students of each type are contrasted, afterwards the extremely good and the extremely bad students are discussed.

The class standing is relative and for obvious reasons should not be taken for comparison with other schools or other peoples, but I believe it is a satisfactory basis for the comparison of the students among themselves.

Average class standing of the students according to type.

Type.	Literature.	Mathematics.	Science.	Total.	Number of students.
Iberian	75.0	77.6	77.8	76.8	18
Modified Primitive	77.2	77.8	75.5	76.9	29
Australoid	73.4	75.7	74.3	74.5	20
Alpine	76.9	79.2	76.0	77.3	23
B. B. B	76.9	77.5	78.4	77.6	20
Adriatic	76.2	79.2	77.6	77.7	17
Total	76.1	77.4	76.5	76.8	126
Blends	76.0	75.3	77.1	76.1	144

The Australoid is the only type that has an average class standing appreciably different from that of the other types. It is lower than the others, and is approached most closely by the Blends. The average of the first three types given is less than that of the next three types, and the Adriatic average is the highest of all. The total average of all the types is greater than that of the Blends and the difference is due to the high mark of the types, and the low mark of the Blends, in mathematics. In the practical work of science the Blends are slightly better in class standing than the types and in the common branches of literature they are about the same.

In literature alone, the Modified Primitive excels and is closely followed by the Alpine and B. B. B. The Australoid has the lowest grade in literature received by any type for any subject.

In mathematics alone the highest grade received by any type for any subject is attained by the Alpine and Adriatic. The Modified Primitive comes third in mathematics, closely followed by the Iberian and B. B. B., whereas the Australoid ranks last except the Blends.

In the practical sciences, the B. B. B. stands easily first with the Iberian second and the Adriatic third. The Australoid is last in this as in all the subjects.

The absence of the Primitive may be noticed, and is due to the fact that the class standing of only three individuals is given. These are as follows:

Class standing of the Primitive Type.

Literature.	Mathematics.	Sciences.	Total.
76	75	75	75.3
76	84	68	76.0
80	85	78	81.0
[a]77.1	[a]81.3	[a]74.0	[a]77.4

[a] Total.

The average is greater than any type except the B. B. B. and Adriatic; the average in mathematics is the greatest of all and only in the sciences is the average low. Disregarding the average and considering the individuals only, there is evident high class standing of at least two students of the Primitive type in mathematics, and one student has a high mark in all three departments. Whatever the physical condition of the Primitive type, there is no evidence of mental deficiency, at least in the three students whose grades are presented above.

The average class standing indicates only slight differences between the types, therefore we turn to the constrast of high and low grade students.

The relation of the low grade to the high grade students by types.

Type.	Literature.		Mathematics.		Science.		Total.		Ratio of 69 to 80.				Number of students.
	69.	80.	69.	80.	69.	80.	69.	80.	Literature.	Mathematics.	Science.	Total.	
Iberian	2	2	1	8	4	8	7	18	10	80	20	26	18
Modified Primitive	2	11	4	11	4	9	10	31	55	28	23	31	29
Australoid	3	7	2	9	5	7	10	23	23	45	14	23	20
Alpine	3	10	2	12	4	8	9	30	33	60	20	33	23
B. B. B	2	9	2	9	1	9	5	27	45	45	90	54	20
Adriatic	3	7	2	9	1	8	6.	24	23	45	80	40	17
Total	15	46	13	58	19	49	47	153	31	45	27	33	126
Blends	24	61	33	53	17	58	74	172	25	16	34	23	144

In this table only students who received grades which do not fall between 70 and 79 are included. This gives three classes of which the low grade received an average of 69 or less, the high grade an average of 80 or more, and the others intermediate grades called mediocre. The ratio is the number of students with grades above 80 divided by the number with grades below 69, and indicates the relative class standing.

The Iberian type has a large number of mediocre students in literature, and a small number in science, in both of which the ratio is low, but in mathematics, where there are an equal number of mediocre and extreme students, the ratio is high and it is exceeded only by the ratio of the B. B. B. in science. The total ratio of the Iberian type is low, however, lower than any except the Australoid and the Blends. The ratio in literature is lower than that of any other type in any subject.

The Modified Primitive type has a larger number of mediocre students than extremes in all departments. The ratio is high for literature but low for mathematics and science. The total ratio is low, a trifle lower than the average for the types, but not so low as the Blends.

The Australoid has more extremes than mediocre students but the extremes are low grade to a greater extent than the other types which makes the ratio low in every department. The total ratio is the lowest of all the types and exactly the same as the Blends with a particularly low grade in science.

The Alpine has more extreme than mediocre students, and in science the extremes are low grade, whereas in mathematics they are high grade. The ratio in literature and the total ratio are the same and equal exactly the total average ratio of all the types.

The B. B. B. type has about equal numbers of mediocre and extreme students, and the extremes are largely high grade. The ratio is mediocre for literature and mathematics but high for science, yet the difference is due to one student less in low grade science than in low grade literature and mathematics. The ratio is on this account greater than that of any other type, and more than twice as great as that of the Australoid and the Blends.

The Adriatic has a greater number of extremes than of mediocre students and the ratio of literature is low, that of mathematics mediocre, whereas that of science is high. The total ratio of the Adriatic is the second of all types being exceeded only by the B. B. B.

The types have a higher total ratio than the Blends, and the ratio of literature and mathematics is also higher, whereas that of science is slightly lower.

The extremely bad and the extremely good students, those with marks below 60 and above 89 respectively, are called Failed and Honor students.

There are none of these among the Iberians except 1 with a grade of 56 in mathematics.

87002——5

The Modified Primitive has 1 Failed in each department, and 1 Honor in mathematics and science respectively.

The Australoid has 2 Failed in literature, 1 in mathematics, 2 in science, and 2 Honor men in mathematics.

The Alpine has 1 Failed in mathematics and 1 in science, and 2 Honor men in mathematics.

The B. B. B. has 1 Failed in mathematics, and 1 Honor man in mathematics.

The Adriatic has no Failed in any subject, but has 1 Honor man in literature and 1 in mathematics.

The Blends have 4 Failed in literature and 2 Honor men, 10 Failed in mathematics and 7 Honor men, and 1 Failed in science and 3 Honor men.

In contrast with this the types have 3 Failed in literature and 1 Honor man, 5 Failed in mathematics and 7 Honor men, 4 Failed in science and 1 Honor man. The Blends have 15 Failed and 12 Honor men, and the types have 12 Failed and 9 Honor men. The greatest difference between the Blends and the types is in mathematics and science. The types excel in mathematics and the Blends in science.

It would be unjust to draw conclusions from so small a number of students when the differences are so slight, therefore only a summary will be given.

SUMMARY.

The Adriatic, B. B. B., and Alpine types which are each composed of Filipino, Chinese, and Spanish elements have the highest class standing.

The Primitive and Modified Primitive, which are probably pure Filipino types have a better class standing than the Iberian and Australoid types which are probably composed of Spanish and Filipino elements alone. However, the Iberian has a high class standing in mathematics.

The Adriatic has the best class standing, the Australoid the worst.

The class standing of the types is better than that of the Blends, especially in mathematics.

The total class standing of all the students, considering the average, the low and high grade students, and the Failed and Honor men, is better in the sciences where practical handiwork is important, than it is in literature and mathematics where memory and imagination are important. There are, however, a relatively greater number of Honor men than Failed men in literature than in either science or mathematics, and there are more than double as many of both Failed and Honor men in mathematics as in either science or literature. Many students are either very good or very bad in mathematics.

II. FILIPINO TYPES: FOUND IN MALECON MORGUE.

By Robert Bennett Bean.

(*From the Anatomical Laboratory of the Philippine Medical School, Manila, P. I.*)

The bodies of the unclaimed dead in the city of Manila are brought to the Malecon Morgue of the Philippine Medical School where they are retained for forty-eight hours before final disposal. About 100 of such bodies were measured by me during the school year 1907–8, and the 70 adults—48 male and 22 female—so utilized are represented by detailed dimensions in Table V. Two Tagalogs, 2 Chinese and 10 Japanese, all living, who were measured at Baguio in 1908 at the same time that I measured the Benguet Igorots, are also included in this study.

The Filipinos whose bodies reach the Malecon Morgue usually belong to the *submerged tenth,* and should be so considered in any discussion or conclusions. However, they form an integral part of the population of the Philippine Islands, and belong to the series of investigations which I have undertaken of the Filipinos in different culture levels. I have already indicated differences in three culture levels in a study of Filipino Ears, a higher level than the three is given in a study of Filipino Types, I, and in the present study a lower level than the three is presented. The Japanese are probably from the lower middle class, if we may use the ordinary expression, because they are all day laborers—carpenters, etc.—who came to the Philippines after being dismissed from the Japanese army following the war with Russia.

The methods of measuring the body are the same as those used for the Benguet Igorots. The head measurements conform to the methods adopted by the commission of the continental (European) anthropological societies in 1906. No conscious selection was made, except that bodies which were distorted by the gas bacillus (*Bacillus aërogenes capsulatus* Welch) were not measured.

The brain weight is not exact except in a few instances where I myself did the weighing, because it was taken on untested scales by the morgue attendant; some of the brains are now preserved in the Wistar Institute of Anatomy, Philadelphia, Pennsylvania, and the Smithsonian Institution, Washington, District of Columbia, where they may be examined. They should be carefully studied in relation to the types of men from whom derived, which are delineated in detail in the following pages.

A series of tables covering the physical measurements of the groups of Japanese, Igorots, Manila Students, and the Malecon Morgue inmates, is presented at the end of this study.

The present work is divided into six sections, each of which is complete in itself but forms a part of the composite whole. A summary is given at the end of each section. The sections are as follows: I, Individual Types; II, Remaining Types; III, Head Outlines; IV, Amplified Scheme for Heredity; V, Group Averages; VI, The Relation of Morphology to Disease.

I. INDIVIDUAL TYPES.

The Japanese and the Morgue subjects will be compared with the Igorots and the Manila students comprising previous studies. Preceding this, the types of Japanese and of Filipinos will be selected and shown to coincide to some extent, and to resemble certain types of the students and of the Igorots.

The types have been selected in precisely the same way that the types of Manila Students were selected, and they will be presented in the following order: Iberian, Primitive, Australoid, Cro-Magnon, Alpine, B. B. B., Adriatic, and Blend, because this is probably the order of precedence in the appearance of the types, or their relative age in world time, the oldest being put first. The Iberian may be out of place, but it is used as the standard of comparison; therefore its position is logical.

THE MODIFIED IBERIAN TYPE.

The characteristics of this type were presented in a previous study of Filipino types among Manila students, and the average measurements are given in tables further on in this paper; therefore, only the principal characters that differentiate this type from the other types will be considered here.

Stature of the Iberian Type.

No.	Group.	Sex.	Stature.
5	Malecon Morgue	♂	163.4
8	do	♀	151.8
5	Japanese	♂	161.0
25	Manila students	♂	164.3

The stature of the three groups—Japanese, Morgue and Students—is so nearly the same as to indicate the homogeneity of the type. The Japanese Iberians are not so tall as the others, although the average stature of the 10 Japanese is greater than that of the 48 Morgue subjects. From this we may infer that the Filipino Iberian is taller than the Japanese Iberian, and, to account for it, the recent infusion of Spanish in the Filipino during the past few hundred years may be suggested. The Japanese Iberian probably came to Japan at a much earlier date than the Spanish arrived in the Philippines, and the Iberian is more completely amalgamated with the other Japanese types than is the Filipino Iberian with the other Filipino types, because in the latter the Iberian is more recent and is also found unmixed and pure in type, as among the Castilian Spanish. The Iberian probably predominates in the Japanese but it does not in the Filipino.

The stature of the women is less (7.2 per cent) than that of the men, but it is about the usual percentage less, and is not greater than it should be as it is among the Igorots. This again is an argument for the homogeneity of the types in the four groups. The difference between the Students and the Morgue subjects may be due to nurture, the former being well nourished and the latter poorly nourished. All of the differences in stature could be accounted for by modifications due to environment, but it is better to find the true explanation than to ascribe the differences to unknown causes. The type is justified also if the group differences can be explained.

Cephalic index of the Iberian type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	76.65
8	do	♀	77.92
5	Japanese	♂	74.14
25	Manila Students	♂	75.20

The heads of this type are moderately dolichocephalic, except those of the women, which are slightly mesocephalic. The morgue subjects have a higher index than the Japanese or the Students, and the women have the highest index. The Japanese have longer, narrower heads than any of the others, which indicates a condition nearly like the original Iberian type. The cephalic index is considered to be one of the best criteria of type, but this must be taken with reservations because of innate abnormalities of the skull and by reason of extraneous influences. The heads of many Filipinos are undoubtedly distorted in infancy by resting on hard substances covered only with the *petate*. This distortion may be counteracted by the later growth of the individual, but it is probably retained to some extent in the adult. Many heads show the dorsal flattening that has been supposed to be characteristic of the East, but it is probably only the retention of this infantile condition.

Nasal index of the Iberian type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	68.14
8	do	♀	69.80
5	Japanese	♂	76.92
25	Manila Students	♂	73.90

The nasal index is probably more reliable than the cephalic index as a differential factor in the racial anatomy of a people, although it is not so accurate on the living as on the skull, because of different methods of measurement used by different observers, and of greater liability to errors of technique. However, the nasal index, although slightly less for the Morgue subjects than for the Japanese and Students, is practically homogeneous for the four groups.

The stature, the cephalic index and the nasal index establish the Iberian type as a homogeneous entity which is found among Filipinos of extremely different culture levels and among the Japanese. There are also other characters that are homogeneous and that differentiate the Iberian from the other types, which characters will now be given.

Morphologic face index of the Iberian type (relative face height).

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	79.90
8	do	♀	81.53
5	Japanese	♂	78.32
25	Manila Students	♂	86.40

This index represents the distance from chin to nasion divided by the greatest interzygomatic distance, and expresses the face height relatively; therefore, it may be said that the face height of students of the Iberian type is greater than that of the other groups, and least in the Japanese. The Morgue males are practically the same as the Japanese. There is no great disharmony among the groups, and the face, although not so long and narrow as the original Iberian type of Europe, is longer and narrower than that of the other types to be considered.

Brachial index of the Iberian type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	77.60
8	do	♀	76.13
5	Japanese	♂	65.52

The brachial index, which represents the length of the forearm in terms of the upper arm as 100, is much less for the Japanese than for the Morgue subjects. The difference noted may be due to locality or nationality rather than to type. The Japanese measured have short forearms and long upper arms, which is characteristic of the Iberian in contrast with other types presently to be discussed. The men and women have nearly the same index.

Crural index of the Iberian type.

No.	Group.	Sex.	Index.
4	Malecon Morgue	♂	100.00 (?)
8	do	♀	93.55
5	Japanese	♂	97.53

The crural index, which represents the length of the lower leg in terms of the upper leg as 100, is less than 100 for the Iberian type, and it is less for the women than for the men.

Shoulder-hip index of the Iberian type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	83.36
8	do	♀	89.65
5	Japanese	♂	74.05

The relative width of the hip in terms of the shoulder width as 100, which is represented in the table above, may not be so good a differential character as those mentioned before this, but it has its merits. By this index the Japanese Iberians have both relatively narrow hips and relatively wide shoulders. The hips of the women are relatively wider than those of the men.

THE PRIMITIVE TYPE.

This type has features in direct contrast with the Iberian. The latter has medium stature, long head, long nose, long face, long hands, and short forearms and lower legs; the former has small stature, wide head, wide nose, wide face, short hands and long forearms and lower legs.

The cephalic index of the Primitive type.

No.	Group.	Sex.	Index.
8	Malecon Morgue	♂	89.10
4	do	♀	89.57
8	Igorots	♂	84.30
9	Manila Students	♂	85.50

The cephalic index of the Igorots and Manila Students is less than that of the Morgue subjects, although the index of all is brachycephalic. The head of the Morgue women is exactly the same in cephalic index as that of the Morgue men.

The stature of the Primitive type.

No.	Group.	Sex.	Stature.
7	Malecon Morgue	♂	152.5
4	do	♀	146.3
8	Igorots	♂	150.3
9	Manila Students	♂	150.8

Stature is one of the most distinct characteristics of the Primitive, because it is so much less than that of any other type. The stature of the Primitive is relatively less for the Students and Igorots and greater for the Morgue subjects than is that of the Iberian; and the stature of the Primitive women, relative to the stature of the Primitive men, is 3.1 per cent greater than that of the Iberian women.

The nasal index of the Primitive type.

No.	Group.	Sex.	Index.
8	Malecon Morgue	♂	90.42
4	do	♀	101.08
8	Igorots	♂	89.40
9	Manila Students	♂	86.50

The Primitive is platyrrhine in all the groups, and the women are more platyrrhine than the men. This is not true of the Iberian, although the Morgue women are more platyrrhine than the Morgue men of that type. The relation of the Morgue to the School is the reverse for the Primitive as compared with the Iberian. The latter type among the Students has wider noses, whereas the former has narrower noses, relatively speaking. Is this an indication of the Galton-Pearson law of regression toward the mean, or does it indicate greater blending of nose types among the students? Probably the latter.

The morphologic face index of the Primitive type.

No.	Group.	Sex.	Index.
7	Malecon Morgue	♂	75.6
4	do	♀	73.1
9	Manila Students	♂	78.8

This index is almost 10 less than for the Iberian, and the same relative difference exists between the Morgue subjects and the Students for this type as for the Iberian, which is that the face of the student is relatively longer compared with the width, than is that of the Morgue subjects. The female Primitive is 3 less than the male, whereas the female Iberian is about 2 greater; but with so few individuals a slight difference may not be significant.

The brachial index of the Primitive type.

No.	Group.	Sex.	Index.
8	Malecon Morgue	♂	81.4
4	do	♀	81.3
8	Igorots	♂	80.0

The index for the Primitive Morgue male is 4 points higher than for the Iberian male, and for the Primitive Morgue female 5 points higher than for the Iberian female; and that of the Primitive type of the Igorots is 14.5 greater than that of the Japanese Iberian. This indicates a longer forearm and shorter upper arm for the Primitive than for the Iberian. The difference in brachial index between the Iberian and Primitive types is not so great, however, as that of the crural index which follows, although this index can be presented only for the Morgue subjects.

The crural index of the Primitive type.

No.	Group.	Sex.	Index.
7	Malecon Morgue	♂	106.1
3	do	♀	102.0

The lower leg of the Primitive is longer than the upper leg, and the character is more marked among the men than among the women. This is one of the most characteristic features of the Primitive type and differentiates it from all others, except the Australoid, which is similar to the Primitive but has not quite so high an index.

The shoulder-hip index of the Primitive type.

No.	Group.	Sex.	Index.
7	Malecon Morgue	♂	79.3
4	do	♀	85.0

The hip breadth of the Primitive is less than that of the Iberian relative to shoulder breadth, and that of the women is greater than that of the men. The actual shoulder breadth of the Iberian and Primitive is the same; therefore the hip index expresses actual hip breadth in percentages. This indicates that the Primitive has a narrow pelvis, whereas the pelvis of the Iberian is broad. Is broad pelvis associated with long head, and narrow pelvis with round head? (Lapicque.)

THE AUSTRALOID TYPE.

The characteristics of this type, in contrast with the Iberian and Primitive, represent an intermediate condition, or a condition similar to one or the other of the two types, facts that will be disclosed as the study advances.

The stature of the Australoid type—averages.

No.	Group.	Sex.	Stature.
5	Malecon Morgue	♂	158.80
3	do	♀	148.30
9	Igorots	♂	146.60
2	Japanese	♂	163.85
30	Students	♂	161.00

The stature of the Australoid is practically uniform in all the groups except the Igorots, which has a stature less than the Morgue females. Only one student has a stature as low as that of the average Australoid Igorot. The Igorots, however, were selected by a method which differs from that used in the selection of the other Australoids, and by this method those with greater stature are admitted to the other groups, but not to the Igorots. If Igorot types are selected in the same way as are student types, the number of Igorot Australoids is brought from 9 up to 45; and the average stature of the group is also increased thereby. The smallest student is about 1 centimeter taller than the average of the 9 Australoid Igorots, however, and this indicates that the student Australoid is different in stature from the Igorot Australoid. The difference is probably due to recent Iberian in the students. The Igorots may represent a remote cross of the Primitive and Iberian, whereas the Students represent a recent cross, and a few of the remote cross still persist among the Students.

The stature of the men is less throughout than that of the Iberian type, except the Japanese who are 2.5 centimeters greater for the Australoid than for the Iberian. Judged by the stature alone, the Australoid men are more like the Iberian, whereas the Australoid women are more like the Primitive.

The cephalic index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	76.74
3	do	♀	78.95
9	Igorots	♂	75.10
2	Japanese	♂	77.32
30	Students	♂	76.80

Differences of cephalic index that are so slight as in the above table, may be due to modifications by local influences, habit, etc. The Igorots have the smallest index which may indicate greater purity of type than in the other groups. The index of the women, similar to that of the Iberian, is greater than that of the men. The index is slightly greater than that of the Iberian type, but is practically the same. The head of the Japanese is the largest, that of the Morgue the smallest, and the Student is between the two in head size. This is true also of the Iberian type.

The nasal index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	96.4
3	____do	♀	92.0
9	Igorots	♂	97.7
2	Japanese	♂	92.7
30	Students	♂	92.7

The index is greater for the Igorots and Morgue than for the other groups, which are all alike. The Igorots and Morgue subjects are probably purer than the others as already indicated by the stature and cephalic index, particularly of the Igorots. The nasal index of the women, unlike that of the Iberian and Primitive type, is less than that of the men, otherwise the nasal index of the Australoid is greater than that of the Primitive. There is not so much evidence of blending with the Iberian or Primitive in nose type as there is in stature and head form.

The morphologic face index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	75.3
3	____do	♀	77.1
2	Japanese	♂	79.5
30	Students	♂	81.1

This is practically identical for the Students and Japanese, but it is less for the Morgue subjects and in this way resembles the Iberian type.

The brachial index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	80.0
3	____do	♀	78.9
9	Igorots	♂	75.1
2	Japanese	♂	62.6

The brachial index is discordant in the several groups and does not differentiate the Australoid from the other types so well as the crural index. The Japanese have a low index as in the other types. The index is less for the Igorots than for the Morgue subjects, as in the Primitive. The Igorot index is nearer the Iberian than the Primitive, whereas the Morgue subjects are nearer the Primitive than the Iberian. The brachial index may be a group differentiator rather than a differentiator of type.

The crural index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	101.1
3	do	♀	106.0
2	Japanese	♂	106.0

The crural index of the Morgue males of this type is not essentially different from that of the Iberian type, although it is 2 points nearer the Primitive than is the Iberian. The Japanese and the Morgue females have an identical relation to each other in the Australoid and Iberian types, and the Primitive Morgue male is intermediate between the two, in relation to both type and group.

The shoulder-hip index of the Australoid type.

No.	Group.	Sex.	Index.
5	Malecon Morgue	♂	82.6
3	do	♀	83.2
2	Japanese	♂	71.6

The index of the men is midway between that of the Iberian and Primitive. The small index of the Japanese and of the women is due to the wide shoulders.

Differential factors of the Iberian, Primitive and Australoid types—adult males.

Characters.	Iberian.	Primitive.	Australoid.
Stature	163.8	151.1	158.1
Cephalic index	75.3	86.4	76.5
Nasal index	73.5	88.7	93.9
Morphologic face index	84.3	77.7	80.2
Brachial index	71.6	80.7	75.1
Crural index	98.6	107.1	102.5
Hip-shoulder index[a]	83.4	79.3	82.6
Intermembral index	73.7	72.0	70.3

[a] Morgue subjects only.

This table includes the Igorots, Japanese, Manila Students and Morgue males measured by me, and the numbers given are the averages for all the individuals of the groups that were measured. The Primitive type is not found among the 10 Japanese, but it would no doubt be found if a larger number were measured.

The Filipino Iberian is not exactly the same as the Mediterranean Race of Sergi, but is really a Spanish-Filipino Mestizo. Two distinct color markings are noted: one is a dark skinned, almost black individual, much darker than the average Filipino; the other is almost white and looks more like a European than a Filipino. The former may be the Indian-Filipino mestizo, and the latter the Spanish-Filipino mestizo; or, if this be not true, then the pigment of Iberian and Filipino react according to Mendel's laws, being intensified in the one and decreased in the other. The Iberian is a remarkably pure type, and, in spite of crossing with the Filipino, remains almost pure especially in the characters given above.

The Primitive type is also pure and probably remains so, but the evidence of crossing can not be positively known as it may be for the Iberian. The two types are extremely different, and more distinct than any other types as evinced by the differences. The origin of the Primitive can not be located with certainty although accumulated evidence points to the Negrito as at least a closely related type. However, either one or both may be only primitive forms due to retarded development. The stature of the Primitive is small, the head is small and round, the nose and face are broad, short and flat. These infantile characters and possibly others, may mean only stunted growth, but, whatever the cause, the type is none the less a true type. Its distribution among Igorots, Students and Morgue subjects indicates that it forms a part of all the Filipino population. If it is the same as the Negrito, with straight instead of kinky hair, as it certainly is by physical measurements, then it is present in many of the Pacific Islands as well.

The Australoid is nearly the same as the Iberian in stature, cephalic index, brachial index and shoulder index; it is nearly the same as the Primitive in nasal index and morphologic face index, and it is intermediate between the two in crural index. The nasal index is the only character that is not between the Iberian and Primitive, and this is the most characteristic trait of the Australoid. The evidence so far accumulated points directly to the Australoid as a cross between the Iberian and Primitive. The stature of the Igorot Australoid is, however, less than that of the other Australoids, and the nasal index is greater. This is probably the ultimate end result of the blending process. The others are more recent blends and, in time, would be like the Igorots under the same conditions.

OMPHALIC INDEX.

This index can not be determined exactly because the height of the pubis was not measured, but the height of the trochanter may be substituted for it. This will not show such a distinctive difference, because the pubis is probably lower in the Primitive than in the Iberian type. However, there is a difference. The Iberian index, using the trochanter instead of the pubis, is 40, and the Primitive index is 43.1: This difference is similar to that between the Bontoc and Lowland Igorots, the Iberian and Bontoc being alike, and the Primitive and Lowland alike. It also places the Primitive nearer the women than is any other type.

II. REMAINING TYPES.

There are so few individuals to represent the remaining types that they are all discussed together. The Cro-Magnon, B. B. B., Alpine, and Adriatic are placed in the table which follows, and the Iberian and Blend alongside, in order that each may be compared with the other. A glance along the columns of this table will reveal very slight differences between the types of the Students and of the Morgue subjects, a fact that argues for the verity of the types.

TABLE I.

Character.	Iberian.		Alpine.		B. B. B.		Adriatic.		Cro-Magnon.		Blend.	
	Morgue.	Student.	Japanese.	Student.	Morgue.	Student.	Morgue.	Student.	Morgue.	Student.	Morgue.	Student.
Stature	163.4	164.3	160.0	160.2	166.3	168.8	165.0	168.6	173.0	170.0	159.8	163.8
Cephalic index	76.6	75.2	84.6	86.9	82.4	86.2	85.0	88.0	74.6	80.5	82.5	82.4
Nasal index	68.1	73.9	65.4	72.9	65.7	72.0	100.0	92.9	92.1	80.6	83.2	84.8
Morphologic face index	79.9	86.4	83.3	83.0	84.0	82.9	82.1	78.4	86.4	82.6	80.0	82.4
Brachial index	71.6	------	76.6	------	74.7	------	79.7	------	78.6	------	77.2?	------
Crural index	98.6	------	85.0	------	90.0	------	104.0	------	99.2	------	95.2	------
Intermembral index	73.2	------	69.8	------	68.1	------	70.3	------	70.6	------	71.3	------
Ear index	58.3	------	63.3	------	61.3	------	54.6	------	58.9	------	59.6	------

THE ALPINE AND B. B. B. TYPES.

The characteristics of the Alpine type are stature below the average, brachycepalic head, leptorhine nose, short lower legs, relatively wide ears and short upper extremities. It is more like the blend than any other type, and is almost identical with the B. B. B. except in stature, which was arbitrarily chosen. Both have the highest ear index of all types, the lowest intermembral index of all types, the lowest brachial index except that of the Iberian, and the lowest nasal index of all types It must be remembered, too, that there is only one Japanese Alpine, and only three B. B. B. Morgue subjects; therefore, the close approximation of these to the 30 Alpine students and 21 B. B. B. students is remarkable and emphasizes the types as real entities. The differences between the Alpine and B. B. B. types are not so great in the characters measured as in the characters observed, such as the square head of the B. B. B. and the round head of the Alpine, the square ear of the B. B. B. and the round ear of the Alpine, and the general stocky build of the B. B. B. and the rotundity of the Alpine, although the head of the student B. B. B. is 5 millimeters longer and 3 millimeters wider than that of the Alpine, and the head circumferences of the B. B. B. are all larger. The face of the Student B. B. B. is 4 millimeters longer and 3 millimeters wider than the face of the Alpine, and the nose is 2 millimeters longer and 1 millimeter wider. The cephalic index is less for the B. B. B. than for the Alpine. The two types would be classed as one if it were not for the differences mentioned, all of which are slight, however, and the separation may prove to be an arbitrary one. I have already expressed an opinion that the B. B. B. is the result of the union of the Alpine and Iberian with possibly Cro-Magnon elements, and I still persist in holding that opinion.

THE CRO-MAGNON TYPE.

This type is the tallest thus far encountered in the Philippines, and the cephalic index is the least of all the types from the Morgue. The nasal index is high, the morphologic face index is also high, as well as the brachial, crural, and intermembral indices. In other words, the head is long and narrow, the nose is short and wide, the face is long and relatively narrow and the forearms, lower legs, and upper extremities are relatively longer than those of the other types. The Cro-Magnon students are largely blended with the other types and partake only to a slight extent of the Cro-Magnon characteristics, as may be seen by reference to the table above, and as expressed in the paper on Manila Students.

The Cro-Magnon resembles the Australoid in cephalic index, nasal index and other characteristics, but is distinctly different in stature, the Australoid being the smallest of all types, and the Cro-Magnon the tallest. A relation between the two, similar to that which exists between the B. B. B. and Alpine, may be true, but the relationship is not so intimate.

THE ADRIATIC TYPE.

This type is tall and has broad head, face, and nose. The other characters are not distinctive, although the forearm and lower leg are rather long. The Adriatic is an enlarged reproduction of the Primitive type, but it is as far removed from the latter as the Cro-Magnon is from the Australoid. The Chinese element of the Adriatic may account in part for the difference.

SUMMARY.

I would suggest that the Adriatic and Primitive are derived from one source, and that the Cro-Magnon and Australoid are derived from one source, but the two sources are not the same. Transferred to Europe from the south of Asia or some other part of the East in prehistoric times, the Primitive and Australoid may have evolved there the Adriatic and Cro-Magnon in much the same way that Sergi accounts for the evolution of the Nordic type from the early Mediterranean Race, the Iberian type. The Sarasin brothers and Martin have found in Ceylon, in the Celebes and in the Malay Peninsula, and others have also found elsewhere, a type closely simulating the Australoid, and they look upon this type as one of the primary types of men from which have sprung many races. The work that I have done adds its mite toward that hypothesis, and illustrates in a more definite way some of the types that may have resulted from this primitive precursor. I believe, however, that my work also demonstrates another type which I call Primitive, that is antecedent to the Australoid and has helped to produce the Australoid by its blending in a disharmonious manner with the Iberian, the latter having probably disappeared in other parts of the East as it has from among the Igorots. The objection to the types selected may be that too few individuals were observed, and if 1,000 individuals had been measured, at least some of the types would fuse by closing of gaps between them with intermediate forms that are necessarily absent when so few are considered. For instance, I have demonstrated the similarity of the Primitive, Modified Primitive and Adriatic, of the Alpine and B. B. B., and of the Australoid and the Cro-Magnon. There are gaps between the types among the Students as well as among the Morgue subjects, but if a larger number were measured these gaps might be bridged over. If this be true, then the types selected represent cross sections of variable species, and this is additional proof that the types are elementary species, and probably represent the separation and segregation by variation and modification of new elementary species of man.

III. HEAD OUTLINES.

Lead fuse wire was used for making three contours of the head in the same way that similar contours were made of the Igorots and of the students of the University of Michigan. Representative outlines of each type are selected for comparison. None of the female Primitive or Australoid head outlines were taken, but the female Iberian and Alpine are presented.

The head of the Alpine woman is almost identical in size and shape with the head of the Primitive man. Both show dorsal flattening and the woman's forehead is characteristic of the female. The head of the woman is distorted behind, which gives a bulging appearance at one side of the horizontal outline. The similarity of the Alpine and Primitive head outlines indicates a close relationship between the two types.

When these outlines are compared with those of the Iberian type a great contrast is observed. Whereas the Primitive is short and broad, the Iberian is long and narrow. The female Iberian outline is smaller than the male, and the Japanese is longer and not so high as the Filipino. The shape of the three Iberian head outlines is similar, each presenting the square vertical forehead and the projecting occiput, so characteristic of the Iberian. There is no appreciable flattening of the dorsum of the head except that of the woman, which may not really be flattened, but exhibits a sloping plane in the rear as noticed to some extent in the Japanese and Filipino male, but at a different angle. The Japanese has a slight indication of scaphocephaly noted by the prominent sagittal eminence of the coronal outline.

The Japanese and Filipino Australoid are almost identical except that the Japanese is longer and not so high, a characteristic that holds true for all the Japanese types. This is similar to the American student; and the Filipino resembles the Igorot by contrast with the Japanese. The Australoid is unlike the Iberian or the Primitive, but resembles the former more than the latter. The head is long, narrow and oval. The forehead is vertical but not square and the occiput does not bulge nor is it flat. The lines of the head look as if the Iberian had been changed only slightly in being rounded off by the Primitive. The Igorot Australoid (type A) head outline is almost identical with that of the outline of the Australoid herewith presented.

The head outline of the Blend of both Japanese and Iberian represents a composite with characteristics resembling different types, and its blended appearance speaks for itself.

The Cro-Magnon Filipino is placed with the Chinese Blend for comparison and contrast. The shape of the two is not greatly unlike except in the frontal region. The Chinese has a sloping head, whereas the forehead of the Cro-Magnon is vertical or bulging. The other characteristics of the European Cro-Magnon are present to some extent. The difference in size between the two individuals is a matter of no great significance, because a Chinaman with a large head and a Filipino with a small head could be found easily.

Further comment on the head outlines is unnecessary, because they are graphic representations and words are inadequate to describe them. Outlines made in the manner of these should be taken with reservations, because they can not be made to conform exactly to the head, and they may be slightly distorted by handling before they are transferred to paper. However, I believe they represent in a fairly accurate way the general contours of the head, and they can be easily taken. As the lead fuse wire is convenient for transportation, the method should be utilized by careful investigators. I have devised a head machine which will be perfected shortly, and with it exact outlines can be made in any direction over any part of the head and face. A description of the head machine, with photographs, is soon to be published.

IV. AMPLIFIED SCHEME FOR HEREDITY.

The relative number of each type is given in the following table of percentages:

Relative number of adult male individuals of the various types in the different groups.

Type.	Primitive.	Australoid.	Iberian.	Modified Primitive.	Alpine.	B. B. B.	Adriatic.	Cro-Magnon.	Blend.
Malecon Morgue	16.6	10.4	10.4	2.0	2.0	6.3	2.0	6.3	43.8
Manila Students	2.4	8.0	6.6	12.2	8.0	5.6	6.4		50.0
Igorots	8.0	9.0				8.0			75.0
Japanese	?	20.0	50.0		10.0				20.0

Malecon Morgue receives a larger proportion of the Primitive, Australoid, Iberian and Cro-Magnon types than is found among the Igorots or the Students, and there are fewer Modified Primitive, Alpine, Adriatic and Blends than among the Students.

The Japanese are too few to draw conclusions from, but it is of interest to note the Australoid, Iberian, and Alpine types among them. the large percentage of Iberians being especially significant.

When the above table is taken in connection with the scheme for heredity herewith reproduced and amplified, one may calculate, somewhat inexactly, the relative condition of amalgamation represented by each group of measured individuals. The calculation is somewhat inexact because of many unknown factors. If only two pure types are concerned, the calculation would be almost exact in representation of the degree of amalgamation of the two types by interbreeding; but more than two types have mingled in each group; the types have not been pure, i. e., perfect blends, or homozygotes of Mendelian characters; and the minglings, re-minglings, crosses and re-crosses have been many and varied. In spite of these disturbing factors, the degree of homogeneity of the population, or the condition of amalgamation, or the extent of the blending process, may be determined approximately. We will consider first the readjusted scheme for heredity, then calculate the degree of mixture of each group in relation to it.

AMPLIFIED SCHEME FOR HEREDITY.

In the scheme for heredity *D* and *R* represent the homozygotes of an allelomorphic pair that meet at 1 in sexual union, begin to blend at 2, present the picture of a variable blend at 3, and fuse completely into a perfect blend at 4. A horizontal cross section of the diagram at any point represents the relative number of individuals of the different kinds present at that time in the process of amalgamation, provided procreation has been continuous and always with the same relative increase in numbers. The width of the diagram, exclusive of the spaces B^3, also indicates the amount of variation at any time. D=homozygous dominants; R=homozygous recessives; DR=heterozygotes; B^1 (inside the solid lines) =a variable blend ever increasing in number with each successive generation; while D, R, and DR decrease to disappear entirely at 3. B^2 (inside the solid lines) represents the continuation of the blend without either of the originals of the allelomorphic pair, but with all shades of intervening characters blending in various ways as influenced by ancestry and by environment, until a homozygote is formed at 4. B^3 (inside the solid lines) represents the increasing purity of the blend until at 4 a perfect blend or an elementary species is formed.

From 1 to 2 True Mendelism exists, Spurious Mendelism is found from 2 to 3, and from 3 to 4 No Mendelism is present, but two tendencies prevail: (a) the reversion to type, and (b) the tendency to blend.

This scheme represents the individual characters but it may also apply to the type composite, although some characters may not follow the scheme but exhibit blending at once when crossed, without intervening Mendelism. Therefore some characters should be represented in one part of the scheme while others are represented in other parts. In types with extremely divergent characters, such as the black and white coat in guinea pigs, Mendelism may persist as indicated in the scheme; whereas if the types that cross are similar, the result may be a more or less perfect blend immediately. The Mendelism is overleaped and the types pass at once into the conditions represented between 3 and 4, or that of a variable blend with No Mendelism.

The ultimate result of a process where many types are blending will depend upon many factors such as environment, natural and sexual selection, the relative number of each type which enters into the amalgamated product, the dominance of one type over another, the time during which amalgamation has taken place, etc.; and the elementary species formed may be unlike the original types, yet not a perfect blend. (For example, the Australoid, as a result of crossing the Iberian and the Primitive.) The calculation may now proceed. The relative number of blends in proportion to the number of types is to be considered, also the number of each type present, and finally the condition of the types as to purity.

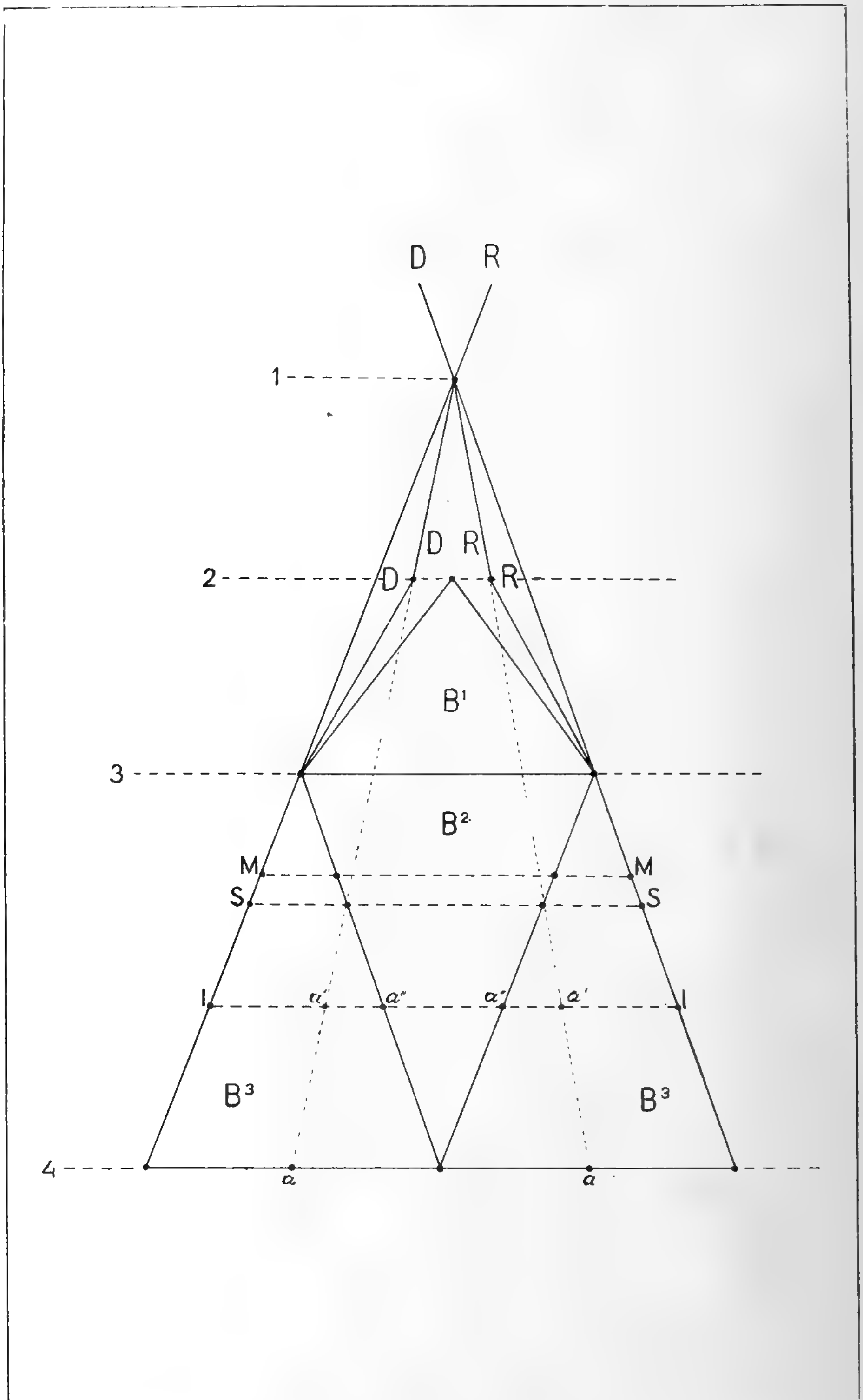


Diagram Representing Scheme for Heredity.

The greatest number of blends is represented among the Igorots, the least among the Japanese, which would indicate that the Igorots are more completely amalgamated than the Japanese, but there are too few Japanese from which to draw conclusions.

A review of the blends of the Igorots, using the methods adopted for selecting the Student and Morgue types, reveals 8 that resemble the Iberian type, and 70 that resemble the Australoid, which would reduce the number of blends and increase the other types accordingly. There are undoubtedly traces of the Iberian among the Igorots, and a careful inspection of the frontispiece of the work on the Benguet Igorots,[1] Plates I, II and III, reveal Iberian characteristics. The ears of the Igorot portrayed there are Iberian type *b*.

The Igorots evidently have more Australoids than previously designated, and a few Iberians, but they are not so pure as those originally selected, and should be classed as blends. If we accept these additional Australoids and Iberians, the Igorots are not so completely amalgamated as the Students and Morgue subjects, but they should not be classed with the types because they are manifestly impure, and are only blends that resemble Australoid and Iberian more than any other types. The Student Australoid represents both recent and remote Iberian and Primitive amalgamated, whereas the Igorot Australoid represents only the remote Iberian and Primitive amalgamated. The Igorots, therefore, are the most completely amalgamated of the three Philippine groups, and the Students are more amalgamated than the Morgue subjects. This is determined by the relative proportion of the blends without reference to the purity of the types. The latter will now be considered.

The types selected from among the Igorots show resemblances to European and Negrito, but they are not pure types, and one type, the Australoid (type A), is distinct and represents a new type, the result of the disharmonic union of the Iberian and the Primitive. This is additional evidence in favor of the nearly complete amalgamation of the types that make the Igorot. The presence of the Australoid blends in so large a proportion among the Igorot blends necessitates an elaboration of the scheme for heredity to indicate that one-half of the blends are Australoid, the other half being divided among the individuals that resemble the Iberian, type M and type N, besides those that may be perfect blends. The Australoid type is represented outside the broken lines a–a in the scheme for heredity, and a correct representation of the relative proportion of the Australoid comprises one-half of the population, which is probably true. This complicates the scheme, but the following explanation may clarify it somewhat. The broken line I–I represents the position of the Igorots. Between I and a^1 are the Australoids which are

[1] *This Journal Sec. A.* (1908) **3**. 413.

relatively pure blends. Between a′ and a″ are the other relatively pure blends. Between a″ and a″ are the impure or variable blends (represented by type M and A and the Iberian). If at any time, by reason of certain conditions, one type increases in numbers more rapidly than another, then the relative proportion which at present exists will be altered. The Australoid now predominates, and if it was not previously present in equal numbers with all the other types, then it is increasing more rapidly than the other types. Among the Japanese the types selected are not pure, but there is a general resemblance among them in such characters as face width, stature, upper arm length, and hip-shoulder index, in which they differ from the other groups. The small number of blends is therefore counterbalanced by the homogeneity of the individuals to such an extent that all the Japanese may be considered as blends, and the types merely resemble their prototypes of the other groups. In consideration of this and because of the small number of individuals who are all from the same culture level, the Japanese are omitted from the scheme for heredity.

The Manila Students are composed of at least three comparatively pure types: Iberian, Primitive, and Australoid, and of several other types that are not so definite: the Alpine, B. B. B., Modified Primitive, Cro-Magnon, and Adriatic. The purest of types are the Iberian and Primitive, the Iberian the purest of all, the Australoid not so pure because it is a mixture of the two, a mixture that has had two successive stages: one remote in time and one recent; the former well represented by the Igorots, the latter better by the Students, which naturally makes the type more variable than the two of which it is composed, they having remained constant in physical characteristics through time and space where not mixed with other types. However, if the types are considered in connection with the blends, there is an equal number of the two (types and blends), and the line S–S would represent the position of the Student in the scheme for heredity if we omit the Iberian, which must be placed above 3 because of its evident purity. It can not be located exactly, but I believe it will exhibit Spurious Mendelism between 2 and 3, and probably in some characters it will exhibit True Mendelism which would place it between 1 and 2.

If the Primitive is a pure type, and if it has not changed its form (does not represent the Negrito undergoing metamorphosis) throughout its existence, it must be placed in a position very near that of the Iberian; but if it is a modified Negrito, the type is not so pure as the Iberian, the loss of kinky hair indicating metamorphosis, and it may be placed with the other types in B^2 between 3 and 4.

The Morgue subjects are in a condition of amalgamation similar to that of the Students, although the actual number of blends which would place them at M–M is less. Here again, as among the Students, the

Iberian and Primitive types, if pure, would alter the position, placing the group in Spurious or Pure Mendelism instead of in No Mendelism. The real condition of both Students and Morgue subjects is probably this: the Iberian and the Primitive types, with the Australoid and their blends, are in a condition of Spurious or Pure Mendelism between 1 and 3, whereas the other types and their blends are in a condition of No Mendelism between 3 and 4, yet above the position of the Igorots. The Cro-Magnon and its blends are nearer the Igorot than any other, and may be more advanced toward complete amalgamation than any type, even beyond the condition of the Igorots.

To summarize: The Japanese are too few in number to justify generalizations, although they are probably in a condition of No Mendelism. The Igorots are in a condition of No Mendelism and by actual calculation they are nearer 4 than 3, but by reason of the presence of certain types that approach purity they may be nearer 3 than 4. The Manila Students and the Malecon Morgue subjects indicate at least three and probably four stages of blending present at the same time: first, the Iberian with its blend is in a condition of True and Spurious Mendelism; second, the Primitive and the recent Australoid with their blends are in a similar condition or one of Spurious Mendelism; third, the remaining selected types with their blends, judging by their similarity to the Primitive and to each other, may never have passed through a condition of Mendelism, but entered immediately into an imperfectly blended condition of No Mendelism near 3; finally the Cro-Magnon and other elements are so firmly fused as to be almost perfect blends and are represented by No Mendelism near 4.

The following inferences may be drawn from the previous representations: The Cro-Magnon and earlier forms first entered into a fusion that started at a time remote from the present. This was followed by a union of the Primitive and Iberian which formed the Australoid, and the three types with their blends joined the Cro-Magnon and earlier forms with their blends. At a still later time, some of the other types and their blends with the Primitive and Australoid joined the fusing types mentioned before, the result of this at present being the Igorots and other people of the interior. Continuous infusions of the other types and their blends with the Primitive and Australoid, and the minglings of all these elements in a disorderly way, resulted in the mixed population of the lowlands or the littoral Filipinos. The Chinese have been almost continuously entering the Philippines, and their types, the Iberian, Cro-Magnon, Alpine, B. B. B., and Adriatic, which are but modified Europeans, have fused with the others. The more recent occupation of the Archipelago has brought the pure Iberian and its blends with the Alpine, B. B. B., and Adriatic, as well as some Cro-Magnon blends into contact with the littoral people, and the Manila Students and

Morgue subjects represent random samples in two small selected strata of this composite population. Even though all European types originated primarily by the union of two divergent forms similar to the Nordic type of Denniker and the Primitive type herein described, yet the above inferences need not be vitiated thereby because the types of Europe had become distinct by isolation, etc., before penetrating the East, and all of these may not have reached the Pacific in the successive waves of migration eastward.

IV. GROUP AVERAGES.

Each measured character will now be examined by averages for the whole of each group, beginning with stature:

Stature.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
47	♂	Malecon Morgue	148.0	160.5	174.0
10	♂	Japanese	153.5	161.7	171.0
377	♂	Manila Students	146.0	163.3	178.0
104	♂	Igorots	135.0	154.0	170.0
22	♀	Malecon Morgue	142.0	151.0	161.0
10	♀	Igorots	142.0	146.7	154.0

The stature of the Students exceeds that of any other group, which may be interpreted in terms of better nurture, or of mestizo blood, or of both, probably the last. The stature of the Igorots is less than that of any other group, and is probably due to the predominance of the Australoid and Primitive types, although nurture may play a part. The Japanese are taller than the Igorots, because they have a greater proportion of European blood (Iberian, Alpine, etc.), for here nurture could hardly exert a different influence on the two groups, although it may have. The Malecon Morgue group has a greater stature than the Igorots for the same reason. They are undoubtedly a poorly nourished group, yet their nurture has not reduced the stature to that of the Igorots. Generalizations such as those just given may not be justified when so few individuals are under consideration, but the indications point strongly to the inferences stated.

Cephalic index of the head—not the skull index.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	72.19	81.99	92.85
10	♂	Japanese	71.3	77.65	84.6
377	♂	Manila Students	72.0	82.1	98.0
104	♂	Igorots	71.7	77.6	86.0
21	♀	Malecon Morgue	75.0	81.85	90.6
10	♀	Igorots	74.0	77.5	81.0

The Igorots and the Japanese are so nearly identical in cephalic index that they must be related peoples if head form is a criterion of type, and at the present time it is one of the best criteria in use. The presence of the Iberian and Australoid types, which have similar head forms among both the Japanese and Igorots, readily accounts for the relationship. The Morgue and the Student groups have almost identical cephalic indices, and their heads are wider than the others. This is no doubt due to a great preponderance of the Primitive, Modified Primitive, Alpine, B. B. B., and Adriatic among the littoral Filipinos. Nurture could hardly exert an influence on head form, but distortion by the sleeping position in infancy and childhood should be considered as a factor, especially in extreme brachycephaly. There are, however, broad heads with no apparent distortion; therefore distortion will not account for all broad-headedness.

Head length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	15.8	17.9	20.5
10	♂	Japanese	17.5	19.1	20.6
377	♂	Manila Students	16.3	18.4	20.5
104	♂	Igorots	16.9	18.8	20.1
21	♀	Malecon Morgue	16.3	17.5	18.6
10	♀	Igorots	17.5	18.2	19.2

The head length conforms to the cephalic index in that the long headed Japanese and Igorots are mesocephalic, and the shorter headed Morgue and Students are brachycephalic. The Japanese have the longest heads, although they are not much longer than the Igorots. The range of variation is greater for the Morgue males than for any other group as indicated by the minimum and maximum head length. The shortest head occurs among the male Morgue subjects, the longest among the Japanese.

Head breadth.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	13.4	14.7	16.0
10	♂	Japanese	14.2	14.8	15.6
377	♂	Manila students	13.5	15.1	16.9
104	♂	Igorots	13.4	14.6	15.9
21	♀	Malecon Morgue	13.2	14.3	16.1
10	♀	Igorots	13.7	14.1	14.4

The broadest heads are found among the Students and the narrowest among the Igorots, although the Japanese and Morgue subjects are but little broader than the Igorots. The narrowest head occurs among the female Morgue subjects, and the broadest among the Students. The female Morgue subjects have the greatest relative range of variation in head breadth as indicated by the minimum and maximum, but the Students have absolutely the greatest range of variation, which they should have because of the greater number of individuals under consideration. Both the head length and the head breadth of the Students are greater than that of the Morgue subjects, therefore the Students have larger heads than the Morgue subjects. The Igorot head is about the size of the Students but is longer and not so broad. The Japanese head is a great deal longer than and almost as broad as the Students. The female head is smaller than that of the male in both dimensions.

Nasal index.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	55.1	84.4	110.0
10	♂	Japanese	64.0	80.7	100.0
377	♂	Manila Students	60.0	82.6	105.0
104	♂	Igorots	72.0	92.7	115.0
22	♀	Malecon Morgue	66.0	83.1	133.0
10	♀	Igorots	88.0	95.5	100.0

The high nasal index is largely confined to the Igorots, although the Morgue has a higher index than the Students or the Japanese. Nurture can have practically no influence on the nasal index, hence this is a good criterion of type. The female Igorots have a higher index than the male, whereas the female Morgue index is less than the male; therefore no conclusions are reached regarding the sexual relations of the nose. The Japanese have the least index, which indicates a greater proportion of European blood if we accept Risley's conclusions following a study of the castes in India. However, it may be only a greater proportion of Iberian in the Japanese which causes the low index, because the Iberian nose is narrower than the other European types, and the Iberian is present among the Japanese in a greater proportion than in the other groups, although the nose of the Japanese Iberian is wider than the Iberian type of the other groups. The greater proportion of Iberian among the female Morgue subjects may account for the nasal index being less with them than with the male Morgue subjects. The difference between the minimum and maximum indicates greater diversity of nose type among the female Morgue subjects.

Nose length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
47	♂	Malecon Morgue	3.80	4.66	5.30
10	♂	Japanese	4.10	4.56	5.20
377	♂	Manila Students	3.60	4.56	5.80
104	♂	Igorots	3.20	4.10	4.80
22	♀	Malecon Morgue	3.30	4.44	5.50
10	♀	Igorots	3.60	3.80	4.10

The Morgue subjects have the longest noses, the Igorots the shortest, and the Japanese and Students are intermediate with noses of equal length. The noses of the women are not so long as those of the men.

Nose breadth.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
47	♂	Malecon Morgue	2.70	3.92	6.20
10	♂	Japanese	3.40	3.66	4.10
377	♂	Manila Students	2.90	3.76	4.50
104	♂	Igorots	3.20	3.80	4.60
22	♀	Malecon Morgue	2.80	3.60	4.10
10	♀	Igorots	3.30	3.63	4.00

The Morgue subjects have the broadest noses, followed by the Igorots, the Students and the Japanese in order of breadth, the Japanese having the narrowest noses. The greatest extent of variation is in the Morgue subjects, among whom the broadest and the narrowest nose is found. The women have narrower noses than the men, and the nose is smaller throughout. The Igorot women have wider noses than the Morgue women.

Head height.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
45	♂	Malecon Morgue	12.3	13.1	14.8
10	♂	Japanese	13.1	13.3	13.7
104	♂	Igorots	11.4	12.9	13.8
21	♀	Malecon Morgue	11.8	12.6	13.6
10	♀	Igorots	11.9	12.3	13.1
372	♂	Manila Students	12.1	13.1	13.9

The Japanese have the highest heads, and the Students and Morgue males come next with slightly less, the Igorots having the least height except the women. The highest head is that of a Morgue male, and the lowest that of an Igorot.

Minimal frontal diameter.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
42	♂	Malecon Morgue	9.1	10.4	11.8
10	♂	Japanese	10.1	10.8	11.6
104	♂	Igorots	9.3	10.3	11.5
21	♀	Malecon Morgue	8.8	10.0	10.9
10	♀	Igorots	9.7	10.3	11.0

The Japanese have the widest foreheads, and the Igorots the narrowest, except that the forehead of the female Morgue subjects is narrower than the Igorots. If this is compared with the maximum interzygomatic breadth, practically the same relation is true.

Interzygomatic breadth—(maximum).

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
41	♂	Malecon Morgue	12.6	13.8	14.6
10	♂	Japanese	13.0	14.4	15.1
104	♂	Igorots	12.2	13.6	14.9
21	♀	Malecon Morgue	12.3	13.1	15.6
10	♀	Igorots	12.0	13.1	13.6
372	♂	Manila Students	12.1	13.6	15.1

The face of the Japanese is considerably wider than that of the Igorots which is not so wide as the Morgue subjects, but the same as the Students. The face of the women is narrower than that of the men.

Nasion hair line.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	4.6	6.7	8.5
10	♂	Japanese	5.8	7.0	7.9
104	♂	Igorots	5.8	7.1	8.8
21	♀	Malecon Morgue	3.8	6.1	8.0
10	♀	Igorots	6.0	6.3	6.6

The Igorots have higher foreheads than the others, but they are almost equaled by the Japanese. The forehead height is less for the women than for the men.

Chin-nasion.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	9.2	11.0	13.0
10	♂	Japanese	11.0	11.8	13.0
104	♂	Igorots	9.4	10.8	12.0
21	♀	Malecon Morgue	7.2	10.2	11.4
10	♀	Igorots	9.8	10.3	11.0
372	♂	Manila Students	9.7	11.1	12.7

Morphologic face index.

No.	Sex.	Group.	Mean.
41	♂	Malecon Morgue	79.7
10	♂	Japanese	81.9
104	♂	Igorots	79.4
372	♂	Manila Students	81.6
21	♀	Malecon Morgue	77.8
10	♀	Igorots	78.7

The absolute face height (chin-nasion) and the relative face height (morphologic face index) are greater for the Japanese than for any other, the Manila Students being second and the Morgue male third in this factor. The Igorot males have the shortest face, although the Igorot females have a longer face than the Morgue females, who have the shortest face of all.

Ear length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
45	♂	Malecon Morgue	5.0	6.1	7.1
10	♂	Japanese	5.3	6.3	6.7
104	♂	Igorots	5.0	5.8	7.0
22	♀	Malecon Morgue	4.6	5.9	7.3
10	♀	Igorots	5.2	5.6	6.0

Ear breadth.

45	♂	Malecon Morgue	3.1	3.6	4.3
10	♂	Japanese	3.2	3.4	3.8
104	♂	Igorots	2.7	3.2	3.8
22	♀	Malecon Morgue	2.8	3.4	4.2
10	♀	Igorots	3.0	3.2	3.5

The Igorots with the shortest ears have also the narrowest, but the Japanese with the longest ears have not such broad ears as the Malecon Morgue subjects. The longest ear and the shortest ear are found among the Morgue females, the widest ear is on a Morgue male, and the narrowest on an Igorot male.

Mouth breadth.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
47	♂	Malecon Morgue	3.0	4.9	6.0
10	♂	Japanese	4.3	5.0	5.6
69	♂	Igorots	4.0	4.8	5.3
21	♀	Malecon Morgue	4.0	4.7	6.0
10	♀	Igorots	3.8	4.4	5.0

Upper lip breadth.

49	♂	Malecon Morgue	0.4	1.0	1.4
10	♂	Japanese	0.6	1.1	1.4
69	♂	Igorots	0.8	1.2	1.3
21	♀	Malecon Morgue	0.6	0.9	1.3
10	♀	Igorots	0.8	1.1	1.3

The mouth of the Japanese is the widest, but the others are almost as wide, except the Igorot women, who have very narrow mouths. The lips of the Igorots are the thickest, and the lips of the female Morgue subjects the thinnest. However, it is not right to compare the lips of the living with those of the dead. There are, nevertheless, wide mouths and thick lips among the Morgue subjects.

Inter-eye distance.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
40	♂	Malecon Morgue	2.6	3.3	4.3
10	♂	Japanese	3.0	3.4	4.1
104	♂	Igorots	2.7	3.4	4.1
22	♀	Malecon Morgue	2.5	3.3	3.7
10	♀	Igorots	3.0	3.3	3.7

Eye breadth.

	♂	Malecon Morgue	2.5	2.8	3.3
10	♂	Japanese	2.6	3.0	3.3
104	♂	Igorots	2.6	2.9	3.5
22	♀	Malecon Morgue	2.3	2.7	3.1
10	♀	Igorots	2.5	2.8	2.9

The distance between the eyes is so nearly the same that no comment is relevant, except to note the fact. There is also little difference in eye width, although the Japanese have wider eyes than the Morgue subjects, and the men wider eyes than the women. The narrowest eye is in a Morgue female, the widest in an Igorot male. The narrowest inter-eye distance is in a Morgue female, the widest in a Morgue male.

Trochanter height.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	72.0	84.1	98.4
10	♂	Japanese	75.4	81.3	88.3
104	♂	Igorots	71.7	79.4	88.0
22	♀	Malecon Morgue	76.4	77.7	91.0
10	♀	Igorots	68.3	74.1	82.3

Pubic height.

10	♂	Japanese	72.6	79.6	84.8
104	♂	Igorots	68.0	77.6	88.0
10	♀	Igorots	64.0	71.6	77.3

The male Morgue subjects with less stature than the Japanese have a greater trochanter height, which indicates the Japanese to be short legged, or the Morgue subjects long legged. The women have shorter legs than the men. The pubic height indicates the same relationships. The pubis is relatively lower in the women than in the men.

Sternum height.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
42	♂	Malecon Morgue	121.0	130.9	147.0
10	♂	Japanese	123.6	131.2	141.6
104	♂	Igorots	92.0	125.3	138.6
21	♀	Malecon Morgue	111.0	123.8	142.0
10	♀	Igorots	111.0	119.4	125.0

The height of the sternum follows the stature, and is thus different from the height of the pubis and trochanter.

Umbilicus height.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
41	♂	Malecon Morgue	85.0	96.7	107.0
10	♂	Japanese	86.0	93.7	101.0
104	♂	Igorots	82.0	91.5	102.7
21	♀	Malecon Morgue	83.0	91.5	101.0
10	♀	Igorots	80.5	87.6	96.6

The height of the umbilicus has inverse relation to stature, the greater the latter, the less the former, except that the women with less stature than the men have a lower umbilicus, but it is relatively higher for the women, notwithstanding.

The omphalic index as determined for the Igorots is higher for the women than for the men, and if we may regard the pubic height of the Morgue men 1.75 centimeters less than the trochanter height, and the pubic height of the Morgue women 2.5 centimeters less than the trochanter height (the difference found for the Igorots and Japanese),[2] then the index for the women is 52.3 (Igorot women 50.0), and of the men, 42.0 (Igorot men 41.1), which confirms the fact that the omphalic index is much greater in women than in men. This is corroborated by further work at present under way.

Ankle height.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
46	♂	Malecon Morgue	4.4	5.89	7.5
10	♂	Japanese	5.2	5.77	6.1
13	♂	Igorots	3.5	5.40	7.8
22	♀	Malecon Morgue	4.0	5.50	7.0

[2] The pubic height was not measured in the Morgue subjects.

Lower leg length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
44	♂	Malecon Morgue	30.0	38.8	48.0
10	♂	Japaness	33.0	37.5	41.3
104	♂	Igorots	31.6	36.0	42.6
22	♀	Malecon Morgue	33.0	35.5	40.0

Upper leg length.

44	♂	Malecon Morgue	32.0	39.4	48.5
10	♂	Japanese	35.4	49.5	44.7
104	♂	Igorots	29.0	38.0	44.0
22	♀	Malecon Morgue	20.0	36.5	48.0
10	♀	Igorots	30.8	33.9	39.7

The ankle height of the Igorots is less than that of the others, as is to be expected from a previous comparison of the Igorots with other people. The lower leg of the Morgue males is longer than that of the others, absolutely and relatively, and the females, although not so long as the Igorots and Japanese, are relatively longer. The upper leg length of the Japanese and the Morgue males is the same and it is greater than that of the Igorots. The upper leg length of the Morgue females is greater than that of the Igorot females. The crural index (tibio-femoral) is greater for the Morgue subjects, which may be due to the greater proportion of Primitive and Australoid types among them, because these types have a higher crural index than any others.

Hand length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
48	♂	Malecon Morgue	15.4	18.3	21.0
10	♂	Japanese	16.0	17.2	19.0
104	♂	Igorots	9.3	16.3	20.0
22	♀	Malecon Morgue	16.0	17.3	19.5
10	♀	Igorots	11.8	15.1	17.0

The hand of the Morgue males is the longest, and that of the Igorots is the shortest, as would be expected from a previous study of the Igorot hand, which is very short. The relative hand length (relative to stature) is the same for Igorots and Japanese, 10.6, but it is greater for the Morgue subjects, 11.3 for males and 11.5 for females.

Forearm length.

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
48	♂	Malecon Morgue	22.0	24.7	27.5
10	♂	Japanese	18.7	22.2	24.5
104	♂	Igorots	15.9	22.4	27.5
22	♀	Malecon Morgue	20.0	22.3	24.5
10	♀	Igorots	17.8	20.5	22.9

Upper arm length.

48	♂	Malecon Morgue	25.0	31.1	39.0
10	♂	Japanese	28.1	32.7	36.7
104	♂	Igorots	25.0	29.4	34.5
22	♀	Malecon Morgue	25.0	28.6	36.0
10	♀	Igorots	24.3	27.1	30.3

The forearm of the Japanese and Igorot is the same, but the Morgue males have longer forearms. The upper arms of the Japanese are longer than the others, and the Morgue males are slightly longer than the Igorots. The Morgue females are longer in each than the Igorots, but the forearm is relatively longer than the upper arm.

Irrespective of type, the Japanese have longer upper arms and short hands. Are these racial traits?

The brachial index (radio-humeral) is 79.3 for the Morgue males, 61.7 for the Japanese, 76.2 for the Igorot males, 77.9 for the Morgue females, and 75.6 for the Igorot females. The Japanese have either unusually short forearms, unusually long upper arms, or both, probably the last.

Shoulder breadth (tips of acromion processes).

No.	Sex.	Group.	Minimum.	Mean.	Maximum.
47	♂	Malecon Morgue	27.0	32.0	37.5
10	♂	Japanese	33.4	37.1	39.4
104	♂	Igorots	30.5	34.7	39.0
22	♀	Malecon Morgue	26.0	29.6	32.3
10	♀	Igorots	29.2	32.0	32.8

Hip breadth (iliac crests).

47	♂	Malecon Morgue	23.9	26.2	31.0
10	♂	Japanese	25.8	27.6	28.7
104	♂	Igorots	21.7	25.6	29.8
22	♀	Malecon Morgue	24.0	26.0	29.0
10	♀	Igorots	23.7	26.0	28.0

The Japanese have both wide hips and wide shoulders, whereas the Morgue subjects, both male and female, have relatively narrow shoulders compared with the Igorots. The relative hip-shoulder breadth of the Morgue females (88.2) is less than that of French women (91.8) or

Belgian (94.5), and that of the Igorot women is much less (81.2). The difference is due more to the shoulder breadth than the hip breadth, although the latter is also less for Filipinos than for Europeans. The Japanese have relatively broader hips and shoulders than either the Europeans or Filipinos, and the relative shoulder breadth is much greater than the relative hip breadth. The Igorot is similar to the Japanese.

Relative shoulder breadth (relative to stature).

No.	Group.	Sex.	Breadth.
47	Morgue	♀	19.6
10	Igorot	♀	21.8
30	French[a]	♀	16.3
47	Japanese	♂	22.9
10	Morgue	♂	19.9
104	Igorot	♂	22.5
40	French[a]	♂	18.9

Relative hip breadth (relative to stature).

47	Morgue	♂	15.9
10	Japanese	♂	17.1
104	Igorot	♂	16.6
40	French[a]	♂	16.9
47	Morgue	♀	16.0
30	French[a]	♀	18.4
10	Igorot	♀	17.7

[a] Topinard: Elèmènts d' Anthropologie Gènèrale. Paris, 1888.

SUMMARY.

The characters that differentiate the Japanese from the other groups are: cephalic index, which is the same as in the Igorots, but different from the others; long, high head and wide forehead; narrow nose, relative to the other groups; face both long and wide, but relatively longer than that of the other groups; relatively long ears; wide mouth; wide eyes; high sternum; relatively short forearm and lower leg, and relatively long upper arm and upper leg; and absolutely and relatively wide shoulders and hips. With a stature about the same as that of the Iberian and other characters simulating the European, the Japanese resemble the European more than do the other groups.

The characters that differentiate the Igorots are: small stature; long, narrow head; exceedingly wide nose; narrow mouth; short hand; and wide shoulder. These all indicate the predominating influence or presence in great numbers of the Australoid.

The differential characteristics of the Morgue subjects are: broad head; cephalic index about the same as the Student; large nose, broader and longer than any other group; narrow eyes; high *trochanter* (long lower extremities); high umbilicus; relatively long lower legs, forearms, ankles and hands; and narrow shoulders. The discordant composite may be due to the large number of Iberian, Primitive and Australoid of comparatively pure type, although nurture can not be excluded as a factor.

The Students are characterized by tall stature; large, broad head; and other features that are more or less intermediate between the other groups. They probably represent a greater fusion of the European and Eastern types than the other groups, with a predominance of relatively tall broad heads. Nurture may have produced some effect in molding this group. The broad head may be due to studious habit, and the greater stature to better nourishment; but I am inclined to believe that both are due to the Chinese and European types as exhibited in the Alpine, B. B. B., and Adriatic, as well as in the majority of the blends.

The final conclusion, reached after a study of the four groups of individuals herein described, is that type has a greater influence than nurture during short periods of time, a few hundred or even a few thousand years. During the longer periods of time, especially with great change of climate, soil, food and water, as well as sociologic and economic conditions, nurture may play a greater rôle than type, although it can act only upon the elements present. Altering the words used, it may be said that during hundreds, or even thousands of years, heredity through variation is more important in molding the type of a people than is environment through modification; whereas environment may be of equal or greater importance during longer periods of time, especially if conditions are such as to favor rapid changes, either through stress and strain, or by different conditions of climate, soil, food, and drink.

It is a notable fact that the mestizo of the Iberian type presents a very unfavorable picture as seen from the results of my studies, whereas mestizos of the Alpine, B. B. B., and Adriatic types give a very favorable impression. The Iberians are small, delicate looking individuals with long, thin chests of the "habitus phthisicus;" 70 per cent of those measured in the Morgue died of tuberculosis; they form a greater percentage of Morgue subjects than of Students; they have the worst teeth and the lowest class standing of all Students; and they have practically disappeared from among the Igorots, either by absorption or by elimination through disease or otherwise.

On the other hand, the Alpine, B. B. B., and Adriatic are the most robust looking individuals; their stature is greater than that of any other types; they form a large number of the Students and practically never are found in the Morgue;[3] they have good teeth and their class standing is the best. These differences may be due to environment, but type is also a factor.

[3] They do not reach the Morgue probably because they are of the better classes and are cared for by friends.

VI. THE RELATION OF MORPHOLOGY TO DISEASE.[4]

In a previous work (I. Filipino Types. Manila Students) I designated the types selected as new or elementary species, and suggested that some of the types might be true systematic or old species from which the new elementary species have been derived. The present work not only confirms that idea, but enables the two kinds of species to be differentiated. The Primitive and the Iberian may be called systematic or old species, whereas the Alphine, B. B. B., Modified Primitive, and Adriatic are elementary or new species which are at present in process of formation and are therefore not so stable and definite as the other two. The Australoid and the Cro-Magnon are intermediate between the old and the new, but they are fairly stable and may be called systematic species. The Blends represent what will probably be the elementary Filipino species, or the Filipino race, of the future.

Great interest attaches to this classification because of the association of different diseases with the Iberian, Primitive, and Australoid, as well as with the Blends. Sufficient numbers of the other species, if we may call them such, were not found in the Morgue to justify deductions. The following tables give the actual number and the percentages of causes of death for each species:

Filipino species of man with cause of death—Malecon Morgue, 1907–8.

NUMBERS ARE ABSOLUTE.

Species.	Tuberculosis.	Beriberi.	Senile debility.	Chronic enteritis.	Septicæmia.	Accident.	Carcinoma.	Pyæmia.	Chronic nephritis.	Other diseases.	Total.
Iberian or Mediterranean	9	------	2	1	------	------	------	1	------	------	13
Primitive	1	4	------	------	------	1	------	------	1	7	14
Australoid	------	2	------	1	------	1	1	------	------	2	7
Blend	14	2	2	------	2	------	1	1	1	4	25
Others	3	1	------	1	1	1	------	------	------	2	9
Total	27	9	4	3	3	3	2	2	2	15	68

PERCENTAGES.

Species.	Tuberculosis.	Beriberi.	Senile debility.	Chronic enteritis.	Septicæmia.	Accident.	Carcinoma.	Pyæmia.	Chronic nephritis.	Other diseases.	Total.
Iberian or Mediterranean	70	------	15	8	------	------	------	8	------	------	100
Primitive	8	33	------	------	------	8	------	------	8	41	100
Australoid	------	30	------	14	------	14	14	------	22	28	100
Blend	56	8	8	------	8	------	4	4	4	8	100
Others	33	11	------	11	11	11	------	------	------	23	100
Total	41	14	6	5	5	5	2	2	2	18	100

[4] Presented before the Manila Medical Society in May, 1909.

The majority of deaths are caused by chronic affections. Tuberculosis heads the list with 41 per cent of deaths, beriberi follows with 14 per cent, and then, in the order given, come senile debility, 6 per cent, chronic enteritis, 5 per cent, septicæmia, 5 per cent, accident, 5 per cent, carcinoma, 2 per cent, pyæmia, 2 per cent, chronic nephritis, 2 per cent, and other diseases, 18 per cent. The other diseases include 1 case each of heart disease, uræmia, diabetes, asthma, meningitis, chronic rheumatism, hæmorrhagic purpura, typhoid fever, influenza, myocarditis, bronchitis, chronic cystitis, liver abscess, and insanity. The clinical diagnosis was confirmed by autopsy in only 23 cases, and these are given at the end of this work.

The most significant facts are that 70 per cent of the Iberians, 56 per cent of the Blends, and 33 per cent of the other types died of tuberculosis, whereas only one Primitive and not a single Australoid died of it. However, 33 per cent of the Primitive, 30 per cent of the Australoid, and but one Iberian died of beriberi. This would indicate that the Iberian is more susceptible to tuberculosis than the Blends and other types, and the Primitive and Australoid are comparatively free from the disease. On the other hand, the Primitive and Australoid are prone to contract beriberi, and the Iberian is not.

I would not draw any far-reaching conclusions from this, but only suggest that the species to which any individual belongs should be taken into consideration in the etiology of such diseases as beriberi and tuberculosis. Other factors play a part: we know that the tubercle bacillus is supposed to be the cause of tuberculosis, but we also know that the soil must be ready or the tubercle bacillus is of no avail. Eating uncured rice is said to be the cause of beriberi, but the physical condition of the individual plays an important rôle. If it can be demonstrated that the Iberian is sedentary and a house worker, whereas the Primitive and Australoid are active open-air laborers; if the Iberian does not live largely on rice, whereas the Primitive and Australoid are heavy rice feeders; and if more extensive observations do not corroborate the present findings, then the suggestion fails. It is put forward simply as a plausible factor in the etiology of the two diseases, tuberculosis and beriberi.

We have, in conclusion, the following inferences:

The Filipinos were originally composed largely of two systematic species of man, which I have termed Primitive and Australoid. To these have been added Chinese and European elementary species, especially in the cities and along the littoral of the Islands.

The elementary species represented by the European and Chinese are now in greater abundance than the systematic species, and the blends constitute about one-half of the littoral population.

The European mestizos and the blends are apparently more liable to tuberculosis, whereas the original Filipinos are comparatively free from the disease, but succumb more frequently to beriberi.

NECROPSY RECORDS[5] OF FOUR IBERIAN FILIPINOS—MEDITERRANEAN RACE.

Morgue No. 44.—Clinical diagnosis: chronic tuberculosis. Anatomic diagnosis: pulmonary tuberculosis; tuberculous enteritis; postural contractures; tuberculous kidneys.

Morgue No. 180.—Clinical diagnosis: pyaemia genital organs. Anatomic diagnosis: pneumonia of left lower lobe and part of left upper lobe; chronic splenic tumor; acute nephritis; perineal and scrotal abscess; gangrene of penis; peritoneal adhesions.

Morgue No. 188—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: chronic ulcerative tuberculosis of both lungs; chronic obliterative pleurisy right side; myocarditis and dilation of heart; fatty degeneration of kidneys; chronic splenic tumor; amœbic ulceration rectum.

Morgue No. 200.—Clinical diagnosis: intestinal tuberculosis. Anatomic diagnosis: chronic pulmonary tuberculosis; acute nephritis; acute and chronic amœbic dysenteric ulcerations large bowel.

NECROPSY RECORDS OF 5 PRIMITIVE FILIPINOS.

Morgue No. 22.—Clinical diagnosis: meningitis. Anatomic diagnosis: acute fibrinous and hæmorrhagic pleurisy right side; small abscesses left lung; accessory spleens; ulcers over left elbow; retention cysts, kidneys.

Morgue No. 43.—Clinical diagnosis: none. Anatomic diagnosis: broncho-pneumonia right lower lobe; œdema of lungs; healed ulceration of large bowel; chronic diffuse nephritis.

Morgue No. 140.—Clinical diagnosis: beriberi. Anatomic diagnosis: beriberi; dilatation of and hypertrophy of all chambers of the heart; general anasarca.

Morgue No. 39.—Clinical diagnosis: typhoid fever and tuberculosis. Anatomic diagnosis: typhoid fever; acute splenic tumor; typhoid ulcerations ileum; general gas bacillus infection; post-mortem changes of all organs.

Morgue No. 149.—Clinical diagnosis: beriberi; myocarditis. Anatomic diagnosis: broncho-pneumonia, both lower lobes; pleural adhesions, old, right side; acute splenic tumor; accessory spleen; acute diffuse nephritis.

NECROPSY RECORDS OF 4 AUSTRALOID FILIPINOS.

Morgue No. 29.—Clinical diagnosis: chronic dysentery. Anatomic diagnosis: amœbic dysentery; ulceration large bowel; chronic diffuse

[5] The records are from the pathological department of the Philippine Medical School.

nephritis; cystic kidneys; ulcerative tuberculosis of right lung; obliterative pleurisy, right; œdema of left lung.

Morgue No. 125.—Clinical diagnosis: acute beriberi. Anatomic diagnosis: dilatation and softening of the heart; fatty degeneration of the heart; œdema of ankles; anasarca; large, hard spleen; fatty degeneration of liver.

Morgue No. 143.—Clinical diagnosis: liver abscess and gall stones. Anatomic diagnosis: chronic fibro-pneumonia, left lower lobe; obliterative pleurisy, right lower lobe, with communication into large bronchus; chronic diffuse nephritis; chronic endocarditis, mitral valve.

Morgue No. 130.—Clinical diagnosis: carcinoma of left cheek. Anatomic diagnosis: carcinoma of left cheek, face and neck; œdema of lungs; healed tuberculosis of lungs; chronic myocarditis; chronic splenic hypoplasia; chronic cystitis; healed ulcerations large bowel; chronic obliterative appendicitis.

NECROPSY RECORDS OF 8 FILIPINO BLENDS.

Morgue No. 23.—Clinical diagnosis: general tuberculosis. Anatomic diagnosis: tuberculous pneumonia, left lower lobe; chronic ulcerative tuberculosis, left upper lobe; chronic caseous tuberculosis, right lung; obliterative pleurisy, right side; miliary tubercles, ileum; tubercular ulceration, transverse colon; acute diffuse nephritis.

Morgue No. 28.—Clinical diagnosis: tuberculosis and beriberi. Anatomic diagnosis; tuberculosis; chronic ulcerative and caseous, both lungs; pleural adhesions, right lung; obliterative pleurisy, left lung; cirrhosis of liver, early stage; ascaris infection.

Morgue No. 45.—Clinical diagnosis: intermittent fever. Anatomic diagnosis: septicæmia; cellulitis arm; periostitis; pustular skin eruption (smallpox?); post-mortem changes.

Morgue No. 174.—Clinical diagnosis: acute enteritis. Anatomic diagnosis: pneumonia lower left lobes; chronic tuberculosis both upper lobes; acute enteritis; chronic diffuse nephritis.

Morgue No. 194.—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: acute dilatation of heart; œdema of lungs; ascites; chronic pulmonary tuberculosis; chronic diffuse nephritis; fatty degeneration of pancreas.

Morgue No. 203.—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: chronic ulcerative tuberculosis, lower right lobe; obliterative pleurisy, right side; myocarditis and dilatation of heart; acute diffuse nephritis; acute splenic tumor.

Morgue No. 204.—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: chronic pulmonary tuberculosis; pleurisy, right side; chronic endocarditis; chronic splenic tumor; acute and chronic nephritis; tuberculosis of lumbar vertebra; large psoas abscess, right side.

Morgue No. 201.—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: pulmonary tuberculosis; chronic pleurisy, right side;

chronic diffuse nephritis; hydrocele, left side; chronic amœbic ulceration large bowel.

NECROPSY RECORDS OF 2 B. B. B. FILIPINOS.

Morgue No. 31.—Clinical diagnosis: chronic enteritis. Anatomic diagnosis: tuberculous enteritis; tuberculous peritonitis; chronic tubercular broncho-pneumonia, both lungs; chronic diffuse nephritis; hydrocele, left side.

Morgue No. 57.—Clinical diagnosis: pulmonary tuberculosis. Anatomic diagnosis: carcinoma of stomach; metastases of liver; emaciation; chronic tuberculosis of lungs and thorax; deformity from fracture of left tibia.

ILLUSTRATIONS.

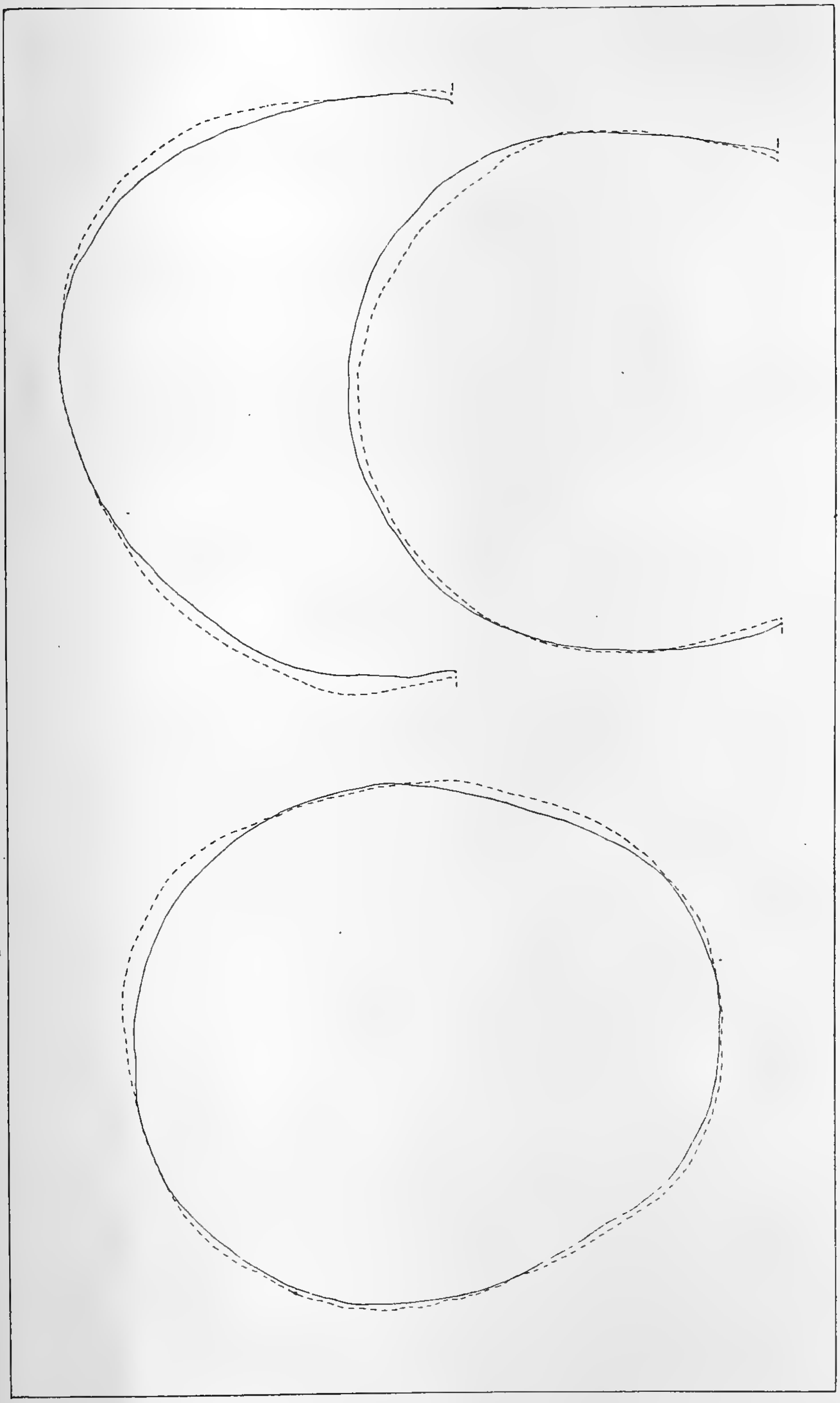


PLATE I.

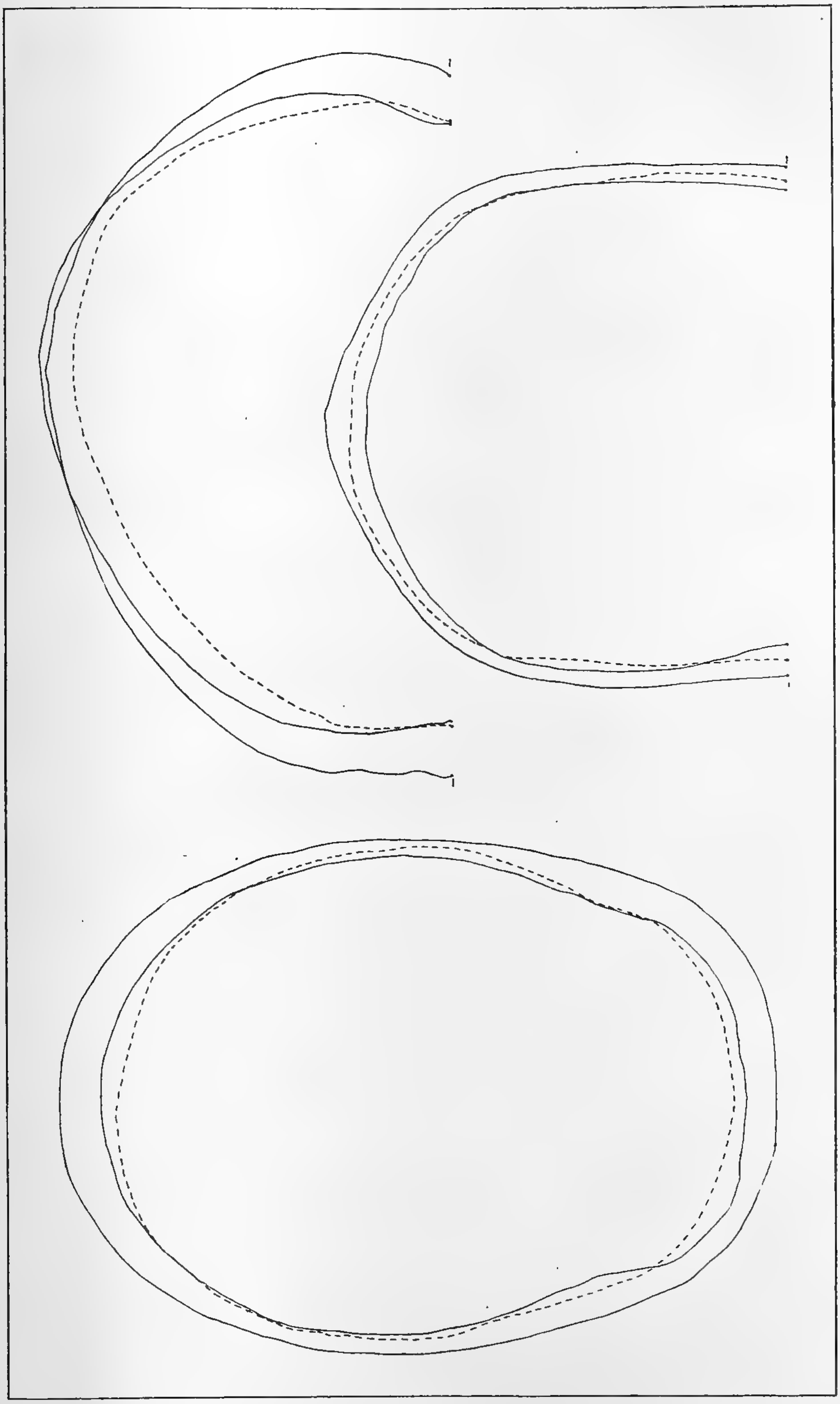


PLATE II.

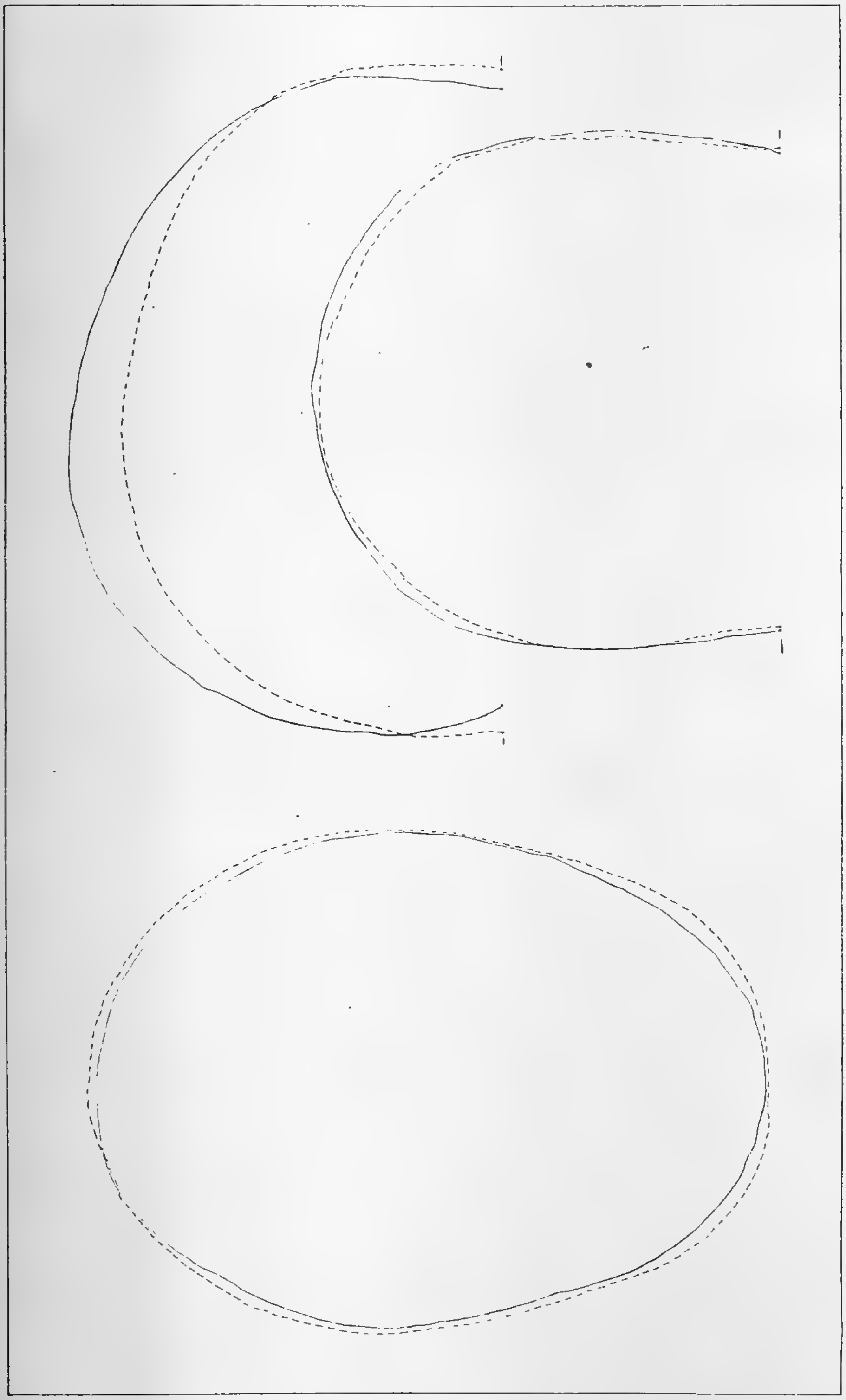


PLATE III.

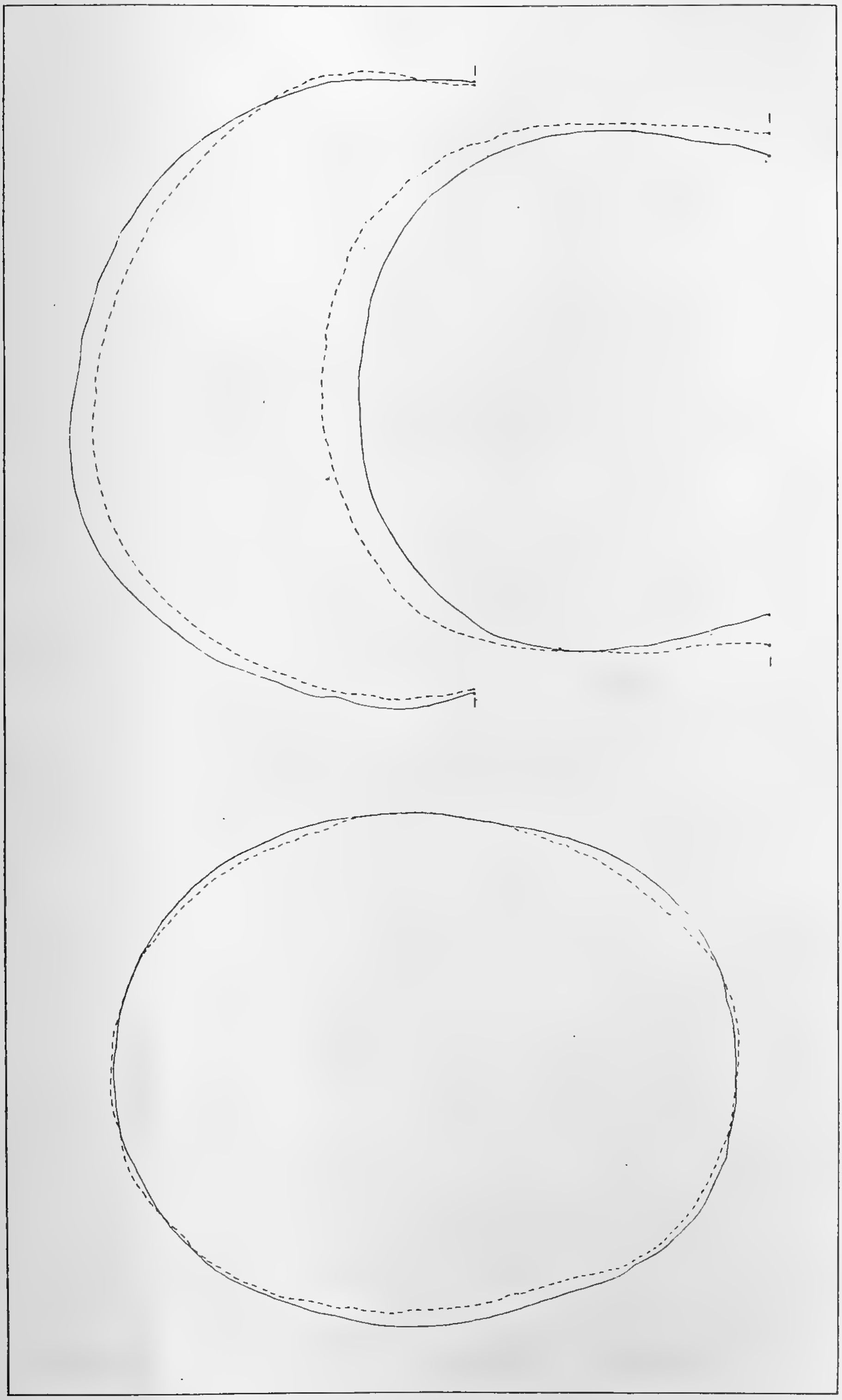


PLATE IV.

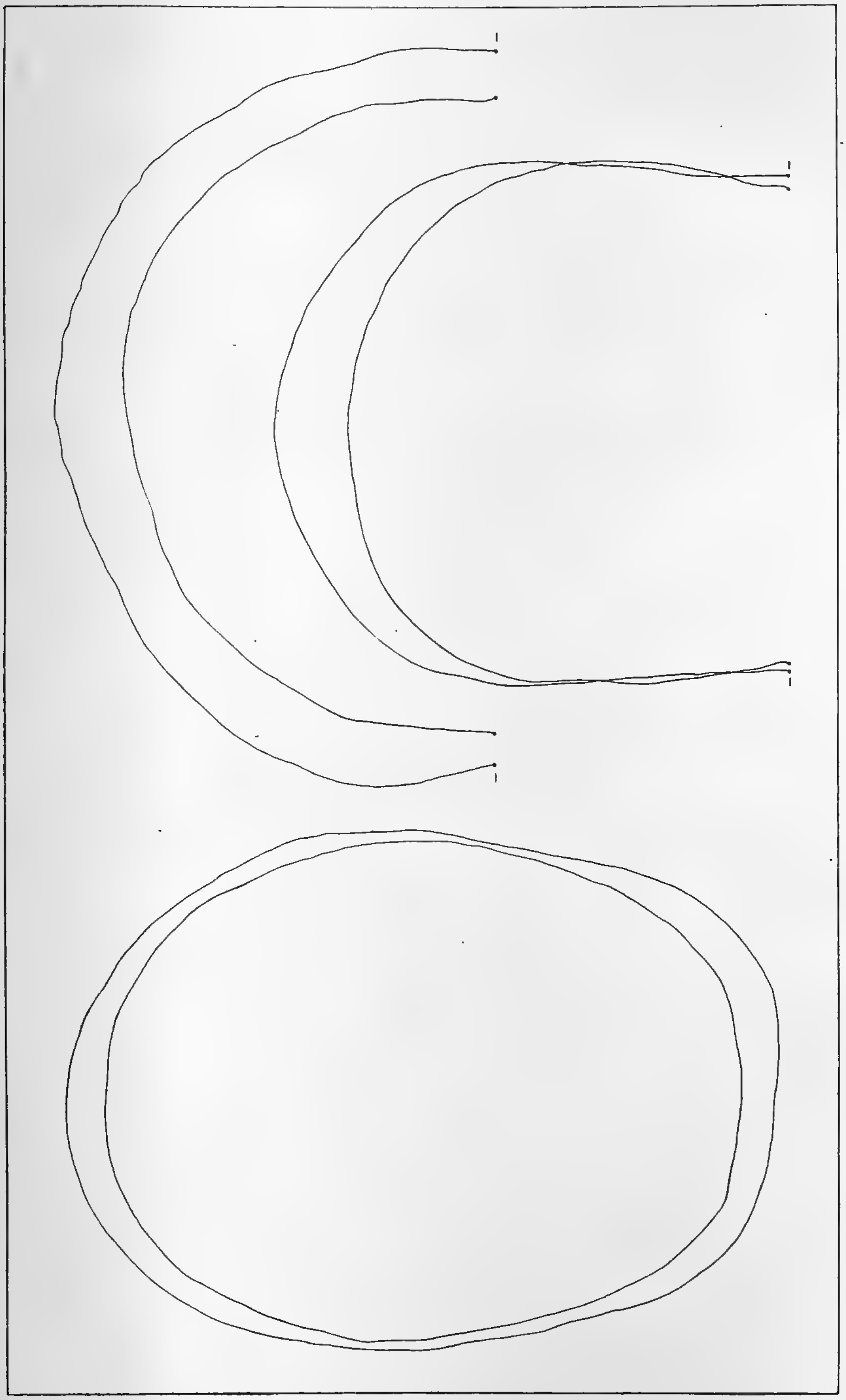


PLATE V.

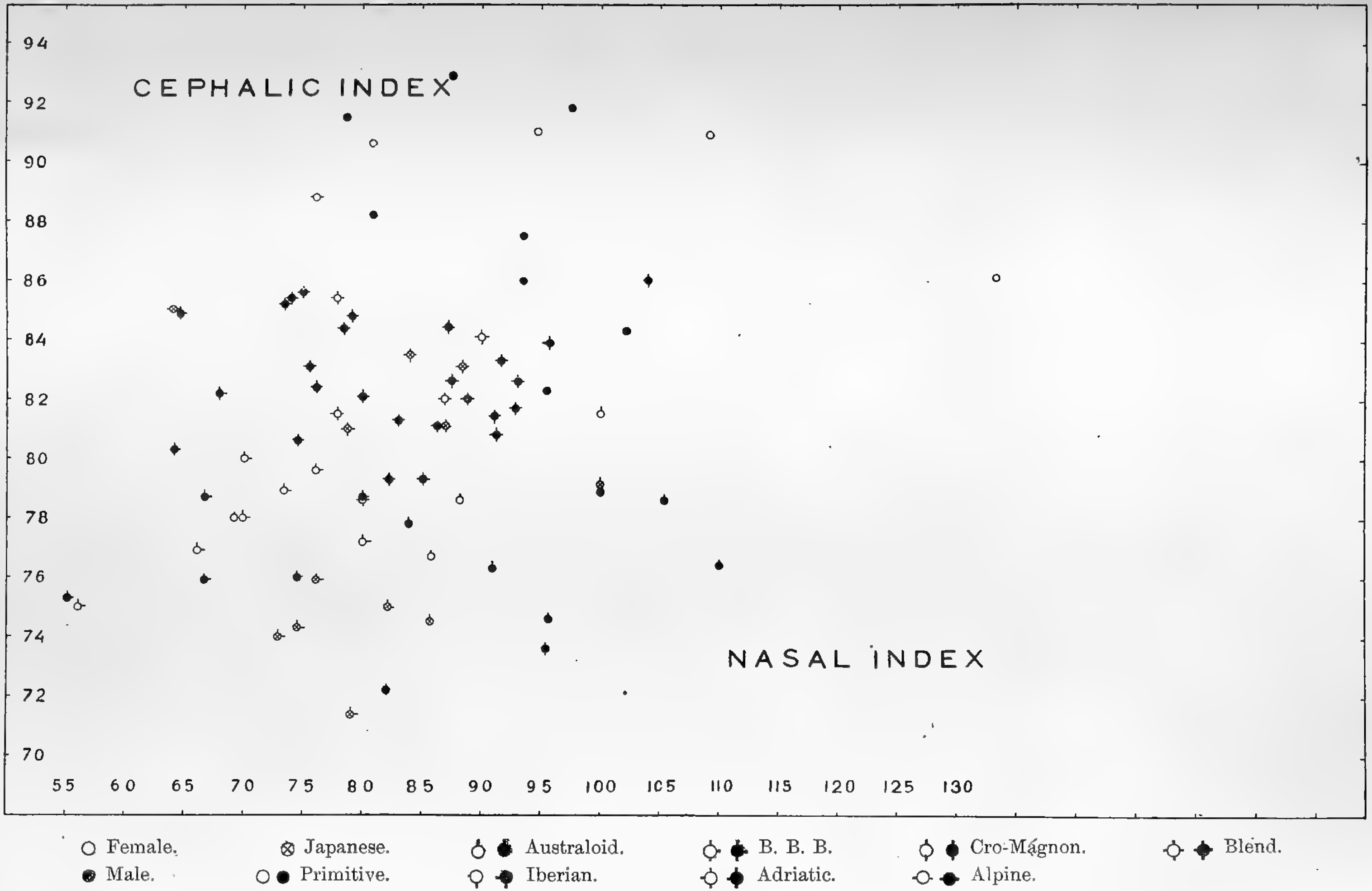

CEPHALIC INDEX
94
92
90
88
86
84
82
80
78
76
74
72
70
NASAL INDEX
55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130
Female.
Male.
Japanese.
Primitive.
Australoid.
Iberian.
B. B. B.
Adriatic.
Cro-Magnon.
Alpine.
Blend.

CHART I.

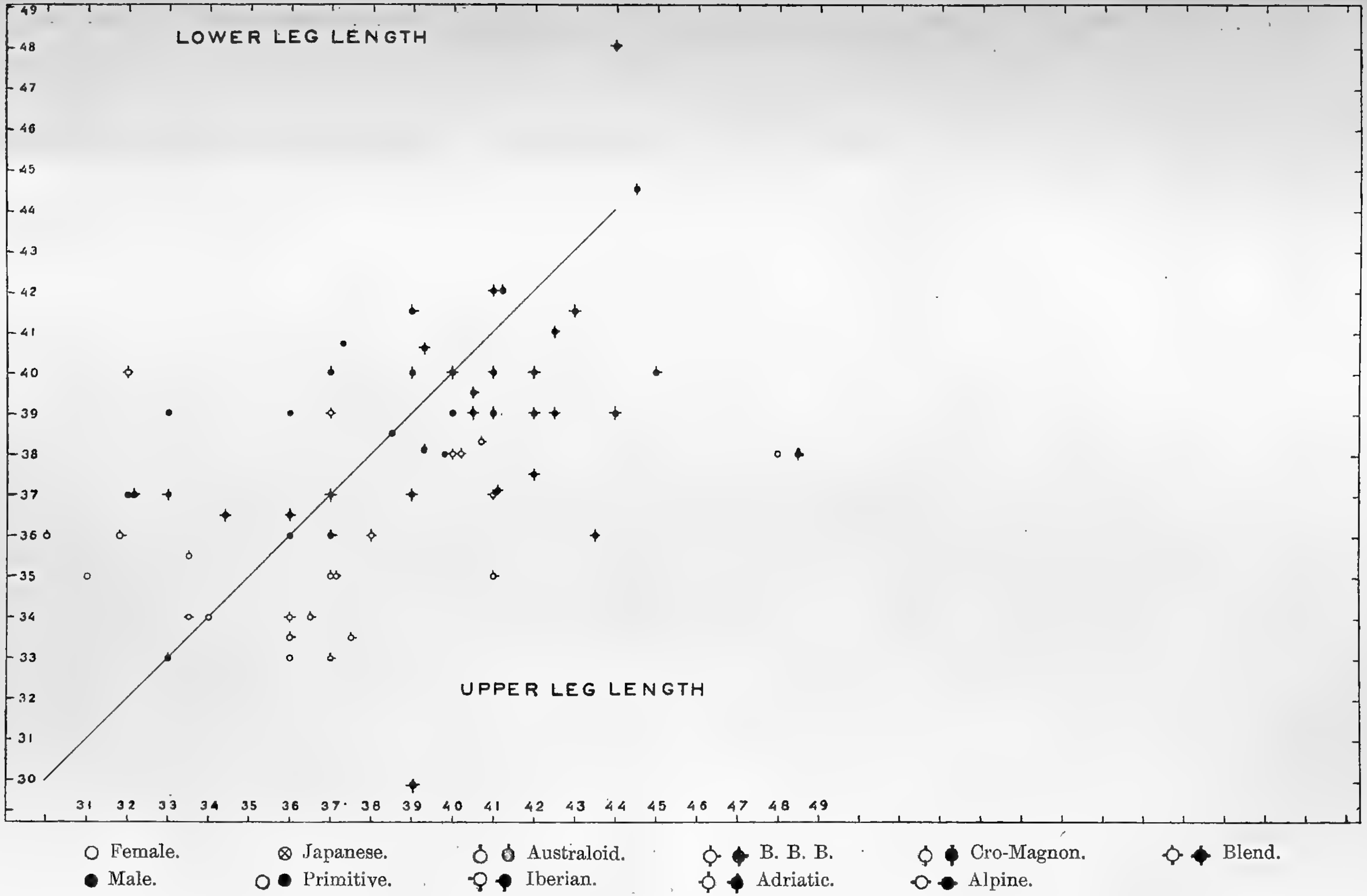

LOWER LEG LENGTH
UPPER LEG LENGTH
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
Female.
Male.
Japanese.
Primitive.
Australoid.
Iberian.
B. B. B.
Adriatic.
Cro-Magnon.
Alpine.
Blend.

CHART II.

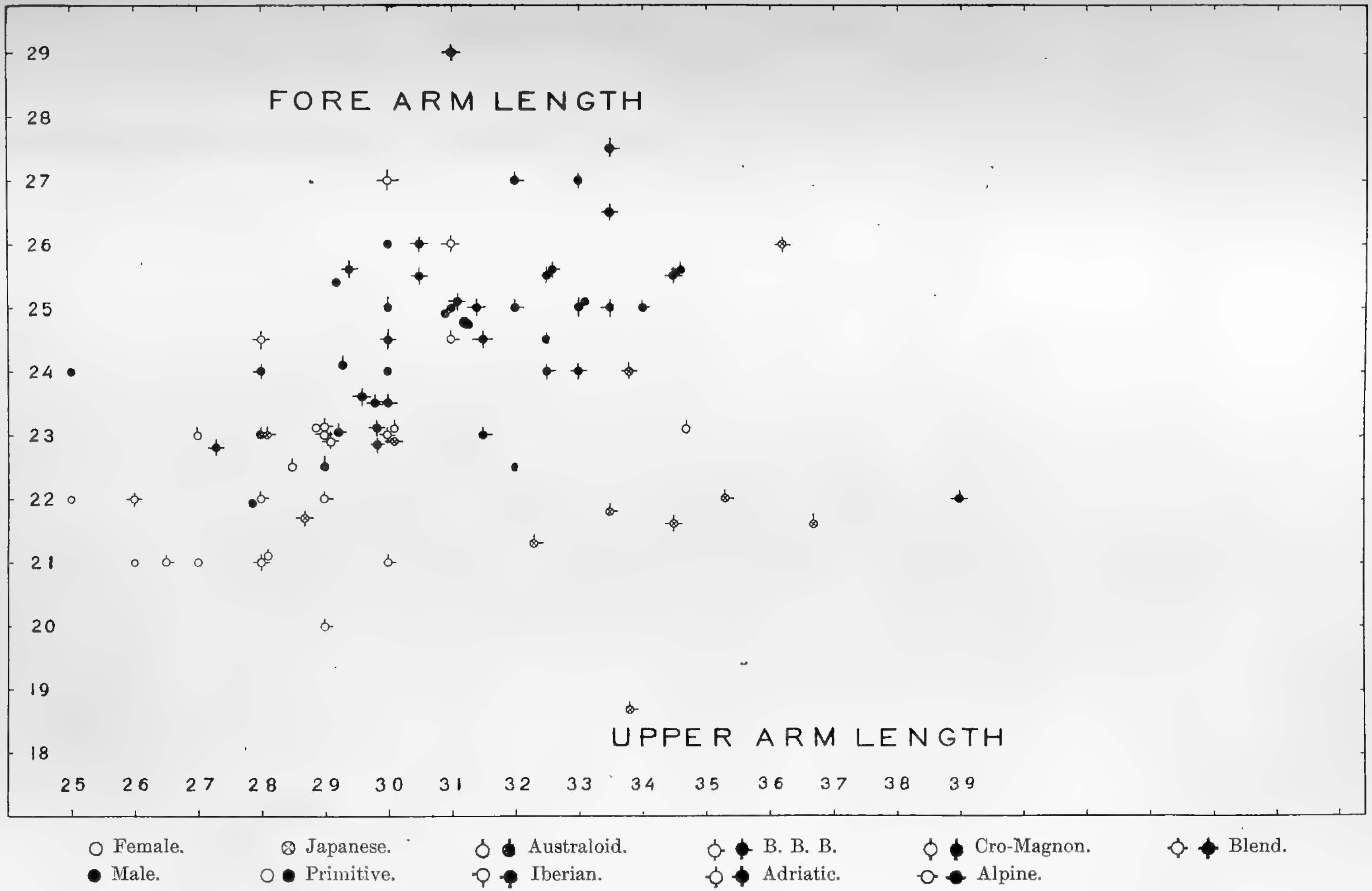

FORE ARM LENGTH
UPPER ARM LENGTH
29
28
27
26
25
24
23
22
21
20
19
18
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Female.
Male.
Japanese.
Primitive.
Australoid.
Iberian.
B. B. B.
Adriatic.
Cro-Magnon.
Alpine.
Blend.

CHART III.

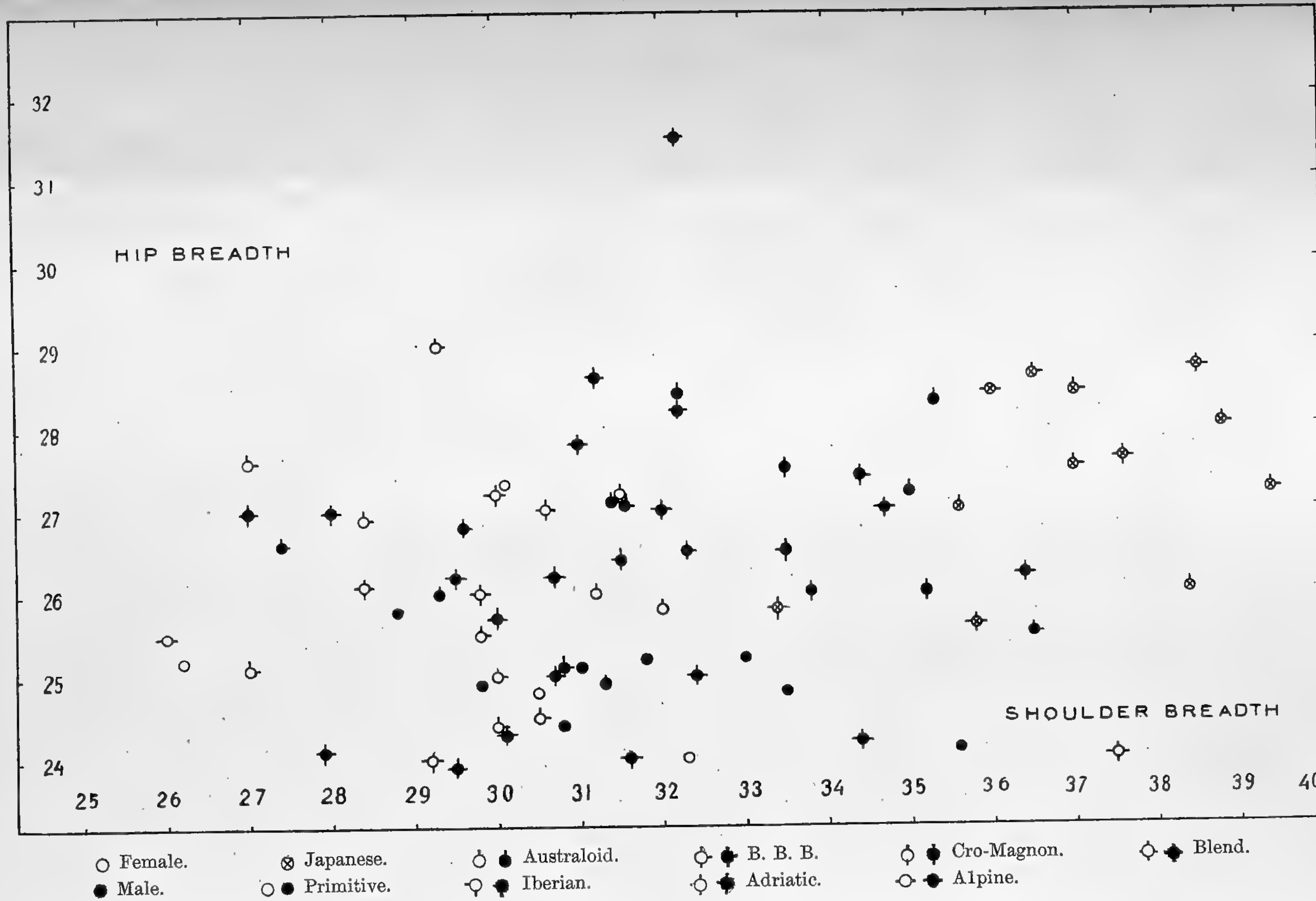

HIP BREADTH
SHOULDER BREADTH
32
31
30
29
28
27
26
25
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
Female.
Male.
Japanese.
Primitive.
Australoid.
Iberian.
B. B. B.
Adriatic.
Cro-Magnon.
Alpine.
Blend.

CHART IV.

TABLE II.—*Japanese adult males, Filipino females and Filipino adult males—averages—types.*

Character.	Japanese adult males.			Filipino females.				Filipino males—adults.					
	Australoid (2).	Iberian (5).	Blend (2).	Primitive (4).	Australoid (3).	Iberian (8).	Blend (5).	Blend (21).	B. B. B. (3).	Cro-Magnon (3).	Australoid (5).	Iberian (5).	Primitive (8).
Head length	19.40	19.80	18.00	16.88	17.87	17.85	17.22	17.83	18.10	19.07	18.66	18.50	16.95
Head breadth	15.00	14.68	15.00	15.12	14.10	13.91	14.16	14.71	14.93	14.27	14.32	14.18	15.10
Head height	13.15	13.48	13.20	12.75	12.87	12.66	12.44	13.095	13.37	13.70	12.94	13.18	12.87
Forehead	11.05	10.72	10.40	10.06	10.70	9.63	9.96	10.26	10.27	10.97	10.56	10.04	10.44
Zygoma	14.40	14.34	14.30	13.00	13.10	12.83	13.10	13.76	13.60	13.05	14.05	13.82	13.87
Nasion hair-line	7.25	7.28	6.60	6.28	7.00	5.90	5.20	6.71	5.83	6.87	7.18	6.44	6.50
Chin-nasion	11.45	12.10	11.20	9.50	10.10	10.46	10.40	11.02	11.43	11.27	10.58	11.04	10.48
Nose length	4.15	4.68	4.35	3.68	4.10	4.80	4.54	4.58	5.13	4.70	4.42	4.96	4.49
Nose breadth	3.85	3.60	3.75	3.72	3.77	3.35	3.68	3.81	3.37	4.33	4.26	3.40	4.06
Upper lip breadth	0.90	1.14	1.10	0.95	1.15	0.775	0.80	0.98	0.90	1.00	1.06	0.86	0.91
Mouth breadth	5.30	4.96	4.65	4.75	4.55	4.575	5.08	4.90	5.00	4.80	5.16	4.90	4.70
Ear length	6.60	6.14	6.30	5.48	5.87	5.91	5.84	6.04	6.03	6.40	5.86	5.90	6.30
Ear breadth	3.45	3.30	3.40	3.08	3.53	3.26	3.68	3.60	3.70	3.77	3.66	3.44	3.30
Inter eye distance	3.80	3.38	3.20	3.075	3.37	3.14	3.38	3.32	3.27	3.30	3.58	3.12	3.31
Eye breadth	2.90	3.05	2.95	2.79	2.77	2.63	2.71	2.78	2.97	3.00	3.00	2.73	2.73
Stature	163.85	161.04	162.25	146.25	148.3	151.75	153.00	159.80	166.33	173.00	158.80	163.40	152.50
Trochanter	84.40	80.74	81.85	77.1	74.77	77.77	80.86	84.69	90.00	88.93	80.40	83.00	82.24
Umbilicus	94.00	94.02	93.65	88.50	92.77	89.63	95.00	96.88	101.70	103.16	95.20	95.00	94.17
Sternum	133.4	130.14	132.60	120.00	125.77	121.50	131.25	132.38	138.30	141.66	131.40	125.00	121.83
Acromion	135.65	131.20	133.35										
Ankle	?	6.10?	5.60	4.6	5.50	5.8	5.66	6.02	6.66	6.27	6.10	6.20	5.52
Lower leg	40.30	37.88	36.20	3–34.0	35.50	34.8	36.80	38.61	39.50	41.17	38.28	38.65}	38.31
Upper leg	38.00	38.84	40.70	3–33.33	35.50	37.2	38.40	40.54	43.83	41.50	37.86	38.25}	36.11
Hand	18.10	16.90	16.50	17.10	17.30	17.1	17.40	18.23	19.17	19.50	17.84	18.90	17.65
Forearm	22.35	21.36	23.10	21.75	22.30	22.0	22.70	24.81	25.67	25.83	23.82	24.60	24.24
Upper arm	35.70	32.60	31.00	26.75	28.30	28.9	28.20	31.30	32.83	32.83	29.76	31.70	29.78
Shoulder	37.00	37.74	36.00	29.75	31.60	29.0	29.60	31.41	32.10	34.17	32.62	31.50	31.46
Hip	26.50	27.94	27.30	25.30	26.30	26.0	26.06	26.15	26.90	26.50	26.96	26.26	24.96
Pubis			79.40										
Brain weight (grams)				2=1,289.00	2=1,332.00	8=1,223.00	3=1,049.00	1,332.00	1,360.00	1,388.00	1,266.00	1,393.80	1,363.60

Number.	Head.												
		Nasion to hair line.	Chin to nasion.	Nose length.	Nose breadth.	Upper lip breadth.	Mouth breadth.	Ear length.	Ear breadth.	Interocular distance.	Eye breadth.	Cephalic index	Nasal index.
1	1	------	10.5	4.0	3.5	1.2	3.0	------	------	------	------	92.85	87.50
2	3	------	10.8	4.6	3.4	0.8	4.3	------	------	------	------	85.38	73.91
3	5	8.2	11.1	4.8	4.2	1.2	5.4	6.6	3.5	------	------	82.60	87.50
4	4	4.6	10.4	4.5	3.6	1.0	6.0	5.6	3.7	------	------	82.08	80.00
5	--	5.5	9.5	4.0	3.0	1.0	4.0	6.0	3.6	------	------	85.54	75.00
6	--	5.6	10.5	4.5	4.0	1.0	4.5	5.8	3.2	------	------	82.02	88.88
7	--	6.6	9.2	3.8	4.0	0.8	4.6	6.0	3.6	------	------	78.58	105.36
8	8	5.8	10.2	4.8	3.1	1.0	4.7	6.8	4.3	3.2	3.2	84.86	64.58
9	9	4.6	11.4	4.7	4.0	1.1	5.2	6.1	3.5	3.2	3.10	79.26	85.10
10	--	6.0	10.0	------	------	------	------	------	------	------	------	91.14	------
11	5	5.5	10.0	4.7	3.7	1.0	4.7	5.9	3.2	3.5	2.65	91.46	78.73
12	3	6.0	11.5	4.9	2.7	1.1	4.7	5.0	3.7	3.2	2.65	75.28	55.10
13	0	5.6	11.3	4.9	3.6	1.0	4.7	6.2	3.4	3.6	2.45	85.02	73.47
14	2	5.5	10.1	4.5	4.6	0.4	5.6	6.4	3.2	3.5	2.65	84.26	102.20
15	4	6.0	12.0	5.3	3.4	0.9	4.6	5.1	3.4	2.6	3.0	80.34	64.15
16	--	6.4	10.3	4.7	4.7	1.0	5.0	6.2	3.5	3.1	3.20	78.92	100.00

TABLE III.—Individual types.

FILIPINOS.

Body.

Number.	Morgue No.	Age.	Sex.	Cause of death.	Stature.	Trochanter height.	Umbilical height.	Sternal height.	Ankle height.	Lower leg length.	Upper leg length.	Hand length.	Forearm length.	Upper arm length.	Shoulder breadth.	Hip breadth.	Brain weight (grams).	Type of individual (species).
1	22	26	M.	Meningitis	152	98.3	—	—	5.6	36.8	—	17.8	25.4	29.2	35.6?	24.1	1,190	Primitive
2	23	43	M.	General tuberculosis	161	87.0	—	—	6.0	39.0	42.0	18.4	25.5	34.5	31.3	28.6	1,389	Blend
3	24	26	M.	Pulmonary tuberculosis	167	87.5	102	140	4.5	39.0	44.0	18.5	25.5	34.5	32.2	28.2	1,361	do
4	26	90	M.	Senile debility	155	79.0?	—	—	6.5	36.5	36.0?	18.5	25.5	30.5	30.0	25.7	1,275	do
5	28	50	M.	Tuberculosis and beriberi	—	75.2	—	—	6.2	30.0?	39.0	16.5	22.0	39.0?	27.0?	27.0	1,077	do
6	27	45	M.	Asthma	168	77.4	96	127	6.9	40.6	39.3	19.0	23.5	29.8	27.9	24.1	1,332	do
7	29	45	M.	Chronic dysentery	158	72.4	98	133	5.1	38.1	39.3	17.8	24.1	29.8	29.3	26.0	1,249	Australoid
8	31	59	M.	Chronic enteritis	168	94.0?	105	141	7.5	38.0	48.5?	18.0	24.0	32.5?	29.6	26.8	1,360	B. B. B
9	38	87	M.	Epilepsy, uræmia	166	85.0	98	135	5.5	36.0	43.5	18.0	26.0	30.5	30.7	25.0	—	Blend
10	40	65?	M.	Drowned	147	78.5	—	—	6.5	39.0	43.0	17.0	24.0	25.0	—	—	—	Primitive?
11	43	22	M.	Chronic nephritis	152	82.2	95	130	5.2	38.5	38.5	17.2	22.5	32.0?	29.8	24.9	1,360	Primitive
12	44	32	M.	Chronic tuberculosis	169	82.0	101	140	5.5	—	—	19.5	25.0	32.0	27.4	26.6	1,247	Iberian
13	45	25	M.	Intermittent fever	150	76.1	89	124	5.2	36.5	44.4	16.8	22.8	27.8	30.0	24.8	1,219	Blend
14	56	60	M.	Chronic rheumatism	152	79.0	106	123	7.0	36.0	36.0	17.2	22.0	28.0	28.2	25.8	1,495	Primitive
15	57	60	M.	Pulmonary tuberculosis	166	89.5	100	136	6.0	41.0	42.5	21.0	27.5	33.5	32.3	36.5	—	B. B. B
16	58	40	M.	Murdered	174	94.5	107	147	5.5	44.5	44.5	19.0	27.0	33.0	35.2	26.0	—	Cro-Magnon
17	69	35	M.	Insane	165	86.5	100	138	6.5	39.5	40.5	18.5	25.5	32.5	34.4	27.4	—	B. B. B
18	76	47	M.	Pulmonary tuberculosis	161	79.0	93	131	6.0	36.0	37.0	19.0	23.0	31.5	31.4	27.1	1,416	Iberian
19	78	?	M.	Organic heart disease	165	88.0	101	137	7.0	40.0	41.0	18.5	25.0	33.5	31.5	26.4	1,470	Adriatic
20	81	23	M.	Pulmonary tuberculosis	173	91.0	107	144	6.5	41.5	43.0	19.0	26.5	33.5	36.4	26.2	1,274	Blend
21	112	67	M.	do	170	87.5	—	—	7.0	41.5	39.0	19.0	25.0	34.0	31.5	27.1	1,416	Iberian
22	115	22	M.	do	162	85.0	96	131	6.0	39.0	40.0	19.5	25.0	31.0	33.5	24.8	—	Modified Primitive
23	118	40	M.	do	159	86.0	98	132	6.5	39.0	40.5	17.5	24.0	33.0?	29.5	23.9	—	Blend
24	120	20	M.	do	174	86.8	103	141	6.8	39.0	41.0	19.5	25.5	32.5	33.8	26.0	—	Cro-Magnon
25	121	50	M.	Chronic cystitis	148	72.0	90	121	6.0	33.0	43.0	17.0	23.0	28.0	31.3	24.9	1,133	Australoid
26	125	25	M.	Beriberi	166	84.0	100	138	7.0	40.0	37.0	19.2	25.0	30.0	35.3	28.3	—	do
27	129	25	M.	Pulmonary tuberculosis	169	89.0	103	138	6.0	42.0	41.0	19.2	25.0	31.4	30.7	—	1,360?	Blend
28	137	50	M.	Septicæmia	171	85.5	101	137	6.5	40.0	39.0	20.0	25.0	33.0	38.5	27.5	1,388	Cro-Magnon
29	140	30	M.	Beriberi	157	75.0	?95	129	6.0	37.0	42.0	18.5	25.0	33.0	31.8	25.2	1,480?	Primitive
30	143	57	M.	Liver abscess; gall stones	164	89.5	100	134	6.5	42.0	41.0	19.8	24.5	32.5	32.2	28.4	1,416	Australoid
31	145	88	M.	Murdered	157	87.0	94	125	6.0	41.0	40.0	19.5	25.0	30.0	35.0	27.5	—	(?)
32	146	27	M.	Beriberi	157	85.0	95	126	7.0	38.0	40.0	18.5	23.5	30.0	32.4	25.0	1,360	Blend
33	147	20	M.	Acute nephritis	166	81.5	96	131	5.5	39.0	37.0	18.3	24.5	31.5	33.5	26.9	1,374	(?)
34	148	50	M.	Pulmonary tuberculosis	158	85.5	96	128	6.0	37.5	42.0	17.5	24.5	30.0	28.0	27.0	1,218	Blend
35	174	90	M.	Acute enteritis, tuberculosis	168	97.0	102	139	5.0	48.0	44.0	20.0	29.0	31.0	32.0	27.0	1,360	do
36	177	20	M.	Beriberi	165	76.0	90	125	6.0	37.0	33.0	17.5	24.0	28.0	33.5	26.5	1,450	Adriatic
37	180	34	M.	General organic pyæmia, pulmonary	148	75.0	85	?88	6.0	37.0	32.0	17.5	23.0	29.0	30.7	25.0	1,303	Iberian
38	181	47	M.	Beriberi; insane	154	63.0	90	128	5.0	38.0	40.0	19.0	26.0	30.0	31.0	25.1	1,478	Primitive
39	186	37	M.	Pulmonary tuberculosis	162	88.0	95	145	6.0	40.0	42.0	18.0	26.0	31.0	30.7	26.2	1,303	Blend
40	193	42	M.	Beriberi	152	79.5	90	96	4.5	39.0	36.0	17.0	25.0	31.0	33.0	25.2	1,360	Primitive
41	194	60	M.	Pulmonary tuberculosis	154	84.5	105	140	6.5	37.0	41.0	18.0	23.0	30.0	37.5	24.0	1,332	Blend
42	195	35	M.	do	169	91.5	101	141	6.5	40.0	45.0	19.5	27.0	32.0	36.5	25.5	1,587	Iberian
43	198	75	M.	Senile debility	161	88.0	97	130	6.6	39.0	42.5	19.0	25.6	29.4	32.2	31.5	1,360	Blend
44	199	18	M.	Pyæmia	156	82.0	92	125	6.0	37.0	39.0	19.0	27.0	30.0	31.6	24.0	—	do
45	201	54	M.	Pulmonary tuberculosis	158	86.0	94	130	6.0	40.0	40.0	18.5	24.5	31.5	34.7	27.0	1,473	do
46	203	44	M.	do	157	—	—	128	5.5	—	—	18.2	25.0	31.0	31.0	27.8	1,730	do
47	204	49	M.	do	151	80.0	88	123	6.0	37.0	37.0	18.0	23.0	30.0	29.5	26.2	1,219	do
48	205	30	M.	Hæmorrhagic purpurea	154	82.4	89	125	4.4	40.7	37.3	17.5	24.0	30.0	30.8	24.4	1,247	Primitive
49	—	32	M.	Not dead	158	85.0	93	131	—	—	39.0	15.4	22.5	29.0	35.0	27.2	—	Australoid
50	—	30	M.	do	157	—	90	129	—	—	—	16.8	23.6	29.6	34.4	24.2	—	Blend
Average male	—	41.8	—	—	160.5	81.1	96.7	130.9	6.0?	38.8	39.1	18.3	24.7	31.1	32.0	26.2	1,351	—
Minimum male	—	18.0	—	—	148.0	72.0	85.0	?88.0	4.4	30.0	32.0	15.4	22.0	25.0	27.0	23.9	1,077	—
Maximum male	—	90.0	—	—	174.0	98.4	107.0	117.0	7.5	48.0	48.5	21.0	27.5	39.0	37.5	31.0	1,730	—
1	35	38	F.	Pulmonary gangrene, tuberculosis	147	73.3	86	123	5.5	36.0	31.8	17.0	22.0	28.0	30.0	25.0	1,332	Iberian
2	36	20	F.	Uterine cancer, tuberculosis	153	72.5	90	113	5.0	34.0	33.5	17.2	23.0	29.0	26.0	25.5	1,360	Alpine
3	39	19	F.	Tuberculosis, typhoid	145	70.4	83	114	4.4	35.0	31.0	17.4	21.0	26.0	30.5	24.8	—	Primitive
4	16	25	F.	Septicæmia	161	81.8	105	142	5.8	39.0	37.0	17.0	22.0	26.0	30.6	27.0	—	Blend
5	48	41	F.	Tuberculosis	157	83.8	96	128	4.8	38.3	40.7	18.0	24.5	31.0	28.4	26.9	1,360	Iberian
6	50	60	F.	Senile debility	155	75.8	88	111	6.8	33.0	37.0	16.8	23.0	29.0	29.3	29.0	1,078	do
7	53	50	F.	Septicæmia	148	84.0	—	—	6.0	37.0	41.0	18.0	24.5	28.0	29.8	26.0	1,190	Blend
8	54	23	F.	Chronic enteritis	154	77.8	91	125	6.8	33.5	37.5	17.0	22.0	29.0	30.0	24.4	1,110	Iberian
9	60	28	F.	Grip	142	73.0	86	118	4.0	38.0	36.0	16.0	22.0	25.0	32.3	24.0	—	Primitive
10	77	70	F.	Cancer of chin	147	76.0	90	122	6.0	34.0	36.5	16.5	21.0	28.0	28.4	26.1	1,050	Blend
11	82	35		Pulmonary tuberculosis	161	82.0	96	128	6.0	35.0	31.0	18.0	21.0	30.0	27.0	27.6	1,246	Iberian
12	113	68	F.	Senile debility	148	75.5	85	115	6.0	33.5	36.0	16.0	21.0	26.5	27.0	25.1	1,303	do
13	123	20	F.	Bright's disease	159	83.5	95	129	5.5	35.0	40.0	17.5	23.0	30.0	29.2	24.0	—	Blend
14	130	45	F.	Inoperable cancer	145	74.5	98	118	5.6	35.5	33.5	16.0	21.0	28.0	31.2	26.0	1,360	Australoid
15	136	Adult	F.	Diabetic ulcer; insane	150	79.0	90	132	5.0	36.0	38.0	18.0	23.0	29.0	30.0	27.2	907	Blend
16	138	27	F.	Peritonitis; stab wound	152	71.0	88	134	5.0	36.0	30.0	18.0	23.0	30.0	32.0	25.8	—	Australoid
17	144	75	F.	Capillary bronchitis	161	79.0	101	139	7.0	40.0	32.0	19.5	24.0	36.0	32.0	29.0	1,360	(?)
18	149	23	F.	Beriberi; myocarditis	145	74.0	85	118	5.0	34.0	37.0	17.0	21.0	27.0	26.2	25.2	1,303	Primitive
19	175	26	F.	Beriberi	148	78.0	92	125	6.0	35.0	37.0	18.0	23.0	27.0	31.5	27.2	1,303	Australoid
20	184	60	F.	Bronchitis	153	91.0	100	130	5.0	38.0?	48.0?	18.0	23.0	29.0	30.0	27.2	1,275	Primitive
21	188	30	F.	Pulmonary tuberculosis	146	78.0	91	125	6.0	35.0	37.0	16.5	22.5	28.5	29.8	25.5	1,190	Iberian
22	200	30	F.	Intestinal tuberculosis	146	76.0	84	117	5.5	34.0	36.5	17.5	20.0	29.0	30.5	24.6	1,137	do
Average female	—	39.05	—	—	151.0	77.7	91.5	123.8	55.3	35.5	36.5	17.3	22.3	28.6	29.6	26.0	1,22?	—
Minimum female	—	19	—	—	142.0	70.4	83.0	111.0	4.0	33.0	30.0	16.0	20.0	25.0	26.0	24.0	907	—
Maximum female	—	75	—	—	161.0	91.0	101.0	142.0	7.0	40.0	48.0	19.5	24.5	36.0	32.3	29.0	1,360	—

Head.

Number.	Maximum length.	Maximum breadth.	Auricular brigmatic height.	Minimum frontal diameter.	Maximum interzygomatic breadth.	Nasion to hair line.	Chin to nasion.	Nose length.	Nose breadth.	Upper lip breadth.	Mouth breadth.	Ear length.	Ear breadth.	Interocular distance.	Eye breadth.	Cephalic index.	Nasal index.
1	16.8	15.6	12.7	—	14.1	—	10.5	4.0	3.5	1.2	3.0	—	—	—	—	92.85	87.50
2	17.1	14.6	13.5	—	13.3	—	10.8	4.6	3.4	0.8	4.3	—	—	—	—	85.38	73.91
3	18.4	15.2	13.7	10.5	14.5	8.2	11.1	4.8	4.2	1.2	5.4	6.6	3.5	—	—	82.60	87.50
4	17.3	14.2	13.3	9.1	13.4	1.6	10.4	4.5	3.6	1.0	6.0	5.6	3.7	—	—	82.08	80.00
5	16.6	14.2	12.3	—	—	5.5	9.5	4.0	3.0	1.0	4.0	6.0	3.6	—	—	85.54	75.00
6	17.8	14.6	12.7	9.5	—	5.6	10.5	4.5	4.0	1.0	4.5	5.8	3.2	—	—	82.02	88.88
7	18.3	14.4	13.0	10.5	—	6.6	9.2	3.8	4.0	0.8	4.6	6.0	3.6	—	—	78.58	105.36
8	18.5	15.7	13.0	10.0	13.8	5.8	10.2	4.8	3.1	1.0	4.7	6.8	4.3	3.2	3.2	81.86	64.58
9	18.8	14.9	13.1	10.5	13.9	4.6	11.4	4.7	4.0	1.1	5.2	6.1	3.5	3.2	3.10	79.26	85.10
10	15.8	14.4	—	11.0	—	6.0	10.0	—	—	—	—	—	—	—	—	91.14	—
11	16.4	15.0	12.3	10.5	13.5	5.5	10.0	4.7	3.7	1.0	4.7	5.9	3.2	3.5	2.65	91.46	78.73
12	17.8	13.4	12.5	9.5	13.3	6.0	11.5	4.9	2.7	1.1	4.7	5.0	3.7	3.2	2.65	75.28	55.10
13	16.7	14.2	12.6	9.8	14.0	5.6	11.8	4.9	3.6	1.0	4.7	6.2	3.4	3.6	2.45	85.02	73.47
14	17.8	15.0	13.8	10.8	14.2	5.5	10.1	4.5	4.6	0.4	5.6	6.4	3.2	3.5	2.65	84.26	102.20
15	17.8	14.3	13.7	10.6	13.4	6.0	12.0	5.3	3.4	0.9	4.6	5.1	3.4	2.6	3.0	80.34	64.15
16	18.5	14.6	13.7	11.5	—	6.4	10.3	4.7	4.7	1.0	5.0	6.2	3.5	3.1	3.20	78.92	100.00
17	18.0	14.8	13.4	10.1	—	5.7	12.1	5.3	3.6	0.8	5.7	6.2	3.6	4.0	2.70	82.22	67.92
18	18.3	13.9	13.5	9.9	14.5	4.8	11.5	5.1	3.4	0.6	5.0	6.6	3.3	3.2	3.15	75.95	66.66
19	18.6	16.0	13.7	11.4	14.2	6.4	12.0	5.0	5.2	1.4	5.4	7.0	3.6	3.6	2.70	86.02	104.00
20	17.8	14.8	13.0	10.2	13.6	6.8	10.3	4.5	3.4	1.0	4.6	5.6	3.0	3.4	2.55	83.15	75.55
21	18.5	14.5	13.8	9.5	13.8	6.1	10.0	5.0	4.0	0.7	4.7	6.3	3.3	2.7	2.65	78.71	80.00
22	17.5	14.4	12.8	10.0	13.5	6.0	10.8	4.5	4.3	1.4	4.4	6.0	3.5	3.1	2.95	82.28	95.55
23	17.3	14.3	12.3	10.0	13.2	5.7	10.4	4.3	4.0	1.0	5.2	6.0	4.0	3.2	2.70	82.66	93.02
24	18.2	13.4	12.6	10.1	12.8	6.2	12.0	4.4	4.2	1.0	4.4	6.0	3.8	3.6	2.85	73.63	95.45
25	18.2	13.9	12.8	10.6	14.1	6.3	9.4	4.0	4.4	1.2	5.0	6.0	3.8	3.6	2.60	76.37	110.00
26	18.9	14.1	12.6	—	14.2	7.3	10.9	4.6	4.4	1.1	5.4	5.8	4.0	3.7	3.25	74.60	95.65
27	18.4	15.6	13.3	11.1	13.8	6.3	12.1	4.3	3.4	.9	5.2	5.6	3.6	3.1	3.25	84.78	79.06
28	20.5	14.8	14.8	11.3	13.3	8.0	11.4	5.0	4.1	1.0	5.0	7.0	4.0	3.2	2.95	72.19	82.00
29	17.8	15.7	12.4	10.9	13.7	6.8	11.0	4.7	3.8	1.2	4.8	6.0	3.0	3.6	2.90	88.20	80.85
30	18.9	14.7	13.5	10.6	14.2	6.9	12.2	5.3	4.5	1.2	5.8	5.2	4.0	4.8	2.96	77.77	84.90
31	—	—	—	10.7	14.5	8.5	11.6	4.6	4.1	1.0	5.1	6.4	3.6	3.5	2.75	—	89.18
32	17.6	14.5	13.3	10.6	13.8	7.3	11.0	4.6	3.5	1.2	5.0	6.3	4.0	3.4	2.85	82.38	76.08
33	—	—	—	—	14.2	8.0	11.1	5.3	3.6	1.0	5.0	5.8	3.3	3.5	2.85	—	67.92
34	17.5	14.1	12.9	9.9	12.6	6.5	11.7	5.1	3.8	1.1	4.2	5.8	3.6	3.1	2.45	80.57	74.50
35	18.0	15.2	13.1	10.5	14.5	7.0	11.7	5.1	4.0	.8	5.0	6.0	3.7	3.8	2.60	84.44	78.43
36	18.0	15.1	12.6	11.0	13.8	7.2	11.0	4.6	4.4	1.2	5.0	6.0	3.5	4.0	2.80	83.88	95.65
37	18.4	14.0	13.0	11.0	13.3	7.8	10.9	4.7	3.5	1.1	4.8	5.6	3.6	3.5	2.50	76.09	74.47
38	17.0	15.6	13.6	10.5	13.8	8.2	11.3	4.3	4.2	1.1	5.0	6.8	3.7	2.7	2.85	91.76	97.67
39	18.0	14.6	13.2	10.4	13.4	7.1	11.0	4.4	3.8	1.1	4.8	6.1	3.1	3.1	2.85	81.11	86.36
40	17.2	14.8	12.8	10.0	13.4	6.0	10.1	4.6	4.3	.8	5.0	7.1	3.7	3.0	2.80	86.04	93.46
41	17.7	14.4	12.5	9.5	13.8	6.3	10.2	4.5	4.1	.8	5.0	6.0	4.0	3.2	2.55	81.35	91.11
42	19.2	15.1	13.1	10.3	14.2	7.5	11.3	5.1	3.4	.8	5.3	6.0	3.8	3.0	2.70	78.65	66.66
43	18.6	15.5	13.5	10.3	14.1	7.8	13.0	4.8	4.4	1.0	4.2	7.1	3.4	3.5	2.90	83.33	91.66
44	17.6	14.3	13.6	—	—	8.0	11.1	4.7	3.9	1.1	4.4	5.9	3.5	3.4	2.80	81.25	82.96
45	18.0	15.2	13.1	10.5	14.2	8.0	11.0	4.7	4.1	.8	5.4	6.2	4.0	3.3	3.05	84.44	87.23
46	19.3	16.0	14.3	11.8	14.6	8.4	11.6	4.6	4.2	1.0	5.6	6.0	3.7	3.4	2.90	80.81	91.30
47	17.4	13.8	12.6	10.5	13.5	7.4	10.6	4.5	3.7	.8	5.3	5.9	4.0	3.1	2.65	79.31	82.22
48	16.8	14.7	12.5	10.0	14.4	7.5	10.8	4.6	4.3	.7	4.8	5.6	3.0	3.6	2.60	87.50	93.48
49	19.0	14.5	13.3	10.6	13.7	8.8	11.2	4.4	4.0	1.0	5.0	6.3	3.4	2.8	3.20	76.31	90.91
50	18.0	14.7	13.1	10.0	13.5	7.4	10.7	4.1	3.8	.9	4.8	6.1	3.5	3.3	2.75	81.66	92.18
Average male	17.9	14.7	13.1	10.4	13.8	6.7	11.0	4.7	3.9	1.0	4.9	6.1	3.6	3.3	2.8	82.12	81.39
Minimum male	15.8	13.4	12.8	9.1	12.6	4.6	9.2	3.8	2.7	0.4	3.0	5.0	3.1	2.6	2.5	72.19	55.10
Maximum male	20.5	16.0	14.8	11.8	14.6	8.5	13.0	5.3	6.2	1.4	6.0	7.1	4.3	4.3	3.3	92.85	110.00
1	17.8	14.2	12.8	9.5	13.0	6.8	10.3	4.6	3.3	.9	4.7	5.5	3.0	3.3	2.90	79.77	76.08
2	16.8	14.9	12.8	10.5	15.6	6.2	9.8	4.8	3.8	.6	4.4	6.2	3.4	3.6	2.95	88.69	76.08
3	16.3	14.8	12.0	10.0	13.2	5.7	10.2	3.3	3.6	.8	4.4	5.7	2.8	3.1	2.95	90.79	109.09
4	16.7	13.7	13.0	10.0	13.2	4.5	11.4	4.7	3.8	1.1	5.4	5.3	3.2	3.6	2.05	82.03	80.86
5	17.5	11.0	12.9	10.0	13.5	5.3	11.7	5.0	3.5	.8	4.7	5.4	2.6	3.0	3.00	80.00	70.00
6	18.2	14.2	13.0	9.5	12.8	5.0	10.2	5.5	3.8	.6	5.0	7.3	4.0	3.0	2.80	78.02	69.09
7	18.2	14.3	12.6	10.3	13.2	5.5	10.5	5.0	4.0	.8	6.0	6.8	4.2	3.5	2.65	78.57	80.00
8	18.0	13.5	12.6	8.8	12.5	3.8	11.2	5.0	2.8	.7	4.0	5.8	3.1	3.0	2.35	75.00	56.00
9	16.5	14.2	12.3	9.7	—	5.2	7.2	8.0	4.0	1.0	5.7	4.6	3.0	3.0	3.10	86.06	133.33
10	16.4	14.0	11.7	9.1	12.4	5.7	9.2	4.5	3.5	.9	4.0	5.5	3.3	2.5	2.60	85.36	77.77
11	18.2	14.0	12.6	9.9	12.8	5.5	10.7	5.0	3.3	.8	5.0	6.0	3.3	3.4	2.55	76.92	66.00
12	17.9	13.8	13.4	9.9	12.8	5.5	9.1	4.5	3.6	.7	4.5	6.2	3.8	3.1	2.40	77.09	80.00
13	17.0	14.3	12.9	9.5	12.8	5.0	10.7	4.0	3.6	.7	5.0	6.0	3.3	3.6	2.85	84.11	90.00
14	17.2	13.2	12.5	—	12.5	—	—	4.2	3.6	—	—	6.0	3.3	3.1	2.45	76.74	85.71
15	17.8	14.5	12.0	10.9	13.8	5.3	10.2	4.5	3.5	.5	5.0	5.6	3.4	3.7	2.60	81.46	77.77
16	18.6	14.6	13.6	10.7	13.8	6.5	10.0	4.2	3.7	1.0	4.1	5.6	3.3	3.5	2.75	78.49	88.09
17	—	—	—	10.0	13.0	7.0	10.3	4.7	4.1	1.0	4.8	7.0	4.0	3.7	2.75	—	87.23
18	17.7	16.1	13.2	9.9	12.8	7.0	10.3	3.7	3.5	1.0	4.4	5.6	3.3	3.6	2.80	90.96	94.59
19	17.8	14.5	12.5	10.7	13.1	7.5	10.2	4.0	4.0	1.3	5.0	6.0	3.8	3.5	3.10	81.46	100.00
20	17.0	15.4	13.5	10.6	13.5	7.2	10.3	4.7	3.8	1.0	4.5	6.0	3.6	3.4	2.30	90.58	80.85
21	17.7	13.8	12.7	9.9	12.9	8.0	10.4	4.3	3.0	1.1	4.4	5.9	3.0	3.3	2.55	77.96	69.76
22	17.5	13.8	11.8	9.5	12.5	7.3	10.0	4.5	3.3	.6	4.3	5.2	3.0	3.0	2.50	78.85	73.33
Average female	17.5	14.3	12.6	10.0	13.1	6.0	10.2	4.4	3.6	0.85	4.7	5.9	3.1	3.3	2.7	81.85	83.07
Minimum female	16.3	13.2	11.8	8.8	12.8	3.8	7.2	3.3	2.8	0.6	4.0	4.6	2.8	2.5	2.3	75.00	56.00
Maximum female	18.6	16.1	13.6	10.9	15.6	8.0	11.4	5.5	4.1	1.8	6.0	7.8	4.2	3.7	3.1	90.96	133.33

JAPANESE AND CHINESE.

Body.

Number.	Number.	Age.	Sex.	Nation.	Stature.	Trochanter height.	Umbilicus height.	Sternum height.	Acromion height.	Ankle height.	Lower leg length.	Upper leg length.	Hand length.	Forearm length.	Upper arm length.	Shoulder breadth.	Hip breadth.	Brain weight.	Type of individuals.
1	142	36	M.	Japan	160.0	83.0	92.0	129.0	—	6.0	33.0	44.0	19.0	23.0	30.0	36.0	28.4	1,416	Alpine
2	65	43	M.	do	166.5	83.5	98.5	134.0	136.3	—	47.0	40.5	17.9	22.0	35.3	38.8	28.0	—	Iberian
3	64	30	M.	do	171.0	85.3	101.0	141.6	142.3	6.0?	37.6	44.7	17.0	24.0	33.8	38.5	28.7	—	Blend
4	63	30	M.	do	157.0	79.0	90.7	125.2	127.3	—	37.0	36.0	15.7	21.8	32.3	37.0	27.5	—	Iberian
5	62	30	M.	do	164.5	80.8	94.5	133.5	133.5	—	35.2	39.6	16.6	21.6	33.5	39.4	27.2	—	do
6	61	33	M.	do	155.7	80.0	92.4	126.0	128.1	—	36.3	37.7	16.7	23.0	28.1	36.5	28.6	—	do
7	60	30	M.	do	165.2	87.0	99.0	136.0	137.0	—	39.3	41.7	18.2	23.1	34.7	38.4	26.0	—	Australoid
8	11	35	M.	do	162.5	81.8	89.0	130.8	134.8	—	41.3	34.5	18.0	21.0	36.7	35.6	27.0	—	do
9	7	30	M.	do	158.5	75.4	86.3	123.6	124.4	5.2	34.8	35.4	16.0	21.7	28.7	33.4	25.8	—	Blend
10	6	33	M.	do	161.5	80.4	94.0	132.0	130.8	6.1	33.9	40.4	17.6	18.7	33.8	37.0	28.4	—	Iberian
11	5	28	M.	China	166.0	87.5	100.0	135.5	138.2	—	43.0	38.5	17.5	26.0	36.2	37.6	27.6	—	Blend
12	14	27	M.	do	158.0	84.0	94.0	127.2	129.3	—	36.0	42.0	15.7	21.6	34.5	35.8	25.6	—	do
Average Japanese	10	33	—	—	161.7	81.9	93.7	131.2	132.7	5.77	37.5	39.5	17.2	22.02	32.7	37.1	27.6	—	—

Head.

Number.	Maximum length.	Maximum breadth.	Auricular brigmatic height.	Minimum frontal diameter.	Maximum interzygomatic breadth.	Nasion to hair line.	Chin to nasion.	Nose length.	Nose breadth.	Upper lip breadth.	Mouth breadth.	Ear length.	Ear breadth.	Interocular distance.	Eye breadth.	Cephalic index.	Nasal index.
1	17.5	14.8	13.3	11.0	14.4	6.2	12.0	5.2	3.4	0.8	5.1	6.0	3.8	3.2	2.7	85.00	64.00
2	20.6	14.7	13.7	11.5	14.5	7.7	12.0	4.7	3.7	1.0	5.3	6.0	3.8	3.4	3.2	71.35	79.00
3	17.8	14.8	13.3	10.6	14.6	7.4	11.0	4.3	3.8	1.0	5.0	6.4	3.4	3.0	3.1	83.10	88.40
4	18.7	14.2	13.5	10.1	13.0	7.1	12.6	4.6	3.5	1.1	4.8	6.3	3.2	3.0	3.05	75.93	76.10
5	20.0	15.0	13.1	10.7	14.7	7.0	12.0	4.6	3.8	1.1	4.8	6.7	3.2	3.2	3.25	75.00	82.60
6	19.5	14.5	13.5	10.6	14.4	7.5	11.0	4.8	3.5	1.1	5.1	6.4	3.5	3.3	2.95	74.30	72.91
7	19.6	15.6	13.2	11.6	14.6	7.9	11.9	4.1	4.1	1.2	5.6	6.7	3.5	4.1	3.2	79.60	100.00
8	19.2	14.3	13.1	10.5	14.2	6.6	11.0	4.2	3.6	0.6	5.1	6.5	3.4	3.5	2.6	74.50	85.70
9	18.2	15.2	13.1	10.2	14.0	5.8	11.4	4.4	3.7	1.2	4.3	6.2	3.4	3.4	2.8	83.50	84.00
10	20.2	15.0	13.6	10.7	15.1	7.1	13.0	4.7	3.5	1.4	4.8	5.3	3.8	4.0	2.8	74.26	74.50
11	18.0	14.6	13.0	9.7	13.7	7.4	10.8	4.6	4.0	1.0	5.3	5.3	2.6	3.2	2.9	81.10	87.00
12	19.0	15.4	12.8	11.3	13.8	7.0	12.0	4.7	3.7	1.5	5.0	6.3	3.6	4.2	2.4	81.00	78.70
Average Japanese	19.1	14.8	13.3	10.8	14.4	7.0	11.8	4.6	3.7	1.1	5.0	6.3	3.1	3.4	3.0	77.65	80.72

Upper leg

ORDER No.

Bureau of Science—Annual Reports.

201. Fifth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1906.
202. Sixth Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1907.
203. Seventh Annual Report of the Director of the Bureau of Science for the Year Ending August 1, 1908.

Philippine Museum.

(Now Section of Ornithology.)

* *No. 1, 1903.*—On Birds from Luzon, Mindoro, Masbate, Ticao, Cuyo, Culion, Cagayan Sulu and Palawan. By Richard C. McGregor.

* *No. 2, 1903.*—List of Bird Skins Offered in Exchange.

43. *No. 3, 1904.*—Birds from Benguet Province, Luzon, and from the Islands of Lubang, Mindoro, Cuyo, and Cagayancillo. By Richard C. McGregor.

* *No. 4, 1904.*—The Birds of Calayan and Fuga, Babuyan Group. By Richard C. McGregor.

Mining Bureau.

(Now Division of Mines.)

45. *1890.*—Descripción física, geológica y minera en bosquejo de la Isla de Panay por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.

* *1890.*—Memoria descriptiva de los manantiales minero-medicinales de la Isla de Luzón, estudiados por la comisión compuesta de los Señores D. José Centeno, Ingeniero de Minas y Vocal Presidente, D. Anacleto del Rosario y Sales, Vocal Farmacéutico, y D. José de Vera y Gómez, Vocal Médico.

47. *1893.*—Estudio descriptivo de algunos manantiales minerales de Filipinas ejecutado por la comisión formada por D. Enrique Abella y Casariego, Inspector General de Minas, D. José de Vera y Gómez, Médico, y D. Anacleto del Rosario y Sales, Farmacéutico; precedido de un prólogo escrito por el Excmo. Sr. D. Angel de Avilés, Director General de Administración Civil.
48. *1893.*—Terremotos experimentados en la Isla de Luzón durante los meses de Marzo y Abril de 1892, especialmente desastrosos en Pangasinán, Unión y Benguet. Estudio ejecutado por D. Enrique Abella y Casariego, Inspector General de Minas del Archipiélago.
49. *1901.*—The Coal Measures of the Philippines. Charles H. Burritt.
50. *1902.*—Abstract of the Mining Laws (in force in the Philippines, 1902). Charles H. Burritt.
51. *1902., Bulletin No. 1.*—Platinum and Associated Rare Metals in Placer Formations, H. D. McCaskey, B. S.
52. *1903.*—Report of the Chief of the Mining Bureau of the Philippine Islands. Charles H. Burritt.
53. *1903, Bulletin No. 2.*—Complete List of Spanish Mining Claims Recorded in the Mining Bureau. Charles H. Burritt.
54. *1903, Bulletin No. 3.*—Report on a Geological Reconnoissance of the Iron Region of Angat, Bulacan. H. D. McCaskey, B. S.
55. *1904.*—Fifth Annual Report of the Mining Bureau. H. D. McCaskey.
56. *1905.*—Sixth Annual Report of the Chief of the Mining Bureau. H. D. McCaskey.
57. *1905, Bulletin No. 4.*—A Preliminary Reconnoissance of the Mancayan-Suyoc Mineral Region, Lepanto, P. I. A. J. Eveland, Geologist.
58. *1905, Bulletin No. 5.*—The Coal Deposits of Batan Island. Warren D. Smith, B. S., M. A., Geologist.

Division of Mines.

301. *1908.*—The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products during the year 1907, issued by Warren D. Smith, Chief of the Division of Mines.

Ethnological Survey.

(Now Division of Ethnology.)

401. *Vol. I, 1905.*—The Bontoc Igorot, by Albert Ernest Jenks. Paper, ₱2; half morocco, ₱3.
402. *Vol. II, Part 1, 1904.*—Negritos of Zambales, by William Allen Reed. Paper, ₱0.50; half morocco, ₱1.50.
403. *Vol. II, Part 2 and Part 3, 1905.*—The Nabaloi Dialect, by Otto Scheerer. The Bataks of Palawan, by Edward Y. Miller. (Bound also in one volume with Part 1, Negritos of Zambales.) Paper, ₱0.50; half morocco, ₱1.50. Combined, half morocco, ₱3.
404. *Vol. III, 1904.*—Relaciones Agustinianas de las razas del Norte de Luzon, by Perez. Paper, ₱0.75; half morocco, ₱2.
405. *Vol. IV, Part 1, 1905.*—Studies in Moro History, Law, and Religion, by Najeeb M. Saleeby. Paper, ₱0.50; half morocco, ₱1.50.

Division of Ethnology.

406. *Vol. IV, Part 2, 1908.*—History of Sulu, by Najeeb M. Saleeby. Paper, ₱1.50.
407. *Vol. V, Part 1 and Part 2, 1908.*—The Batán Dialect as a Member of the Philippine Group of Languages, by Otto Scheerer. "F" and "V" in Philippine Languages, by C. E. Conant. Paper, ₱1.60.
408. *Vol. V, Part 3.*—A Vocabulary of the Igorot Language as spoken by the Bontok Igorots, by the Rev. Walter Clayton Clapp. Igorot-English, English-Igorot. Paper, ₱1.50.
409. Directions for Ethnographic Observations and Collections, 1908. *For free distribution.*

NOTE.

Those of the above-listed publications which are for sale may be obtained from the Director of Printing, Manila, P. I. Publications for free distribution, listed above, may be had by writing to the Business Manager, Philippine Journal of Science, Manila, P. I. Please give order number.

* Out of print.

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.
Authors receive 100 copies of their papers free.
The numbers of each section will appear as rapidly as material is available. Each section will be separately paged and indexed.
Subscriptions may be sent to the DIRECTOR OF PRINTING, Manila, P. I. Correspondence should be addressed to the Business Manager, Philippine Journal of Science, Manila, P. I.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
Messrs. WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
Messrs. MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
Messrs. KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
Messrs. A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

VOL. IV SEPTEMBER, 1909 No. 5

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., PH. D.

CO-EDITOR,

RICHARD P. STRONG, PH. B., M. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, PH. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, PH. D.; ALVIN J. COX, PH. D.
RAYMOND F. BACON, PH. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS, B. S.; R. C. McGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. GENERAL SCIENCE

MANILA
BUREAU OF PRINTING
1909

Order No. 406.

THE HISTORY OF SULU.

By NAJEEB M. SALEEBY.

275 pages.

A complete History of the Moro People in Sulu, with maps and many translations from the original documents.

Price $0.75, United States currency.

Order No. 407.

THE BATAN DIALECT AS A MEMBER OF THE PHILIPPINE GROUP OF LANGUAGES.

By OTTO SCHEERER.

AND

"F" AND "V" IN PHILIPPINE LANGUAGES.

By CARLOS EVERETT CONANT.

141 pages

Price $0.80, United States currency.

Order No. 402.

NEGRITOS OF ZAMBALES.

By WILLIAM ALLAN REED.

62 photographic illustrations. 91 pages.

An interesting ethnological study of the pygmy blacks of Zambales.

Price $0.25, United States currency.

Any of the above-announced publications may be ordered from the Business Manager, Philippine Journal of Science, Manila, P. I., or from any of the agents listed on the cover of this Journal. Please give order number.

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV SEPTEMBER, 1909 No. 5

GEOLOGICAL RECONNAISSANCE OF THE ISLAND OF LEYTE—WITH NOTES AND OBSERVATIONS ON THE ADJACENT SMALLER ISLANDS AND SOUTHWESTERN SAMAR.

By GEORGE I. ADAMS.

(*From the Division of Mines, Bureau of Science.*)

Little has been published concerning the geology of the Islands discussed in this report. Jagor, who visited the northeastern part of Leyte in 1860, noted the occurrence of a schist south of Tanauan, and described Bito Lake near Abuyog and the solfataras south of Burauen. His petrographic specimens were examined by Roth. A single specimen of igneous rock from the Island of Limasaua was described by Oebbeke who studied Semper's collections. Abella visited and described the Island of Biliran in 1882, especially its sulphur deposits. Becker cites passages from a manuscript report made by Ashburner in 1883 on the gold mines of the Island of Panaon. All the publications above mentioned were made use of by Becker in his report on the geology of the Philippines. In treating of the tectonic features of the islands, he discusses the structural relations of the Island of Leyte as surmised by others and adds some observations from his study of the maps. In the Atlas de Filipinas, prepared at the Jesuit Observatory in Manila, the conventional sign for an extinct volcano is shown on a general map of the islands near the name "Mount Amandiuing." This symbol, as will be explained later, may have been intended to indicate the solfataras south of Burauen. There is also a manuscript report by Maurice Goodman, formerly mining engineer of this division of the Bureau, which describes the sulphur deposits on Biliran Island and those near Burauen on Leyte visited by him in 1906.

No previous attempt has been made to describe the physiographic and geologic districts of Leyte and so the present report, although meager, may serve as an introduction. The reconnaissance on which it is based was made during April and the first half of May, 1909, while studying the geologic conditions governing the drilling of deep and artesian wells for the Bureau of Public Works. The island was circumnavigated and fifteen coast towns and three interior towns in the northeastern part were visited.

Maps.—The best map of Leyte is by d'Almonte, published on a scale of 1–200,000. It was evidently used in preparing the one published in the Atlas de Filipinas. On it the adjacent Islands of Biliran and Panaon are shown in some detail. The two most notable errors which it contains are in the representations of Lake Bito and the Leyte River. Jagor, who visited Lake Bito, has shown that it was drawn too large on Coello's map, which may have been d'Almonte's source of information. The description of the lake, translated from the Spanish edition of Jagor's travels, is as follows:

"The rain having passed, we arrived at the Bito River in an hour (from Abuyog) by an agreeable road and in a banca ascended the river which follows through heavy vegetation. The margins are low, level and sandy, and are covered with tall bamboo and reeds. After having ascended ten minutes the way was found obstructed by fallen tree trunks, which obliged us to make a detour of half an hour on land in order to reach the river above the obstruction. Rafts of bamboo were constructed, on which we journeyed, very much crowded because of their small size, due to the little amount of material available. We arrived at the lake in ten minutes. To the north and south of the lake there are hills. Seen from the center, the lake is nearly circular and is surrounded by a forest. Coello represents it too large (4 sea miles instead of the one which it has). It is about 1 league distant from Abuyog. * * * We found the greatest breadth to be 585 brazas, equal to 977 meters (its greatest breadth must be a little more than 1 kilometer) and its length is about 1,007 brazas, equal to 1,680 meters, or less than a mile. Soundings showed the bottom to incline gradually toward the center where the depth is 8 brazas, equal to 13.3 meters."

Lake Bito will be correctly shown on a Coast and Geodetic Survey chart now in preparation for publication.

There is a general impression among those who have an opinion in regard to this lake, that it occupies a crater and that the hills which surround it are the remnants of a crater rim, but there is no information confirming this. The idea is suggested by the position and appearance of the hills in the plain, as seen from a steamer when leaving Abuyog for Dulag. The depth of the lake indicates a depression greater than would be expected from the grade of the stream. The locality is worthy of geologic investigation.

The Leyte River is much shorter than is indicated on published maps, and does not have its source in Lake Danao, nor is Danao the source of the Cancatoco River, as is shown on some maps. The Iwaásan River is the outlet of the lake, and it flows to the east to Amandiuing Lake which, in turn, is the source of the Binahaán. Lieut. Philip H. Rockstroh, of the Philippines Constabulary, kindly furnished this criticism, together with other information concerning the hot and mineralized springs and topographic features of the island, and his description of Lake Bito corresponds with the one by Jagor given above. On a manuscript atlas of the Philippines by d'Almonte, which is now the property of the Coast and Geodetic Survey, these features of the drainage near Lake Danao are shown as here described. The errors in the published map may be due to the lithographer.

There are a number of sectional and route maps made by officers of the United States Army and Philippines Constabulary, but it is not possible at present to compile a satisfactory map. The Coast and Geodetic surveys now in progress, as well as surveys by the Bureau of Lands, indicate that many details of the Spanish maps will be changed when the present surveys are concluded and combined. Accordingly, in this report only an outline map on a small scale is used, and the reader who may have a special interest in the island is advised for the present to consult d'Almonte's map or the one in the Atlas de Filipinas, which was taken from d'Almonte's, and also the Coast and Geodetic Survey charts.

Physiographic and geologic districts.—No previous attempt has been made to describe the physiography of Leyte and the only suggestion as to its topographic features is in the disposition of the streams and the names of the mountains on the maps. The hachuring of d'Almonte's is, to say the least, misleading, and in the absence of elevations accompanying the names of the mountains, an imperfect idea of the relief is presented. The physiographic districts distinguished in this report correspond closely with the geologic structure and are accordingly indicated by the geologic districts on the accompanying outline map. The dominant feature of Leyte is the Central Cordillera which runs from Cabalian in a northwesterly direction through the island and is continued in Biliran and Maripipi Islands. In addition may be distinguished the southwestern semi-mountainous district, the northeastern semi-mountainous district and the northeastern plains. There are also some littoral lowlands of small extent which are not shown on the map.

CENTRAL CORDILLERA.

This district is for the most part rugged and is dominated by many high peaks. Its lowest portion is to the west of Carigara, where it is also narrowest. This is the most practicable place for a road to cross the district, and a trail now exists which can be developed into a road.

The trail over the cordillera between Dolores to Jaro is very difficult, because of the steepness of the western slope, and it is impracticable for a wagon trail. There is an idea prevalent that a road should be established between Abuyog and Baybay following the river valley in so far as possible. This route has been surveyed by the division of roads, and some money has been spent in clearing a trail, but the route is not an easy one and the building and maintaining of a road in this section would be very costly.

Similarly, from Abuyog to Sogod the foot trail is rugged and difficult, and the coast between Abuyog and Hinunangan affords no place for the construction of a road. With the exception of the route from Carigara westward, it is probable that the Cordillera forms a barrier to transportation which will prove effective for a very long time.

Mount Amandiuing.—The only peak of the Central Cordillera which appears to be indicated in the Philippine Atlas as an extinct volcano is Amandiuing. No explanation of the reason for this is given and it may be that the symbol was intended to show the solfataras of Burauen. However, several military officers who have ascended the flanks of Amandiuing have stated that it has the appearance of an extinct volcano, and it may prove to be one since there is a hot sulphur mud spot on its flank, and there are hot springs at the source of a stream which heads in this peak and flows towards Jaro.

Solfataras near Burauen.—The solfatara of Casiboy south of Burauen is indicated on d'Almonte's map as situated in Mount Himalacagan. As will be seen from the succeeding quotations there is a second solffara near by.

The following description of these solfataras by Jagor is translated from the Spanish edition of his travels in the Philippines:

"South of Burauen rises the mountain ridge Manacagan,[1] on the further slope of which is a large solfatara from which sulphur is obtained for the powder factory established in Manila. From the gateway there is seen to the south, through the shade of the trees, a great white slope of Mount Danan."

"At 9 o'clock we reached the crater of Casiboi where there is much vegetation and advancing to the south we saw some sheds in which sulphur is sublimated. A few hundred paces more to the south a stream flows 12 feet wide, the water of which is hot (30° Réaumur) and deposits siliceous sinter at its borders."

"Following from north to south along a ravine the walls of which have a height of from 100 to 200 feet, the vegetation gradually diminishes and the rock is so white as to affect the eyes. In places it is of a yellow color due to the sublimated sulphur deposited on it. In many places there rises from the ground a penetrating, dense vapor with a pronounced odor of sulphur. Several hundred paces beyond, the valley turns to the left (east) and widens. Here numerous siliceous springs break through the clayey earth which is impregnated with sulphur. This solfatara must formerly have been more active. The depression formed by the decomposition of the rock has a floor covered with débris and measures about 1,000 feet wide and five times as long."

"In the eastern part there are a number of small boiling mud spots. From holes made in their borders with a stick, water and steam ascend. In some

[1] Mount Himalacagan on Abella's map.

deep places to the west beds of gray, white, red, and yellow clay lie deposited in layers and having the aspect of variegated marls."

"Exactly to the south in front of the gate-way on the trail from Burauen there is a cavern in white decomposed rock, having an opening 25 feet wide from which much water which deposits siliceous incrustations flows. The roof of the cave is hung with stalactites which are covered partially or completely, with sublimed sulphur."

"In the high part of the slope of Mount Danán near the summit so much sulphur is deposited from the vapors that it can be collected in coconut shells. In some crevices protected from the action of the cold air it accumulates in thick brown crusts."

"The solfatara of Mount Danán is situated exactly south of the other at the opposite side of the ridge of the Casiboi. The clay, which remains after the siliceous matter has been washed out, is carried by the rain to the valley where it forms a plain, the greater part of which is occupied by the Lake Malaksan. (Malaksan signifies sour.) It is limited by low ground, and its extent, which is subject to frequent variations according to the weather, was found to be 500 paces long and 100 wide. From the elevation at the solfatara there is seen through an opening to the south a somewhat larger lake of fresh water surrounded by wooded mountains. Its name is Járnanan. * * * Soundings gave the following results: Near the southern margin, which is somewhat more steep than the north, 13 fathoms (equals 21.7 meters); the greatest length was found to be 800 varas (668 meters) and the width about half of this."

Mr. Goodman described the same locality as follows; he introduced some names not contained in Jagor's description, but the reader will be able to reconcile the two descriptions without difficulty:

"The earliest indication of our proximity to solfataric activity was observed when we came to the crossing of the Mainit River, about a third of a mile south of 'la puerta.' The source of the heat and sulphur carried by the Mainit lies in the solfatara, which is only about a quarter of a mile east of where we crossed the river and about 100 feet above it. The To-od Grande, as this solfatara is called, is a large barren space about 800 feet long by 500 feet wide. Its surface consists of white kaolin resulting from the corrosion by acid fumes of some volcanic rock, probably andesite. A portion of this superficial layer has incrusted upon it a greenish yellow mixture of sulphur and clay, deposited from the sulphurous gases which still emanate from numerous fissures and crater-like openings in the surface of this barren area."

"These openings are of two kinds—dry vents from which gases escape into the atmosphere without the association of water, and wet holes which are like large earthern caldrons containing either boiling mud or water. Extending some distance around the orifice of the dry vents there is usually formed an incrustation of beautiful yellow crystals of sulphur. The bulk of the sulphur, however, lies in the impure clayey mixture distributed over the surface in irregular patches. An average sample of the crust to a depth of about nine inches yielded on analysis 66.1 per cent of free sulphur."

"The To-od Pequeño is a continuation of the same solfatara, situated to the south of and at a lower level than the To-od Grande. It exhibits the same phenomena as the upper solfatara, but is much smaller in area. In one portion of the To-od Pequeño is a large cave from the bottom of which issue steam, sulphurous, chlorine, and other gases, corroding the sides and roof of the vault and giving to it a vari-colored appearance, due to the secondary minerals formed."

"About half a mile southeast of the To-od and separated from it by a high ridge of andesite is another solfatara called the Pangujaan.[2] It is situated on the southern slope of a slide, about 125 feet high and about 300 feet wide, from the sides of which four or five larger and several smaller vents give off steam and sulphurous gases in a continuous flow. As at the To-od, these vents are usually fringed with a sublimate of sulphur, close approach to which, however, is very difficult on account of the precipitousness of the slide, as well as on account of the heat and noxious gases given off. Occasionally the channel leading to one of these vents may become closed, and the flow of gases deflected in another direction, in which event the rich sublimate which has formed in the neck and about the mouth of the vent becomes covered over with a subsequent layer of kaolin, forming a hidden deposit of almost pure sulphur."

"South and southwest of the two solfataras are two small lakes which drain that region. The smaller of these, called the Malaksan, has low and flat banks, is quite shallow, and is about 100 feet long by about 500 feet wide. Its waters are slightly acid, and apparently barren of all living matter. The larger and deeper of the two lakes, called the Pangi, is situated about half a mile south of lake Malaksan, has high, steep and wooded banks, and contains fresh water with an abundance of large fish. The approximate altitudes of the two lakes are respectively 1,230 and 1,160 feet above sea level. With the exception of a few occasional fishermen who venture into this country, the entire neighborhood of the solfataras is uninhabited and uncultivated for miles around."

Mount Cabalían.—Another topographical feature worthy of description is Mount Cabalían, which is situated in the extreme southeastern point of the island. Its lower slopes have the characteristics of a volcanic cone, but its summit is broken up into irregular peaks inclosing a lake which evidently occupies the crater. To the south and east the lower slopes of the mountain descend gradually to the sea, and to the northeast they descend with the same regularity to a lowland. To the north and west there are hills which destroy the outline of the cone. To the west and east of the mountain there are hot springs, and several of the streams which flow down its lower slope are slightly mineralized, so that fish do not live in them.

In Bulletin III, Census of the Philippines, 1905, Rev. Sáderra Masó, S. J., records that it is stated that near Cabalían there lies an active solfatara. This probably refers to Mount Cabalían which, however, does not exhibit solfataric action. In 1907 it was the center of a local earthquake disturbance which continued from May 17 to 25 and caused several large landslides from the peaks of the mountains. The barren rock faces and the paths of the descending avalanches, as indicated by the absence of trees, were clearly distinguishable at the time this reconnaissance was made. In the Bulletin of the Weather Bureau for May, 1907, the reports of this earthquake from inhabitants of the locality state that the disturbance caused some nipa houses to fall, and that on

[2] Solfatara of Mount Danán of Jagor's description.

May 20 the shocks were so frequent that the people had difficulty in cooking their meals. In his report for May, 1907, Director Algué, of the Weather Bureau, writes concerning the character of the disturbance:

"It is certain that these earthquakes, besides having a very reduced meizoseismic area (about 10 kilometers in diameter) must have proceeded from a center at a small depth, since of more than sixty disturbances felt in the epicentrum between the 17th and 25th of May, only eight were perceptible in Maasin, 30 kilometers distant, and four in the extreme northeast of Mindanao, which is 60 kilometers distant."

Solfataras on Biliran Island.—According to Abella the central cordillera continues to the north in the islands of Bilirán and Maripipi. He describes the Cordillera of Bilirán as extending from the northwest to southeast and lying near the eastern sides of the island, and then curving to the south where it terminates in abrupt slopes at the narrow strait which separates the island from Leyte.

The active solfataras of Bilirán are described by Abella as follows (translation from the original in Spanish):

"The most important of all, the one in the drainage of the Caraycaray River, is situated in the place called Cajúco on the western slope of Mount Guinon on one of the spurs which gives rise to the Cailjián ravine. One sees at that place an elliptical space about 100 meters long entirely devoid of vegetation in which the rocks are whitened or of variegated colors produced by the deposits and concretions of various natures which are found there, and from some distance there is a noticeable sulphurous odor from the fumaroles at various points"

The mine San Antonio was located on this deposit.

"The solfataras of the Caibiran River occur principally in three bare spots analogous to the one at Cajúcao situated parallel to the Mapulá ravine on the eastern side of Mount Guinón opposite those of Cajúcao. * * * These three spots or bare places present phenomena and products similar to the others just described. * * * However, the disintegrating products of the rocks are here more extensive, which seems to indicate that these sulphur deposits are somewhat older than that of the other slope and are in their period of decline or extinction."

The mine Santa Rosalia was located on this deposit.

"The solfatara situated in the drainage of the Anas River on the western slope of Mount Guianasan is still more energetic and important than the one in the Mapula ravine, but on the other hand possesses a much more ferruginous character than the others."

The extinct solfataras which Abella saw are situated at Guiso del Monte Panámao near Almeria and at Catmon near Naval. At the first he found clays, oxide of iron, and pyrite, the soluble substances and sulphur having disappeared. The second, which is near the sea and away from any stream, has a circular crater-like depression 50 meters in diameter and contains some clay deposits, but no sulphur.

Goodman, who visited the Island of Bilirán to examine the sulphur deposits, gives a description of them similar to that of Abella. He also noted a conglomerate on the beach about a half mile north of Almena, the boulders of which are encrusted with deposit of aluminous sulphate, probably alunogen, but of no commercial importance. In addition he refers to a hot spring near Catmon with a temperature of 107 F. and containing a small amount of gas, but no sulphur.

Springs: Besides the springs already mentioned as associated with the solfataras on Bilirán Island and near Burauen in Leyte and those related to the extinct volcanoes, Mount Amandiuing and Mount Cabalían, there is a small hot spring on the west side of the point of land which projects from Leyte opposite Poro Island in the Biliran strait and a hot sulphur spring on Mount Ogris south of Mount Nipga between Abuyog and Baybay. South of Abuyog in the barrio Buenavista there is a cold mineral spring. To the west of Alangalang, on the west side of the Cabayong River, there are some small and apparently nearly buried hills which are probably outliers of the Cordillera and at the base of one of these there is a cold mineral spring.

Igneous rocks.[3]—The rocks from the Cordillera which were collected by Jagor, were studied by Roth who states that there is an amphibolitic andesite at the gateway of the mountain of Dagami. Evidently he refers to the gateway in the mountain Himalicagan which Jagor passed on his way to the solfataras south of Burauen, since on Coellós map the names Dagami and Burauen are transposed. Roth, in his comments, states that the rock is exacty like that of Isarog, a dormant volcano in Camarines Sur, and that to the north of it there is a lapilli formation. This would seem to be a proof that there was once an active volcano near by and would support Jagor's statement that the solfataras are in a crater. In another portion of his article Roth writes that it is well known that Mount Dagami (Himalicagan) is an extinct volcano. Goodman found andesites at a locality near the solfatara.

According to Becker's opinion Abella's descriptions of the rocks of Biliran Island make it substantially certain that they are hornblende andesites.

The rocks which the streams bring down to the vicinities of Alangalang, Dagami, and Cabalían and which were collected during the reconnaissance on which this report is based, were mostly hornblende andesites with a few basaltic boulders.

One of Roth's conclusions is as follows:

"Among the numerous volcanic rocks which I have from the south of Luzon, Samar, and Leyte and in the related tuffs, there are represented with few exceptions only two types, closely related, both being characterized by the presence of triclinic feldspars and distinguished one by hornblende, and the other by augite; hornblende andesites and augitic andesites or dolerites."

[3] In this paper Kemp's classification of igneous rocks is followed. The petrographic determinations are by Dr. W. D. Smith.

Sedimentary rocks.—Thus far no sedimentary rocks have been reported as occurring in the cordillera in Leyte, and Abella did not mention any in his description of Biliran Island. However, according to a seemingly reliable report, there is an occurrence of petroleum on the east coast of Biliran, inland from the *sitio* Capalis, and it is quite probable that it is in sedimentary rocks.

The eastern flank of the cordillera is buried for a long distance by the alluvial deposits of the northwestern plains. The western flank from Ormoc to Baybay descends to the coast. The places where the relations of the sedimentaries may best be studied have not been visited, although it is certain from a few observations made during this reconnaissance that on the western flank of the Cordillera there is an extensive series of stratified deposits in which limestones are conspicuous. They are more fully discussed in describing the southwestern district. On the east side of the island similar limestones were seen at only one locality. At Patyucan point and extending inland to the road between Hinunangan and Hinundayan, there is a mountain called Patyucan which consists of massive and thinner bedded limestones which outcrop in conspicuous sea cliffs. They dip towards the south as if they had been given their inclination through a subsidence peripheral to the volcanic center, Mount Cabalían.

Origin of the Cordillera.—The trend of the Cordillera, as shown on the accompanying sketch map, is about N. 30° W. Abella has expressed his opinion that Biliran Island is due to a volcanic action and that it is a part of a volcanic belt which continues to the southward through Leyte and Panaón and the Eastern Cordillera of Surigao (Mindanao) to point San Agustín with some similar volcanic manifestations, and to the northward in the island of Maripipi and others until it connects with the active volcano Bulusan in Luzon, being thus situated on one of the volcanic fractures of the Archipelago. Becker cites this opinion of Abella and also the rather untenable theory of volcanic belts by Koto in his "Geological Structure of the Malay Archipelago" in which is included a structural line from Masbate through Leyte and eastern Mindanao. Especially suggestive are the following remarks by Becker,

> "To my thinking too much effort has been made to show unbroken continuity of volcanic zones. Fissures occur far more often in parallel systems than singly and, just as dikes jump from one fissure of such a system to another, so, I think, do the greater volcanic phenomena."

Much more study will be necessary before the relations of the volcanic zone of Leyte are determined definitely and in the meantime it will be better not to try to extend it too far. In the accompanying map Panaón Island is not included in the trend of the Cordillera, since it is not known to contain any true volcanic phenomena and the rocks seen in the northern end indicate that it is more closely related to the southwestern semi-mountainous district.

SOUTHWESTERN SEMIMOUNTAINOUS DISTRICT.

If the limits of this district, as shown on the accompanying sketch map, are studied, it will be noted that between Ormoc and Baybay the Central Cordillera descends to the coast. Accordingly, the southwestern district is discontinuous and may be spoken of as consisting of a northern and a southern part.

The northern part contains a number of hills and low mountains which are indicated on d'Almonte's map, although no elevations are shown. They are situated in the western part of the area. The landscape in general presents a broken appearance, and near San Isidro and Villaba is a cogon hill country which formerly contained many haciendas devoted to the cultivation of sugar. Communication is largely by sea. There is, however, a trail leading north from Ormoc to Valencia and thence continuing northward to the head of the estuary into which the Leyte and Palapay Rivers flow. This trail passes through relatively low country and has a branch which turns to the eastward and crosses the Cordillera to Capoocan and Caragara. There are also branches from this trail which turn off at various points to Villaba and Polompon. The only improved road is one newly built from Ormoc to Dolores, which it will be impracticable to extend eastward over the cordillera to Jaro. The country along the trail north from Ormoc will probably develop into an important agricultural district, inasmuch as it contains a large amount of valley land. At present it is very sparsely inhabited.

The southern part of the southwestern district is more mountainous than the northern. To the south of Baybay there is a high ridge which runs in a southeasterly direction to a point opposite Bato, where there is a break in the mountains which is taken advantage of for a trail across this peninsular part of Leyte, the remaining roads of this area being along the coast. To the south of this route of travel there are mountainous ridges, one of which lies to the north of Maasin and the other to the west of Malitabog. Pananon Island, which is separated from Leyte by a narrow strait, appears to be a continuation of the mountains which parallel the coast south from Sogod. If we analyze the coast line of Leyte and judge of the trend of the mountains as shown by the position of the names on d'Almonte's map, we might be led to the same conclusion which was expressed by Becker, who, in his remarks concerning the structural lines of the Philippine Islands writes:

> "Near the center of our own Island of Leyte there is a fork in the mountain system, and the westerly branch is seemingly continued southward through Mount Apo and the southermost part of Mindanao by the way of Sanguir Island to Celebes."

It is probable that this remark was based upon a study of the map of Leyte rather than its topographic features seen in the field. The coast line of d'Almonte's map is far from perfect. When the bay in the southern part of the island, which may have suggested the forking in the mountain systems, is properly mapped and the trend of the adjacent mountains is shown, it will be seen that the structure of the southwestern district is approximately parallel with that of the central cordillera.

Sedimentary formations.—At all of the places where the rocks of this district were examined, and in all of the landscapes which were studied while passing along the coast, conspicuous outcrops of coralline limestone were seen exposed on the flanks of the hills and even resting on the tops of some of the higher mountains. The relation of these outcrops to the topography and the apparent dip of the formations, as well as their attitudes when studied at close range, show that they have been elevated, faulted, and tilted. In some places masses were caught in between eruptive igneous rocks. It is probable that they were deposited on a basement of older igneous rocks and that with the gradual elevation and emergence of the Island of Leyte igneous rocks were intruded along some lines of fracture, giving rise to the dominant mountain trends. The sedimentary formations include beds of shales and conglomerates, but these are far less conspicuous than the limestones. In the northern part, near Eulalia, which is now known as Port Calubian, outcrops of coal are reported. Becker states that Leyte possesses coal but the locality is unknown, although it is said to be in the southwestern part of the island. It may be that the locality near Calubian is the one which furnished the samples which, as noted by Becker, were analyzed by the Inspección de Minas and shown to be of the same class as the Cebu coal, having a fuel value of 5,800 calories. On d'Almonte's map, the occurrence of petroleum is indicated at a point about 7 kilometers north of Villaba. It is reported that some prospectors have studied this part of Leyte and have found much to encourage them in the belief that petroleum exists there in paying quantities, but they have been deterred from developing the field because of the difficulty of enlisting capital.

Igneous rocks.—The igneous rocks of the southwestern district have been very little studied. From the island of Limasaua a specimen of hornblende andesite was determined by Oebbeke. During this reconnaissance some specimens of igneous rocks were collected to the west of Malitbog. They have been classified as diorites and peridotite porphyries.

The field relations of the igneous rocks to the west of Malitbog and on the northern end of Panaón Island, near Liloan, show clearly that eruptive and intrusive rocks have broken through the sedimentaries and included masses of the limestone. On the eastern side of Panaón, near Pinutan Point, d'Almonte indicates the occurrence of gold mines. Becker states that the wall rock at these mines was called by Ashburner "greenstone porphyry," and that this term, while it would not exclude prophylitic neo-volcanics, in all probability points to diorite or diabase.

Gold Mines on Panaón Island.—These mines were examined by Ashburner in 1883. From a manuscript report in the possession of Ashburner's clients, we have the following information given by Becker:

"Several veins of quartz outcrop on the coast and extend in a westerly direction into the mountain. These veins are paralled. They strike east and dip south. The wall rock is 'green-stone porphyry.' There is some wall rock in the vein and the sulphurettes are generally pyrites and accompanied by galena and zinc blende. One vein about six feet wide has been worked to a considerable extent, some 871 tons having been treated up to 1883. The yield was $6 or $7 per ton. Concessions for gold mining have been granted at Tigbuan, just south of Pinutan, and, according to the Compendio de Geografia, there was a productive mine at Inalinan."

Becker further says that Ashburner found nothing which he could recommend to his clients. However, a mine which at that time was not attractive to capitalists, may prove worthy of exploitation when the conditions of the country are favorable to mining.

NORTHEASTERN SEMIMOUNTAINOUS DISTRICT.

There is an elongate mountainous area to the west of the straits which separate Leyte and Samar Islands, in which the highest elevations are toward the northern end. There are some broken ridges on the east and west of the mountains, and to the south are isolated hills forming a continuation of the district. The rugged portion is heavily timbered and but sparsely inhabited.

From Tacloban, the principal port of Leyte, the road to the interior makes a detour of this district, first running to the south along the coast to the town of Palo, where it branches to the northeastern plains. South of Palo there are a few scattered hills situated near the coast and having their flanks partly buried by the sediments which constitute the plain.

Geologic formation.—The only note concerning the rocks of this district is by Jagor, who reported that he found a cliff of grayish green quartzose chloritic schists on the sandy beach about a league from Tanauan. This locality is evidently to the south of Tanauan about half way to Tolosa where there is such an exposure. Inland, in a long hill which the road touches in two places, this schist is more fully represented and is cut by dikes and larger intrusions of an augite andesite porphyry which probably produced the schist by metamorphosing the sedimentaries with which it came in contact.

Further south on the seashore, just to the northeast of Tolosa, there is a high subconical hill surmounted by an old tower built as an outlook and defense against the Moros. An exposure of rock in a sea cliff of a neighboring lower hill to the northeast shows an altered shale much squeezed and slickensided. Between Tolosa and Dulag there is a hill in which exposures near the road show a fine igneous rock which on microscopic examination proved to be felsitic andesite.

About 1 kilometer to the west of Tanauan the United States Army opened a quarry in an isolated hill, in order to obtain stone for repairing the road from Tanauan to Dagmi. There is exposed in this quarry a squeezed, slickensided and very much altered rock which under the microscope showed only serpentine.

In the falls of the Milarong River to the west of Palo, and also in the hill near by, there is exposed an augite andesite with gabbroic texture. It is similar to the rock which is found cutting the schist south of Tanauan. The road nearer Palo cuts into a hill of altered shales. At Palo, at the north end of the bridge, a quarry has been opened for road material in a high hill of hard and slickensided and somewhat altered shale. The abutments of the bridge rest on exposures of this rock which produces a small fall in the river. The main area of the northeastern district was not visited, but such gravels as were seen from its streams indicate that the rocks which constitute it are similar to those found in the hills which form its southern continuation. The geologic history of the district, as may be interpretated from the data now available, indicates that the mountainous structure was due to the intrusion of igneous rocks into a series of sediments producing an uplift along an axis trending approximately north 30° west.

A peninsular part of Samar and the very irregular shaped Daram Island, as well as other lesser islands, lie to the northward, in strike with the northeastern district of Leyte, a fact which indicates that the structure continues to the northward. In traveling by steamer from Catbalogan, Samar, to Carigara, Leyte, and returning from Tacloban through the straits and interisland passages to Catbalogan, an opportunity was given to see the islands at close range, but no landing was made. The islands consist of sedimentary rocks with some igneous rocks which appear to form the axis of the trend, and, if they are not a continuation of the igneous rocks of northeastern Leyte, they at least follow parallel structural lines. Without landing and making a close examination it can not be determined whether they are intrusive or not, but the sedimentary beds do not appear to be altered and probably represent a younger formation than those which are cut and metamorphosed by the intrusives of the northeastern district of Leyte. In fact, at Tacloban, in the point of the peninsula on which the town is built, there are some low hills around which the Army post is located and exposures made by cutting roads show that the formation of which these hills are composed is a series of variable sandstones, shales and conglomerates, dipping at a low angle to the eastward. In the conglomerates there are pebbles and small boulders of igneous rocks which apparently had their origin in the northeastern district. Especially significant are the pebbles of schist. The hills in Tacloban were once islands, and they have been united to the mainland by a recent formation consisting of marine deposits and coral reefs which form the neck of the peninsula. A second peninsula of apparently similar origin but without any hills, lies to the east of the town, forming the limits of Cancabato cove. To the west of Tacloban the first low ridge consists of a series of sedimentaries very little exposed, but giving evidence of containing sandstones and some limestones. The direction of this ridge is about north 30° west. Looking across the straits to the north of Tacloban on the Island of Samar, there is a conspicuous hill showing a high escarpment, well toward its upper portion. This escarpment is due to the weathering of a thick bed of variable sandstone and conglomerate. In passing through the straits between Samar and Leyte, in the portion which has approximately a north south direction, one may observe outcrops of sedimentary beds dipping at low angles to the eastward. These are imperfect sandstones and nodular and concretionary argillaceous beds. The many changes in the direction of the channel in this part are due to the development of the channel by erosion along the strike of the least resistant beds which have an eastward dip and a strike of about north 30° west. The topography of the shores and the islands in the straits shows a series of hills or ridges and the channel occupies the lowest valleys between them, passing in a zigzag direction.

This series of sedimentary beds may best be studied on the Island of Samar where it contains some heavy limestones. Besides a number of sea cliffs which were seen in the small islands along its western shore, exposures were studied at Catbalogan and Calbayog. The formation is probably very extensive in Samar where its history may some day be worked out in detail. It is but slightly represented in the northeastern part of Leyte, and there is little certainty of correlating it with the sedimentary formation in the southwestern districts of the island because of the wide belts of the northeastern plains and the Central Cordillera which intervene. Nevertheless, the idea suggests itself that the sedimentaries of western Samar and southeastern Leyte belong to the same series which at present are not classified closely as to age, but which are now called late Tertiary.

NORTHEASTERN PLAINS.

This district is the part of Leyte best adapted to agriculture because of the character of its soil and the general level surface of the land. It lies between the northeastern semimountainous district and the Central Cordillera, having considerable seacoast on Carigara Bay, and a longer coast line on the Pacific Ocean between Palo and Abuyog. Roads are being built to connect Carigara and Tacloban by the way of Palo, and to extend from Palo through Tanauan and Dagami to Burauen; and gradually this system will extend along the coast as far south as Abuyog, and have branches to all the important centers of population. Carigara is a very shallow port and ships must anchor well out in the bay. At low tide a broad beach is left bare, and the channel across it is too shallow for transporting cargo by lighters. On the east coast the towns are unprotected ports and open toward the Pacific. As a result, Tacloban, which has deep water and is well protected, will always receive a large amount of traffic from the plains district.

Geologic formation.—With the exception of a few exposures in low river banks which reveal very soft sandstones and poorly cemented conglomerates, little idea of the underlying formation of the northeastern plains can be obtained. Its surface deposits are largely alluvial and have been brought down by the streams from the Cordillera. Accordingly, near the foot of the Cordillera, coarser sediments are to be expected, and along the sea coast where the plains are low, little else is seen besides beach sand and silts deposited near river mouths. Reference has already been made to the partially buried hills, which are the southern continuation of the northeastern semi-mountainous district. The occurrence of some low hills near Alangalang which are probably outliers of the Cordillera district, has been noted in connection with the description of the Cordillera. Also reference has been made to the hills which surround Lake Bito. These are all inliers in the plain and give very little information as to the general formation. The only place thus far at which a deep well has been drilled in this district is Carigara, where artesian water was encountered at a depth of 56 meters. An examination of the samples of drillings which came from the well showed sands, detrital material from andesite rocks such as might have been brought in by rivers from the Cordillera, and interbedded marine sands containing marine shells. While it is not possible from the present data to prove the emergence of this plains district, it appears very reasonable to suppose that it was a strait at some period not very far removed, and that the elevation of the island has converted it into an alluvial plain, the surface of which has been aggraded by the streams. Marine sediments may be expected under the alluvial surface deposits.

GEOLOGIC HISTORY.

Our present knowledge of the geology of Leyte is very incomplete but it points to an interesting history of the island which may be tentatively outlined as follows:

The basal formations do not appear in any area thus far studied unless the dioritic rocks represent the igneous portion of the older formations. Thus far diorites have been found only near Malitbog, and, possibly, as Becker has suggested, they are represented at the gold mines on Panaón Island.

In the northeastern district there is a series of sedimentaries, perhaps older Tertiary, which have been metamorphosed into schists and altered shales by intrusive igneous rocks. Some stream gravels indicate that a similar series of more or less metamorphosed sedimentaries and accompanying intrusives are present in the southwestern district. The erosion of these formations has contributed sediments to the later Tertiary.

The most widely distributed formation is a series which contains besides conspicuous beds of limestone, some shales, sandstones, and conglomerates. It is the predominating formation in the southwestern district and is reported to contain coal near Port Calubian (Eulalia) and petroleum north of Villaba. There is a small area of limestone of this series in the hills at Patyacan point on the east side of the Cordillera in the southeastern part of the island, and it is represented in the northeastern part of the island near the strait of San Juanico, and extensively in southwestern Samar. These sedimentaries are usually considered as later Tertiary. They have been lifted, faulted, and intruded by igneous rocks which appear to be closely related to the igneous rocks of the Cordillera.

The Central Cordillera of Leyte is a volcanic belt which extends in a direction north 30° west, through the island and continues in Biliran and Maripipi Islands. It contains the extinct volcano Cabalían, the solfataras south of Burauen, Mount Amandiuing, which is probably an extinct volcano, and the solftaras in Biliran Island. The rocks of this district are largely hornblendic andesites.

The northeastern plains, which are largely alluvial, represent the latest extensive formation. In addition there are some marginal littoral deposits formed in part of coralline limestone.

The emergences and submergences of Leyte and the adjacent islands, including especially Samar, form a complicated history. The coal in Leyte (and it may be noted that coal is also reported in western Samar but not yet known to be of economic importance) and the wide distribution of coralline limestone, in what is called the later Tertiary series of sedimentaries, indicates an extensive area of low-lying lands, coral reefs and shallow seas in late Tertiary time. The emergence of this series, which formed the Island of Leyte, seems to have been brought about by the igneous intrusions and volcanic eruptions which took place in the zone of the Cordillera. During the first stages of this process a strait probably extended in what is now the northeastern plains district. By continued elevation and the contribution of sediments from the Cordillera this strait has been transformed into an aggraded alluvial area. The development of the San Juanico Strait apparently occurred later and may be attributed to a submergence along an axis parallel to the Cordillera of Leyte, and perhaps resulting concomitantly with the growth in elevation of the central portions of the Islands of Samar and Leyte.

SUMMARY OF MINERAL RESOURCES.

Gold.—The mines in Panaón Island have been abandoned for several years. If the veins permit of favorable mining and a yield of from $6 or $7 per ton can be obtained, as reported by Ashburner, it may be worth while to reopen the mines.

Coal.—The commercial value of the coal near Calubían probably depends more upon the character of the beds and facilities for delivering it at the sea coast, than upon the quality, since most Philippine coals are of about the same grade. Concerning the nature and location of the coal there are at present only hearsay reports.

Sulphur.—Goodman, from an examination of the surface estimated that there are about 3,000 tons of sulphur in sight at the To-od and Pangujan solfataras south of Burauen. At the mining claim San Antonio on Biliran Island there are 400 tons and at the Santa Rosalia claim the amount is inappreciable. He suggests the deduction of 25 per cent for loss in mining and treating. The cost of transportation from the Burauen deposits he considered prohibitive and the Biliran deposits too small to warrant the cost of installing machinery. However, transportation from Burauen to Tacloban will soon be improved by the completion of a good road, and since the remaining distance is short it may be that the sulphur can be exploited at a profit.

Petroleum.—No wells have been drilled and no study of the geologic structure near the oil showings has been made. There is some talk of prospecting at the showings near Villaba and on Biliran, but at present there is lack of capital for such an enterprise because of the attendant risk.

Stone.—Thus far two quarries have been opened for road material, one just west of Tanauan and the other at Palo. No doubt others will be developed in order to obtain stone of good quality for road building. Up to the present time gravel has been extensively used, but with better equipment crushed stone will be employed for road surfacing and a diligent search will probably reveal that it can be made available at many places.

Clay.—At present, ordinary pottery is manufactured at Tanauan and probably at some other towns which were not visited.

Formerly brick kilns were operated for burning soft brick at Baybay, but after supplying the local demand they were allowed to fall into disuse.

BIBLIOGRAPHY.

JAGOR, F. Reisen in den Philippinen. Berlin, Wiedmannsche Buchhandlung (1873) XVI–381; 1 map. This work contains the paper by Roth catalogued separately. A Spanish edition, "Viajes por Filipinas," translated from the German, was published in Madrid in 1875; and an English edition, "Travels in the Philippines," was published in London in 1875. The English translation is very poor and omits Roth's paper.

ROTH, JUSTUS. Ueber die geologische Beschaffenheit der Philippinen. *Ibid,* 331–354.

OEBBEKE, Dr. K. Bertrage zur Petrographie der Philippinen und der Palau Insel. *Neues Jahrbuch für Mineralogie,* etc. (1881), Beilage-Band, 451–501.

ABELLA Y CASARIEGO, ENRIQUE. La Isla Biliran (Filipinas) y sus actuales emanaciones volcánicas. *Boletin de la Comisión del Mapa Geológico de España* (1884), V, 11. Later published separately in Madrid in 1885.

KOTO, B. On the geologic structure of the Malayan Archipelago. *Journ. Coll. Sci.,* Tokyo (1899), V, 11.

BECKER, GEORGE F. Report on the Geology of the Philippine Islands. *Annual Rep. U. S. Geol. Survey* (1899–1900), Part III.

ILLUSTRATIONS.

RECONNAISSANCE MAP OF THE GEOLOGIC DISTRICTS OF LEYTE.

PLATE I.

III. FILIPINO TYPES: RACIAL ANATOMY IN TAYTAY.[1]

A. THE MEN.

By Robert Bennett Bean, assisted by Federico S. Planta.
(*From the Anatomical Laboratory, Philippine Medical School, Manila, P. I.*)

A study of the physical characteristics of the people of Taytay was suggested by Doctor Freer in conjunction with the medical investigations to be made there in 1909. This study throughout the season of investigation was greatly facilitated by the kind coöperation of Doctors Clements and Nichols.

A series of observations was conducted on about 500 individuals, forty measurements of each individual being made by Doctor Bean, and transcribed by Mr. Planta. The head measurements were performed in accordance with the prescribed regulations of the International Congress of Anthropologists assembled at Monaco in 1906(10,14), and the body measurements in accordance with the personal instructions of Professor Monouvrier(3). Additional observations on the ear type, color of eyes, structure of hair, etc., were carried on, and sagittal outlines of the head from inion to nasion were produced with the cephalograph(7). The statistical part of the work was done by Mr. Planta, who alone is responsible for the averages, although every calculation has been verified until its accuracy is assured. Doctor Bean alone is responsible for the interpretation of the results and the writing of the paper.

This study is divided into six parts: I, Physical Measurements; II, Descriptive Characters; III, The Segregation of Types; IV, Ear Type and Species; V, Diseases and Species; and VI, Conclusions, The Separation of the Types into Systematic and Elementary Species.

GENERAL CONSIDERATIONS.

The town of Taytay probably contains a more mixed population than the average Filipino town at the same distance from the coast (20 kilometers), for the following reasons: It is near enough to Manila (15 kilometers) to receive some of the overflow of the population from that city, and perhaps for this reason and because of its pleasant location on an elevated knoll at the base of the foothills of adjacent mountains, it is

[1] These studies form a part of those carried on during the medical survey of the town of Taytay, the remaining papers on which have already been published in Sec. B. 4 (1909) of this Journal—Co-Editor.

the country residence of some of the Government's high Filipino officials. The proximity to the town of the hills and mountains is sufficient to attract the hill people, and its situation on the borders of Bay Lake (Laguna de Bay) attracts the fisher folk. It is only a few kilometers from Pasig, the capital of Rizal Province, where a mixed population of Filipinos, Americans, Spaniards and Chinamen reside. The pilgrims to Antipolo, situated in the hills, pass through Taytay, and one of the most important industries of the place is the transportation by cart and hammock of many thousands of passengers on this pilgrimage during the month of May each year. Finally, the town of Cainta, where a garrison of British soldiers, natives of India, are reported to have been left when the British evacuated Manila one hundred and fifty years ago, is little more than a stone's throw from Taytay, and there has probably been an infiltration of the Indian element into the latter place.

The individuals measured were those who came to the dispensary and they should be considered in part as a hospital population, but the majority showed no other affliction than infestation with intestinal parasites and many were only friends of the sick who came with them as companions. The resulting components of this randon sample represent more nearly the normal average of the population than if a selected group such as recruits, students or other homogenous bodies of people had been taken. Therefore it may be assumed fairly that the individuals herein presented are typical of the littoral population of the Philippines, although a larger percentage than usual belongs to the hospital population, and the Indian element may exert a small influence.

I. PHYSICAL MEASUREMENTS.

STATURE.

Topinard(31) classified the races of men by stature as follows:

	Men.	Women.
Small	below 160 cm.	below 140 cm.
Below medium	160–165 (inclusive)	140–153 (inclusive)
Above medium	165–169 (inclusive)	153–157 (inclusive)
Tall	above 170	above 158

The Taytayans, according to this classification, are on the border line between the *small* races and the races *below medium* height. The average of 183 adult males is 159.47 centimeters. The minimum is 145.7 centimeters and the maximum is 171.0 centimeters. The stature is 5.47 centimeters greater than that of 104 adult male Igorots(3), but the distance between the extremes is not so great. The extremes should be separated more in 183 individuals than in 104, if the composition is the same. However, this is not true of the two groups, Igorots and Taytayans, from which the inference is that the stature of the component elements forming the Igorots was more diverse than that forming the Taytayans.

The Igorots are apparently derived from a *tall* stock (170 centimeters), a small stock (148 centimeters), and a stock below medium height. The Taytayans are probably derived from both the latter stocks, and, in addition, their stature has been influenced by Spanish and Chinese elements. The Spanish are slightly below medium stature and the Chinese are *slightly above,* although the Northern Chinese (Manchus) are tall (8,10,14,17,22,35); the two original stocks were *small.* A combination of these elements with a greater proportion of the original stocks could easily produce an average stature of 159.47 centimeters. The curve of stature illustrates how this might result. There is a

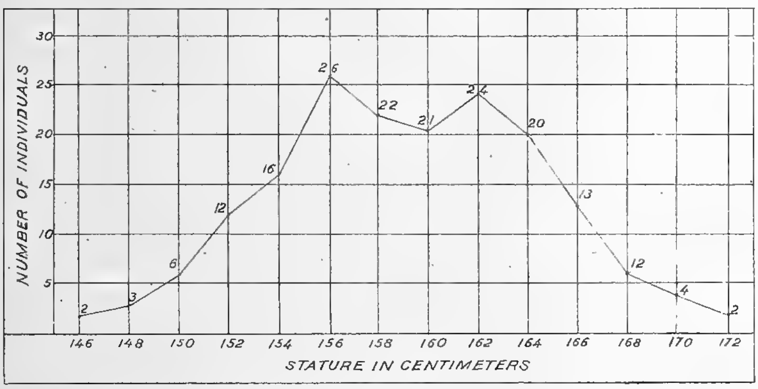


FIG. 1.—CURVE OF STATURE OF 183 ADULT MALE TAYTAYANS.

summit at 156 centimeters where the mode is found, there is another summit at 162 centimeters, and a break of the curve at 168. The first summit includes the greatest number of individuals with the same stature, a *small* stature, that would represent the primary stocks; the second summit has fewer individuals and a stature below medium, which represents the Spanish; and the break *above medium* stature, with still fewer individuals, represents the Chinese. The Spanish element is apparently in excess of the Chinese but is not present in so great a number as the primary stocks. The presentation of types in a subsequent part of this paper corroborates the inferences stated here.

The stature of the Taytayans exceeds that of the inhabitants of the inland part of the Malay Peninsula (18), that of the Veddahs of Ceylon (24), the Dyaks of Borneo (18), the Dravidians of Bengal (18), the Annamites in general (10), the Igorots (3), the Ainos and the Japanese (18); it is practically the same as the Malays of South Perak (18), and the Menangkabau-Malayan of Hagen (12); and it is less than that of the Chinese (12,18), Coreans (18), Javanese (12,17,30), Sumatrans (39), North American Indian (13), the African and North American Negro (31), and practically the whole body of European and American whites (10,23,31,36).

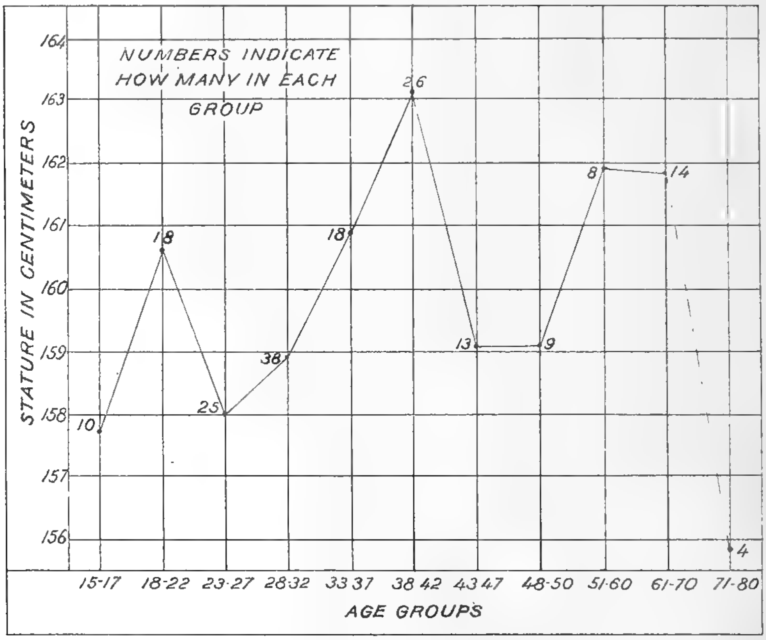


FIG. 2.—STATURE AND AGE.

STATURE AND AGE.

This array presents a bizarre effect, and no deductions may safely be drawn from the correlation of stature and age. However, the facts speak for themselves.

The age is only approximate as indicated by the manner of grouping.

For instance, there are 6 men at the age 20, but only 4 at 19 and 1 at 21; there are 7 at 25, but only 2 at 24 and 2 at 26; there are 15 at 30, but 4 at 29 and 2 at 31; there are 9 at 35, but 2 at 34 and 1 at 36; there are 13 at 40, but 3 at 39 and 2 at 41; and there are 7 at 45, and but 1 at 44 and 1 at 46. Therefore, it seems justifiable to group the ages in series of 5 except that the ages 15 to 17 form one group and the age groups above 50 are in series of 10.

Accordingly, the stature appears to increase from 15 to 20, to decrease from 20 to 25, to increase from 25 to 40, to drop considerably at 45 and 50, to increase again at 60 and 70, and finally to reach a stature at 80 that is less than that below 20. There is a fastigium at 40, the stature increasing up to that age and decreasing thereafter. The individual with the smallest stature is aged 38, and the one with the tallest, aged 33. There are 58 individuals above the age of 20 who have a stature less than the average of the group aged 15 to 17. For this and other reasons the few individuals below the age of 20 are included as adults in this study. The conclusion reached is that stature in age groups is a matter of the chance types that were measured at each age rather than altered stature due to age. If the stature increases to the age of 40, this would indicate that the Filipino reaches maturity in stature late in life, and if the stature at age 15 is equal to that in adult life the Filipino reaches maturity at an early age. Both may be true. There may be an early rapid maturity that is premature, and a late ripening that is real maturity, or some types may mature early and others late, or there may be waves of progression superceded by regression, although the last is very improbable.

There is no such regularity in the increase of stature as found among the Igorots, and the fastigium for the latter was between 20 and 30 instead of about 40. The fastigium for stature of the following peoples from records of more than a million individuals(31) is given for comparison with the people of Taytay:

	Years.
North American Irish	31–34
English	29
Scotch	28
French	27
Scandinavian	25
German	23
Igorot	20–30
Taytay	40

Liharzig gives the twenty-fifth year, Villermi the twenty-third.

SITTING HEIGHT.

This linear dimension is the distance between the ischial tuberosity and the vertex of the head when the person is sitting erect. It may be divided into three parts, the total head height, from the chin to the vertex; the neck length, from the chin to the suprasternal notch; and the body length, from the suprasternal notch to the pubic spine; although the three dimensions do not quite equal the sitting height because the pubis is several centimeters higher than the ischial tuberosities.

The average sitting height of 181 adult males is 83.99 centimeters with minimum and maximum of 74.3 and 91.7, respectively. It is 7.6 centimeters more than the distance from the trochanter to the vertex, 6.9 centimeters more than the distance from the pubic spine to the vertex, and 0.9 centimeter more than the total leg length. It is 53.3 per cent of the stature which is 0.8 more than the European according to Topinard, and 3.9 less than the length "Scheitel bis Damm" of 130 Europeans (Swiss?) measured by Hoffmann and given in Vierordt's tables(36). The sitting height of 60 Apache and 53 Pima Indians of the southwestern United States measured by Hrdlicka(13) is 53.2 and 52.9 per cent respectively, which is practically the same as my figures for Taytay.

Soularue(29) approximates the relative body length by comparing the length of the vertebral column of 174 skeletons to the calculated stature, and concludes that the white and yellow races have relatively long bodies and short legs compared with the black and other races. The North American Indian is intermediate between the yellow and the black races which are less than the white in body length.

The length of the body is measured in so many ways by different men that one is at a loss to know which method to select. The distance from the suprasternal notch to the symphysis pubis is the easiest and most direct method and lends itself to photometry as well as anthropometry. Although it is variable on account of the movable points from which it is measured, it is probably as exact as any other. The acromion to the symphysis is probably more variable, and the suprasternal notch to the trochanter is scarcely less so. The length of the vertebral column is the actual body length, and can be measured from the nasal spine to the pubis, but these are also variable points.

The average body length of the Taytayans from the suprasternal notch to the symphysis pubis is 47.1 centimeters, from the suprasternal notch to the trochanter it is 45.8 centimeters, and from the acromion to the symphysis pubis it is 47.8 centimeters.

The body length of the inhabitants of the inland part of the Malay Peninsula (18), (p. 283), measured from the suprasternal notch to the trochanter (?), averages from 43.5 centimeters in the Senoi I, to 47.2 centimeters in the Western Senoi. The body length of the inhabitants of central Sumatra (39), measured from the acromion to the symphysis pubis, averages 45.2 centimeters. The body length of the Igorots (3) (p. 431) from the suprasternal notch to the pubis in 47.7 centimeters. Topinard (31) (p. 1068) gives the body length "de la fourchette du sternum au siegé" in relation to the stature which may be compared with that of the Taytayans in the following table:

Body length in relation to stature.

Group.	Relative body length.	Author.	Number of individuals.
Europeans	33.5	Topinard	280
Kabyles	32.5	do	163
Annamites	30.2	do	27
Kalmucks	34.6	do	6
Taytayans	33.6	Bean	170

This places the relative body length of the Taytayans in the same class as the Europeans and it is different from the Annamites.

Differences of body length can not mean a great deal until the methods of measuring the body have been unified, and the basis for the body length should be the distance from the suprasternal notch to the symphysis pubis. At least this measurement should be made and utilized in a comparison of different people.

The total head height (chin to vertex) is 23.2 centimeters for Taytay, which is 14.5 per cent of the stature or nearly that of the Chinese.

Topinard(31) (p. 1071) assigns the greatest total head height to the Chinese, the least to the European, and places the Negroes of Africa near the latter and the Negroes of Oceania near the former.

The European has 7.5 heads of stature, the Negro, 7 heads of stature, and the yellow people, 6.5 heads of stature. The Taytayans are therefore like the Negro in total head height, because this is $^1/_7$ of the stature. The total head height of the Igorots(3) (p. 437) is 21.6 centimeters and their stature is exactly the same as the Taytayans in relation to it.

The neck length of the Igorots is 0.3 centimeter less than the Taytayans, which is 7.39 centimeters. This is the same as that of the Besisi of the Malay Peninsula, (Martin) (18) and of the Japanese, but it is greater than that of the Senoi.

It has been demonstrated that the Filipinos of Taytay resemble the Negroes, the Europeans, the Chinese, the North American Indians, and the East Indian peoples; therefore it can not be doubted that they represent a much mixed population and that many diverse types are to be found among them. This becomes more evident as we proceed, and finally an attempt will be made to select some of the types and to relate them to the people from whom they were derived.

LOWER EXTREMITY.

The total length of the lower extremity, as determined by the height of the trochanter from the sole of the foot when the person stands erect, is 83.08 centimeters for 170 adult males, with a minimum of 72.8 centimeters and a maximum of 93.5 centimeters. The height of the trochanter is 1.3 centimeters greater than that of the pubic spine. It is 3.92 centimeters higher than the Igorots which is 1.8 centimeters greater than their pubic spine. The relatively greater trochanter height of the Igorots is probably due to the heavy fascia and muscles that cover the trochanter in these hardy mountain climbers, thus projecting upward its palpable part. However, the trochanter height of the Igorots in relation to stature is but 51.6, whereas that of the Taytayans is 52.1; therefore the lower extremity of the latter is both absolutely and relatively longer than the Igorots.

Hoffmann(36) gives the trochanter height of 130 European males as 89.8 centimeters. Topinard(31) (p. 1074) gives the relative trochanter height as follows:

30 Belgians	52.0
12 Arabs	52.6
13 Berbers	53.6
27 Annamites	50.2
3 Esquimaux	50.7
10 Negroes	53.1

This places the Taytayans intermediate between the Annamites and Negroes and almost the same as the Belgians and Arabs.

The relative public height by Topinard (31) (p. 1074) is somewhat different:

1,061 Whites	50.3
27 Annamites	51.2
2,020 Negroes	51.8

That of the Taytayans is 51.3 which approximates the Annamites and is between the white and the Negro, although nearer the latter than the former.

Martin's (18) Malays (p. 260) present a variable average length of the inferior extremity from 76.3 centimenters to 83.2, and the relative length varies from 51.2 to 53.3. This length is estimated by subtracting 4 centimeters from the height of the anterior superior iliac spine, therefore it is comparable neither with the trochanter nor with the pubic height. However, Martin gives a long list of trochanter heights of other peoples from which we extract a few:

Group.	Absolute.	Relative.
Japanese students	78.1	48.5
Japanese workmen	81.2	50.0
North Chinese	83.8	50.0
South Chinese	83.9	51.9
Ainos	81.8	51.5
Europeans		52.0
Kru Negroes	91.0	56.0
Taytayans	83.08	52.1

The trochanter height makes the Taytayan resemble a European similar to the Ainos and Southern Chinese.

The lower extremity offers three parts for examination, the upper leg from the trochanter to the knee, the lower leg from the knee to the ankle, and the ankle height from the ankle to the sole, to which may be added another, the leg minus foot equal to the length of the lower leg plus that of the upper leg.

LEG MINUS FOOT.

This may be given best in three groups recently measured.

Group.	Absolute.	Relative.	Number.
Martin's Malays (p. 260)	70.9–76.8	47.2–49.7	100 ?
Igorots	74.0	48.1	104
Taytayans	76.5	48.0	175

The relative length does not vary greatly in the three groups, but the absolute length is greater for the Taytayans than for the Igorots or for the majority of Martin's Malays.

UPPER LEG.

The absolute upper leg length from the trochanter to the skin line of the knee of 176 men of Taytay is 39.2 centimeters and the relative length is 24.6. The Europeans of Hoffmann(36) (p. 15) have an absolute length of 41.9 centimeters and a relative length of 20 (Topinard)(31). Martin(18), however, gives the relative length for Europeans as 24 to 28. The Igorots have an absolute length of 38.0 centimeters and a relative length of 24.7, whereas the Malays of Martin(18) (p. 265) have an absolute length of 38.5 to 42.2 centimeters and a relative length of 23.6 to 26.5, which is greater than that of the Igorots and Taytayans absolutely and relatively.

The upper leg length (Topinard(31), p. 1041, Martin(17), p. 265) increases absolutely and relatively from the Asiatic through the African to the European. Soularue(29) gives the following length of the femur in different groups of men:

Group.	Absolute.	Relative.
American	41.6	29.4
Negro	42.3	28.8
Asiatic	43.1	28.9
Polynesian	44.1	29.3
European	44.3	29.4

The absolute length varies considerably but there is no great difference in the relative length. We may conclude from the foregoing facts that the length of the femur and of the upper leg is a matter of stature rather than of race.

LOWER LEG.

The length of the lower leg from the knee to the ankle for 175 men of Taytay is 37.29 centimeters absolutely, and 23.37 relatively; that of the Igorots is 36 and 23.4 respectively.

Martin's Malays vary from 31.4 to 35.4 centimeters absolutely and from 20.8 to 22.7 relatively. For Hoffmann's Europeans, Vierordt(36) gives 39.6 and 23 centimeters respectively, and Martin(18) gives 22 to 24 centimeters for the relative length of the Europeans.

The lower leg length (Martin(18), Topinard)(31) increases relatively and absolutely through the Asiatic and European to the African. Soularue(29) gives the following:

Group.	Absolute.	Relative.
Asiatic	34.6	23.2
American	35.2	24.9
Negro	35.8	24.5
European	35.8	23.9
Polynesian	36.8	24.4

The Taytayan resembles the Polynesian and is more like the European than like any other group, although resembling more the Asiatic than the Negro or American Indian.

THE TIBIO-FEMORAL INDEX OR CRURAL INDEX.

The length of the tibia multiplied by 100 and divided by the length of the femur, or, on the living, the length of the lower leg multiplied by 100 and divided by the length of the upper leg, gives the tibio-femoral index, which represents the length of the lower leg in terms of the upper leg equal to 100.

The tibio-femoral index of the Taytayan men is 95.1. For purposes of comparison, a table is given with the tibio-femoral indices of various groups by different authors.

Tibio-femoral index on the living.

Group.	Index.	Number of individuals.	Author.
Veddahs	80.4		Martin.
Malays	79.1-88.4	74	Do.
Sumatrans	87.0	57	Kleiweg de Zwaan.
Alas	90.8		Hagen.
Neu Mechlenburger	97.4		Do.
Igorots	94.7	104	Bean.
Europeans	94.3	130	Hoffmann.

To this may be added a few records on the skeleton.

Tibio-femoral index on the skeleton.

Group.	Index.	Number of individuals.	Author.
Europeans	79.7		Broca.
Negroes	81.3		Do.
Europeans	81.1	77	Topinard.
Negroes	82.9	32	Do.
Grimaldi	83.8	2	Verneau.
Cro-Magnon	81.2-86	4	Do.
Japanese	80.6	4	Soularue.
Malayo-Polynesia	82.1	13	Do.
Chinese and Annamese	83.6	22	Do.
Europeans	84.5	19	Do.
Negroes	86.8	21	Do.
Negritos	88.1	6	Do.

It is evident from the above that the tibio-femoral index differs in the different groups of individuals, and there is a transition through the Asiatic and European to the African. The Taytayans have a higher index than the Asiatic or European, and I believe we can safely say a lower index than the Negro or Negrito.

THE ANKLE HEIGHT.

This is 6.5 centimeters for the Taytayans, 5.4 centimeters for the Igorots and 7.8 for the Europeans according to Hoffmann. The Taytayans are almost exactly intermediate between the Igorots and the Europeans, which may be significant and can be taken to mean that the Taytayans represent a cross of the early Malay and the later European peoples.

THE UPPER EXTREMITY.

The total length of the upper extremity is the distance from the acromion process to the tip of the middle finger with the arm hanging straight by the side. This may be divided into three parts, the upper arm from the acromion to the head of the radius, the forearm from the head of the radius to its styloid process, the hand from this point to the tip of the middle fingers, to which may be added a fourth part, the arm minus hand by combining the length of the upper arm and forearm. The absolute length of the upper extremity of 176 Taytayans is 72.97 centimeters and the relative length is 45.8, which is greater than that of the Igorots(3) (absolute, 67.82 centimeters, relative, 44.0 centimeters), of the Malays(18) (absolute, 64.5 to 71.8 centimeters, relative, 43.1 to 45.9 centimeters), of the Sumatrans(39) (absolute, 70.34 centimeters, relative, 44.62 centimeters), is the same as the Battaks(12) (absolute, 73.4 centimeters, relative, 45.8 centimeters); and it is less than the Ainos(18) (relative, 46.0 centimeters) and the Veddahs(18) (absolute, 73.9 centimeters, relative, 47.0 centimeters). It is about the same as the European(18) (relative(18), 45.5; relative(31), 45.0, absolute(36), 74.2).

The upper extremity of the Negro is not longer relatively than that of the European according to Topinard(31) (Negro, 45.2, European, 43.2 to 45.5 centimeters) although Keane(14) (p. 36) gives the long upper extremity of the Negro as an important differential character. Soularue(29) (p. 375) finds little difference between the two in the combined length of the humerus and radius in relation to stature, which is 37.3 for the Negro and 36.8 for the Europeans. Topinard(31) (p. 1036) gives the relative length as 35.5 for the Negro and 35.0 for the European.

The upper extremity of the Negro may be a trifle longer relative to stature than is the European, but whatever the difference, it is slight and the Taytayan is not so greatly unlike either one.

THE ARM MINUS HAND.

This linear dimension is 55.42 centimeters absolutely, and 34.7 in relation to stature in 175 Taytayans. The same dimension of the Igorots varies from 50.5 to 53.9 centimeters absolutely and from 33.3 to 33.6 relatively. Among the Malays (18) (p. 247), it varies from 48.5 to 53.1 centimeters absolutely and from 31.6 to 34 relatively. Referring to the length of the humerus plus the radius as given above, it is clear that the Taytayan is more like the Negro and the European than like the Igorot or the inhabitants of the Malay peninsula.

THE UPPER ARM.

The absolute upper arm length of 175 Taytayans is 32.37 centimeters and the relative arm length is 20.3. That of the Igorots is from 28.6 to 30.6 centimeters absolutely and from 18.7 to 19.8 relatively, and that of the Malays (18) from 27.6 to 30.7 centimeters absolutely and from 17.9 to 19.8 relatively.

The 130 Europeans of Hoffmann have an absolute length of 31.2 centimeters and a relative length of 18.5. Topinard (31) gives the European's relative length 19.5. The following figures are taken from Martin (18) for comparison:

The upper arm lengths of various peoples.

Group.	Absolute.	Relative.
Japanese students	26.2	16.9
Japanese (fine)	29.7	18.3
Senoi	28.0	18.0
Malays	30.3	18.9
Jews	30.7	19.0
Germans	--------	19.0
South Chinese	31.1	19.2
Ainos	30.3	19.3
Veddahs	31.0	19.4
Battaks	31.1	19.4
Malays	31.7	19.6
Europeans	--------	19.8
Sikhs	34.2	20.1
Taytayans	32.37	20.3
Highland Igorots	29.8	19.8

The relative length of the humerus as given by Soularue in several groups follows:

Malayo-Polynesian	20.1
Negroes	20.2
Europeans	21.3
Yellows	21.5
Arabs and Berbers	22.0

From the foregoing it may be inferred that the Taytayans resemble in the upper arm length the Europeans, Sikhs, American Indians, Chinese, Arabs and Berbers more than they do the Japanese, Senoi and Negroes, and they are not greatly different from the Highland Igorots.

THE FOREARM.

The length of this part is 23.05 centimeters absolutely in 176 Taytayans and 14.45 relatively. Among the Igorots(3) (p. 424) it varies from 22.0 to 23.3 centimeters absolutely and from 14.4 to 14.8 relatively, and among the Malays(18) (p. 250) from 20.1 to 23.6 absolutely and from 13.3 to 15.2 relatively.

For Europeans, Hoffmann(36) (p. 15) gives 24.6 centimeters absolute and Topinard(31) gives 14 relative. The following list is taken from(18) Martin (p. 255) for comparison:

Group.	Absolute.	Relative.
Senoi	21.3	13.8
Japanese	22.7	14.1
Veddahs	22.9	14.3
Europeans		14.4
Malays	23.7	14.8
South Chinese	25.0	14.8
Sikhs	27.5	15.2
Ainos	23.9	15.3
Battaks	24.1	15.5
Germans		15.9
Jews	25.8	15.9
Negroes		16.5–17.1
Congo-Negroes		18.6

Topinard(31) (p. 1087) places the relative length of the forearm in the Negro above that of any other people, although three Kaffir Negroes were less than some Europeans and Asiatics.

The Taytayans are intermediate between the Negro and the Japanese or Senoi, and almost exactly the same as the European.

The length of the radius as given by Soularue and Topinard may be compared with the length of the forearm as already given.

Group.	Relative.	Author.
Europeans	15.5	Soularue.
Asiatics	15.7	Do.
Arabs-Berbers	15.9	Do.
Malayo-Polynesians	16.0	Do.
Americans	16.2	Do.
Negroes in general	17.1	Do.
Europeans	14.3–14.9	Topinard.
Asiatics	14.1–15.6	Do.
Negroes in general	15.2–15.7	Do.

The length of the radius separates the European and Negro still further than does the length of the forearm, which indicates that this dimension is a good differential factor for large groups of individuals. The length of this part in relation to the upper arm may also help to differentiate the world's groups of people.

THE RADIO-HUMERAL INDEX OR BRACHIAL INDEX.

This is equal to the radius times 100 divided by the humerus, or, in the living, it is the forearm times 100 divided by the upper arm. For 175 Taytayans it is 71.2, for 104 Igorots(3) (p. 425) it is 76.2, and for the Malays(18) (p. 252) 73.2 (Senoi 76.0).

Topinard gives the European 82.2 to 86.8 and the Negroes 87.9 to 93.4. Martin found the brachial index unsatisfactory as a differential factor because of the varied results of different authors, due no doubt to lack of a uniform standard for taking the measurements. However, Hoffmann(36) makes the European index 78.8 on the living, and Annandale(18) (p. 147) gives that of the Semang as 98.7. The radio-humeral index (skeleton) given by Soularue(29) follows:

19 Europeans	73
12 Chinese and Annamese	75.4
22 Americans	76.3
13 Malayo-Polynesians	76.8
21 Negroes of Africa	78.0
6 Negritos	78.3

There is a gradual transition from the European to the African. Evidently the Taytayans are more like the European than like the Negro or Negrito.

THE HAND LENGTH.

The absolute hand length of 176 Taytayans is 17.55 centimeters and the relative is 11.05, that of the Igorots(3) (p. 424) is 16.0 to 17.8 centimeters absolutely and 10.6 to 11.3 relatively, and of the Malays(18) (p. 250) is 16.0 to 18.7 centimeters absolutely, and 10.5 to 12.5 relatively.

Martin gives the following for other peoples.

Group.	Absolute.	Relative.
South Chinese	16.3	10.1
Javanese	16.8	10.2
Malay	16.9	10.5
Battaks	17.0	10.6
Sikhs	17.8	10.7
Senoi	16.8	10.9
Jews	18.5	11.2
European		11.3
Japanese students	18.7	11.5
Veddahs	18.4	11.5
Ainos	18.4	11.7

The Europeans (Hoffmann(36) and Topinard(31)) have an absolute hand length of 18.4 centimeters and a relative hand length of 11.5.

From these measurements the Taytayans would be placed in the midst of the groups given above and in hand length they are not a great deal less than the Europeans.

Krause(36) gives the distance from the knee to the middle finger with the arm straight at the side as 14 centimeters in Europeans and only 5 to 8 centimeters in Negroes.

In the Taytayans the same distance is 13.83 centimeters, which is practically equal to that in the Europeans.

THE INTERMEMBRAL INDEX.

This may be represented best by the four long parts of the extremities: upper arm, forearm, upper leg and lower leg, on the living, and by the corresponding bones: humerus, radius, femur and tibia on the skeleton. The index is the length of the upper extremity, or upper arm plus forearm, in terms of the lower extremity, upper leg plus lower leg, when the latter equals 100. For the Taytayans it is 72.4, for the Igorots(3) (p. 457) it is 69.2 to 70.6, and for the Malays(18) (p. 267) it is from 63.7 to 71.4.

Soularue(29) gives the following on the skeleton:

Europeans	69.1
Chinese and Annamese	68.5
Americans	69.0
Negroes	68.3
Negritos	69.0
Australians	69.1

Apparently the lower extremity of the Negro is relatively long and the upper is relatively short. The difference is slight and this factor is not so good a differentiator as others.

The facts hereinbefore presented are given in the usual manner with a system of averages which may be of assistance in establishing differences and resemblances of various groups of men, but it is not of much assistance in fathoming the complex consistency of the group under consideration. This must be done in a different way, and the only way that presents itself as feasible is to study the individuals(38). This we will do presently by grouping them so that the individuals of each group resemble one another. The object in view in giving the measurements that have gone before was to convince anyone that very little could be derived from such a study except what was known before.

We have already demonstrated that the stature of the Taytayan is similar to the other eastern Asiatic and Pacific peoples; the sitting height is the same as that of the North American Indian; the body length is the same as the European's; the total head height resembles that of the

Negro; the length of the lower extremity is the same as that of the European; the tibio-femoral index is intermediate between that of the Asiatic-European and the Negro-Negrito; and the total length of the upper extremity is like both Negro and European. The upper arm length resembles that of the European and the Sikh, and the forearm length is exactly that of the European, but different from either the Japanese on the one hand or the Negro on the other; and lastly, the Taytayan is more like the European than the Negro or Negrito in the brachial index and the hand length. At the beginning of this paper it was stated that the Taytayans are probably derived from mixtures of Filipinos, Chinese, Spanish, and East Indian elements. This has been established by body measurements. There is also evidence of some relationship with the Negro although there is considerable evidence that the greatest amount of resemblance is for the European. When the types are established it will be seen that a majority of them are European, and that a majority of the individuals pertain to the European types.

THE AVERAGE TAYTAYAN—A TYPICAL FILIPINO?

The individual represented by serial number 99, clinical number 176, is almost exactly equal in every dimension to the average of the first 100 measured, and to the total average; therefore he may be taken to represent the type of the Taytay population, if this constitutes a type. This man is an Australoid with a cephalic index higher than usual, indicating some Primitive influence or a slight dorsal flattening of the head. The head outline is low in front but the *front bombé* is seen (fig. 3). The occiput neither bulges nor is it much flattened, the vertex is high, the glabella prominent. Australoid and Primitive are both represented, but Iberian can not be excluded.

The radio-humeral index is 67.8, the tibio-femoral is 94.2 and the intermembral is 74. Negroid characteristics are lacking, but European characteristics are in evidence. One can safely say that a typical Filipino (?) of to-day is European rather than Negroid but retains Primitive characteristics.

THE TAYTAYAN, THE EUROPEAN AND THE NILOTIC NEGRO.

It may be of interest to compare the average linear dimensions of these three groups of individuals to determine similarities and differences.

The Nilotic Negroes were recently measured by the late Dr. Alexander MacTier Pirrie, and reported by Dr. David Waterston (38) from the Anthropological Laboratory of Edinburgh University in 1908. The Nilotic Negroes include the whole native population "extending from the western frontier of Abyssinia across the Nile Valley, through the Barh-El-Ghazal region westwards to the Central Niger, and from about 200 miles south of Khartoum, to the northeastern shores of Lake Nyanza."

FIG. 3.—AVERAGE TAYTAYAN. SERIAL NO. 99. CLINICAL NO. 176.

The individuals measured are distributed among 12 different tribes, the Dinkas (60 males) and the Buruns (43 males) making more than half the number.

The Dinkas are the tallest and have relatively the shortest limb parts of all the groups. The averages and indices of the measurements of 187 adult males are given in a table at the end of Waterston's paper from which we extract the following:

Character.	187 Nilotic Negroes.				183 Taytayans.		130 Europeans.[a]	
	Absolute.		Relative.		Absolute.	Relative.	Absolute.	Relative.
Stature	168.25-	**180.16**	100.00-	100.00	159.47	100.00	167.80	100.00
Upper leg length	40.70-	47.00	**25.80**-	28.00	39.20	24.60	41.90	25.00
Lower leg length	39.60-	44.42	**24.40**-	24.80	37.29	23.37	39.60	23.60
Upper arm length	32.00-	34.79	**18.60**-	19.30	32.37	20.30	31.20	18.60
Forearm length	28.68-	31.08	**17.10**-	17.70	23.05	14.45	24.60	14.70
Tibio-femoral index	89. 5-	98.6			95.1		94.5	
Radio-humeral index	87. 6-	92.9			71.2		78.8	
Intermembral index	68. 4-	77.4			72.4		68.4	

[a] Hoffmann in Vierordt's tables (Swiss men?). The black faced type represents the figures for the group of Dinkas (60 males).

The stature of the groups of Negroes ranges from above medium to tall, the European is above medium, and the Taytayan is small.

The limb parts of the Negro are longer individually and collectively, absolutely and relatively, than those of the European or Taytayan, except the relative upper arm length which is the same for the European as for the group of Negroes that has the smallest relative length, and is greater for the Taytayan than for either the Negro or the European.

The absolute upper arm length of the Taytayan is measured from the upper edge instead of the lower edge of the acromion process to the elbow, and this may make it about 1 centimeter longer than it should be, therefore it is probably the same as the European, and less than the Negro. However, even a greater reduction than 1 centimeter would not reduce the relative length as low as either of the other two peoples. The relative length of the upper arm is therefore a distinctive feature of the Taytayan, is different from the European, and even surpasses the Negro (cf. Japanese (3)).

The absolute and relative forearm length of the Negro is so much greater than that of the other two peoples that it may be at once designated as the most characteristic limb quality of the Nilotic Negro.

The tibio-femoral index of the various groups of Negroes gives both lower and higher figures than those of Taytay and of the Europeans, and if all the groups of Negroes are averaged the index would not be different from the other two. It may be significant, however, that some groups of Negroes have a high index and others have a low one; the same condition is found among the Taytayans where a low index pertains to some types and a high index to others. One Negro had an index of more than 100, and one or more among the Taytayans have like indices.

The radio-humeral index is greater for the Negroes than for the others, because of their great forearm length. The Taytayan, because of the great upper arm length, is more distantly removed from the Negro by this index than by any other factor of the limb measurements.

The intermembral index puts the Taytayan intermediate between the extremes of the Negroes and separates them from the Europeans.

The Negroes, except one group, have longer arms in relation to their leg length than the European.

After all is said, one must admit that in the limb parts the differences that separate the three peoples are not great except in the long forearm of the Negro and the long upper arm of the Taytayan.

We now arrive at a consideration of the artistic canon of the Taytayan from the measurements that already have been discussed.

ARTISTIC CANON.

For the purpose of comparing the Taytayan with the European from the standpoint of the artist, the canon of Fritsch(30) (p. 197) is used in the same way in which it was used for the Igorots(3) (p. 451). The length of the vertebral column as represented by the distance from the symphysis pubis to the nasal spine is taken as the base line, and all other linear dimensions are given in relation to that. A glance at the chart (fig. 4) will show that the total head height, the length of the upper and the length of the lower extremities are greater in the Taytayan than in the European. Compared with the Normal Benguet Igorot, and the Igorot from Bontoc(3) (p. 452), the Taytayan is similar to both, and the protomorphic characters are evident in the long arms and the long total head height. According to Stratz (p. 204), the total head height varies with the stature, and a stature of 160 centimeters corresponds to a total head height of 23 centimeters. The stature of the Taytayans is 159.47 centimeters and the total head height is 23 centimeters.

HEAD FORM AND PHYSIOGNOMY.

The mean head length of 182 Taytayans is 18.30 centimeters and the mean head breadth is 14.96 centimeters with the resulting cephalic index of 81.79. This would be altered if the diameters of the head are reduced by 1 centimeter each as an allowance for the thickness of the extracranial tissues. The cephalic index of the skull would thereby be 80.7, a frankly brachycephalic skull, but very close to mesocephaly.

The cephalic index of the head is 4.19 points greater than that of the Igorots, and about as great as the greatest of Martin's Malays(18) (p. 344), which vary from 76.4 to 82.4.

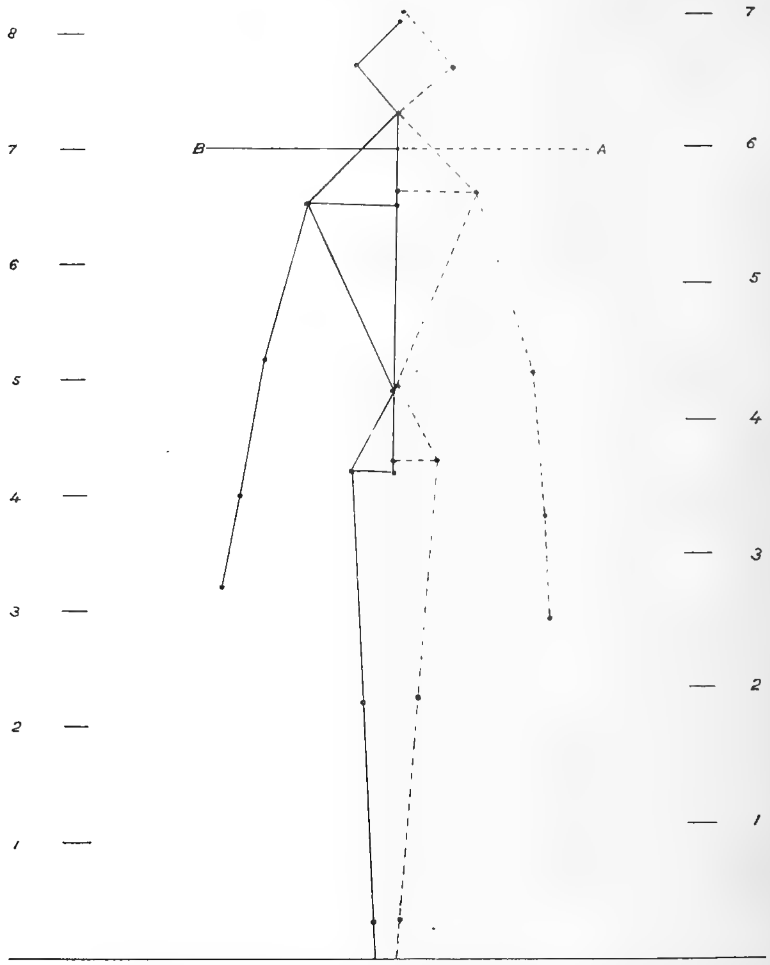


FIG. 4.—THE SOLID LINES ON THE LEFT REPRESENT THE AVERAGE EUROPEAN ACCORDING TO THE CANON OF FRITSCH. THE BROKEN LINES ON THE RIGHT REPRESENT THE AVERAGE TAYTAYAN ACCORDING TO THE SAME CANON. THE EUROPEAN STATURE IS EQUAL TO 8 TOTAL HEAD HEIGHTS. THE TAYTAYAN STATURE IS EQUAL TO 7 TOTAL HEAD HEIGHTS. A AND B POINT TO THE CHIN.

The narrowest forehead breadth is 45.2 millimeters less than the widest part of the head. This difference is only 43.0 millimeters for the Igorots and from 38 to 46 for the Malays(18) (p. 347).

The nose length, from the skin line at the greatest depression of the nose bridge between the eyes, to the nasal point or spine, is 4.7 centimeters, and the nose width from tip to tip of the flaring nostrils is 4 centimeters, with the resulting nasal index of 85.2. The Igorots have a nasal index of 92.7 measured in the same way. That of the Malays is only 82, because Martin used the nasion instead of the skin line.

The morphologic face index is 82.1, that of the Igorots is 79.4, whereas Martin's Malays vary from 80.5 to 85.8 which is greater than it would be were the methods of measuring the same.

The following facial indices are taken from Martin(18) for comparison:

Battaks	82.0
Javanese	82.1
Malays	83.0–83.8
South Chinese	85.3
Ainos	86.9
North Chinese	87.0
Sikhs	88.3

If the chin-nasion distance of the Taytayans were increased by 7 or 8 millimeters, which would be fair under the circumstances, the index would then surpass even that of the Sikhs. Undoubtedly, the face of the average Taytayan is long like that of the Sikh, the northern Chinese and the European.

The lower face height (chin to nasal spine 6.6 centimeters) compared with the upper face height (nasal spine to vertex, 16.4 centimeters) is not so great as that of the Igorots (6.7 centimeters lower, 14.9 centimeters upper) which again places the Taytayan close to the European.

TABLE I.—*Men of Taytay*—

Type of individual.	Serial No.	Clinical No.	Age.	Stature.	Sitting height.	Pubic height.	Umbilical height.	Sternal height.	Chin height.	Ear height.	Ankle height.	Knee height.	Trochanter height.	Finger tip.	Wrist height.	Elbow height.	Acromion height.
				Body.													
Australoid	1	8	18	162.4	85.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Alpine	2	293	47	161.5	84.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cro-Magnon	3	366	27	166.0	87.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Blend	4	370	29	154.4	82.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Australoid	5	-----	48	162.4	88.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Blend	6	755	25	165.1	86.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Blend	7	828	54	154.4	83.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
B. B. B	8	353	65	166.8	88.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Australoid	9	390	45	162.2	89.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Blend	10	398	30	168.2	90.7	84.0	101.0	136.0	144.5	153.4	6.3	45.3	86.0	62.0	80.3	105.2	137.0
Primitive Australoid	11	384	45	150.5	78.9	76.5	89.0	121.6	126.0	137.5	6.7	42.0	76.0	55.5	71.5	94.8	124.3
Blend	12	-----	70	169.2	89.2	85.5	104.2	137.5	141.0	153.5	7.6	44.5	87.5	63.3	82.6	110.5	139.8
Blend	13	385	45	153.8	83.3	79.0	92.0	123.0	128.0	139.7	(?)	42.3	80.0	54.0	70.3	92.3	123.2
Blend	14	419	20	161.7	81.5	87.0	100.0	132.8	138.7	148.2	6.1	46.7	88.0	60.2	78.0	99.4	132.5
Blend	15	405	46	152.1	81.5	76.8	90.0	124.0	128.0	139.6	6.2	40.4	79.5	56.6	72.7	93.0	123.6
Blend	16	380	70	153.6	77.2	83.6	90.4	123.8	129.3	140.0	6.5	45.0	82.2	52.5	68.4	91.5	123.0
Australoid	17	390	41	163.2	89.9	81.5	95.0	132.5	140.5	151.0	7.4	43.0	79.2	60.5	77.3	103.0	131.5
Blend	18	376	23	152.7	82.0	69.0	88.0	121.0	127.3	138.2	7.6	42.3	75.5	54.0	68.8	89.9	118.4
Alpine	19	404	80	151.5	79.2	80.5	91.6	121.5	126.7	137.5	6.5	41.0	81.3	53.0	69.5	90.3	123.0
Blend	20	315	42	168.4	88.1	89.0	101.8	134.6	144.4	153.8	7.1	46.6	88.0	60.0	77.2	103.0	138.0
Australoid	21	158	41	159.4	84.5	83.5	94.5	129.0	134.6	146.3	7.0	40.0	83.0	56.0	73.0	98.0	128.3
Blend	22	373	70	160.8	83.5	82.8	97.6	131.2	138.0	147.0	7.5	45.2	84.9	58.8	77.5	102.4	132.0
B. B. B. ?	23	237	62	165.0	87.0	85.0	98.4	134.5	142.4	153.0	6.0	44.5	87.0	66.8	83.7	107.5	137.3
Primitive	24	303	25	147.1	78.8	73.0	85.5	119.3	127.0	135.0	6.3	37.0	76.2	53.0	68.7	90.0	119.0
Iberian	25	421	17	160.7	82.7	87.8	101.2	130.6	129.5	149.8	5.7	44.8	87.4	57.7	74.4	96.8	132.4
Blend	26	22	42	153.2	81.5	76.5	91.0	123.5	130.3	138.0	6.2	41.7	79.5	53.5	70.5	92.2	125.8
Australoid	27	238	30	163.4	86.8	85.7	97.8	131.8	138.6	148.8	7.4	45.6	86.3	59.7	77.3	100.0	130.8
Modified Primitive	28	-----	29	158.9	86.5	78.3	93.3	128.4	135.5	146.0	7.0	43.5	81.0	59.7	77.7	99.4	130.0
Australoid	29	-----	23	155.7	84.5	78.5	95.0	124.5	135.0	141.6	6.0	41.0	80.4	58.3	74.7	97.0	126.5
Blend	30	-----	20	150.4	82.5	71.0	85.0	119.3	126.0	137.8	5.8	40.4	77.0	53.4	70.4	90.0	119.0
Primitive	31	432	39	153.6	82.1	78.7	91.8	125.6	132.4	141.4	6.7	41.4	80.0	53.0	70.2	95.5	124.5
Blend	32	438	50	159.3	82.3	85.4	96.5	129.8	137.3	145.3	6.2	44.0	85.3	60.0	77.0	100.0	132.0
Iberian	33	431	22	169.3	86.8	90.5	105.0	139.0	147.0	156.6	8.0	48.6	92.2	59.8	80.4	104.2	137.3
Australoid	34	-----	32	160.1	85.5	82.8	96.0	129.0	137.2	146.0	7.0	44.9	83.4	58.0	76.2	98.0	130.8
Iberian	35	430	35	163.5	88.0	82.3	96.0	134.0	139.7	148.6	6.8	43.8	84.8	62.0	79.8	101.8	133.9
Adriatic?	36	-----	17	164.5	86.2	84.5	100.0	134.0	140.0	149.4	6.7	44.8	87.6	60.0	76.7	96.5	130.5
Australoid	37	169	35	156.3	82.4	83.0	96.2	128.0	134.2	145.2	5.5	44.2	83.0	56.0	73.1	96.9	131.0
Blend	38	448	70	158.4	80.9	85.4	96.4	127.0	138.0	146.4	5.6	44.8	85.7	53.8	71.8	97.2	128.5
Australoid	39	-----	19	157.1	83.5	80.0	94.6	128.0	135.8	144.2	5.1	43.2	82.4	55.0	73.0	96.7	127.0
Blend	40	-----	24	156.1	83.3	78.7	94.8	127.4	134.0	143.8	6.4	43.7	81.8	55.7	73.3	93.7	124.8

absolute measurements, in centimeters.

Head.																									
Maximum—																					Circumference.				
Length.	Breadth.	Height.	Forehead width.	Bizygomatic.	Bimastoid.	Bigoniac.	Naso buccal.	Naso alveolar.	Nose base.	Nasion hair line.	Chin nasion.	Nose width.	Nose length.	Mouth width.	Mouth length.	Ear width.	Ear length.	Interocular distance.	Eye length.	Eye color.	Frontal.	Parietal.	Forehead.	Occipital.	Ear cartilage.
18.2	14.6	12.4	11.0	14.1	12.9	12.0	6.3	5.6	2.0	6.2	9.5	4.1	4.0	2.0	5.0	3.2	5.8	3.7	3.15	2.0	30.0	35.2	27.0	28.6	4.6
18.6	15.8	12.7	10.3	14.8	14.1	11.0	---	---	---	8.2	11.5	3.5	5.2	2.0	4.0	3.0	6.0	3.5	3.10	3.0	31.3	36.4	29.1	29.6	4.5
18.8	15.4	13.5	11.0	14.4	13.4	11.2	7.0	6.4	2.3	7.2	11.6	4.5	4.3	2.5	5.2	3.5	5.8	4.2	3.00	4.0	31.7	37.4	28.0	31.0	4.6
17.5	14.5	12.1	9.8	12.9	11.6	9.7	6.4	6.0	2.6	---	----	4.0	4.3	2.7	5.1	3.5	6.0	3.3	2.90	2.0	29.7	35.2	26.4	27.5	4.7
18.9	14.6	12.6	10.7	13.3	12.5	11.0	6.4	6.3	1.8	7.7	11.0	4.5	4.3	1.7	5.0	3.5	6.6	3.0	3.10	3.0	31.5	34.3	27.2	28.0	5.2
18.2	14.6	11.7	9.8	13.3	13.3	10.8	7.2	6.4	3.0	6.3	10.7	4.1	4.9	1.7	4.9	3.7	5.8	3.1	3.30	3.5	28.4	34.8	26.2	30.0	4.8
17.9	15.8	11.8	9.7	13.7	12.8	10.7	7.5	6.7	2.3	8.3	11.6	4.0	5.0	2.3	5.2	3.9	6.8	3.2	2.90	2.3	28.3	36.4	26.4	31.0	5.5
18.3	15.1	13.2	11.0	14.6	13.8	11.7	8.4	7.5	2.4	7.4	13.0	3.8	5.7	1.7	5.3	3.6	6.7	3.5	3.05	4	30.2	35.3	28.5	29.3	5.5
19.5	14.8	12.2	10.4	13.9	13.2	10.8	7.3	6.7	2.5	8.0	11.4	4.3	4.7	1.8	4.6	3.5	6.1	2.8	3.10	4	30.0	36.8	27.2	31.6	4.9
18.4	15.5	12.6	10.4	14.0	13.1	11.4	7.3	6.9	2.0	8.2	10.6	3.7	5.0	2.0	4.5	3.0	6.1	3.1	2.95	4	30.0	36.0	26.8	31.0	4.7
17.7	14.5	11.8	10.7	13.1	12.2	10.1	6.4	(?)	1.8	8.3	9.8	4.3	4.3	1.5	4.6	3.1	5.5	4.5	2.50	3	29.5	35.3	26.4	29.6	4.2
19.5	15.5	12.5	10.5	14.2	13.7	11.8	8.1	7.4	3.1	5.8	12.0	4.2	5.4	0.8	5.1	3.9	6.8	3.5	2.95	3.5	31.8	36.8	29.0	31.0	5.4
17.4	15.0	12.5	9.5	12.7	11.6	10.4	7.2	6.7	2.9	6.3	10.9	4.1	5.0	1.0	4.5	3.6	6.0	2.6	3.05	3.5	28.8	36.4	26.5	27.0	4.8
18.3	15.4	13.5	10.8	13.8	12.8	10.5	7.2	6.4	3.1	8.0	11.5	3.7	5.0	2.2	4.1	3.5	5.4	3.6	3.10	3	33.5	37.0	29.0	28.0	4.7
18.1	15.7	12.2	11.0	14.3	13.6	10.7	7.0	6.6	2.5	7.4	10.4	4.4	4.6	2.1	4.7	3.8	6.4	3.4	3.20	3	31.5	36.3	28.6	29.7	4.9
18.6	14.8	12.5	10.3	13.6	12.5	11.3	6.6	6.4	2.7	7.8	10.6	4.1	5.1	0.5	4.4	3.7	6.6	3.0	2.90	4	32.6	35.8	27.7	29.7	5.2
19.7	15.0	12.4	10.4	14.0	13.1	11.1	7.7	6.7	2.7	8.0	11.6	4.3	4.9	2.0	4.7	3.6	6.1	2.7	3.15	4.5	30.6	36.0	27.6	31.2	4.8
18.7	14.8	12.6	10.6	13.7	12.8	10.4	7.5	7.1	3.0	7.8	11.8	3.6	5.0	2.2	4.4	3.6	5.3	3.4	3.00	3	31.2	36.5	28.0	30.6	4.2
18.6	15.7	12.5	10.0	13.7	13.5	11.0	8.1	7.3	3.2	7.3	12.3	4.0	5.6	1.7	4.8	3.5	6.5	3.5	2.50	5	31.0	36.3	27.0	30.0	4.7
18.3	15.6	12.3	10.5	14.3	14.2	12.0	7.2	6.6	3.0	7.6	11.1	4.2	4.7	2.4	4.5	3.8	6.7	3.5	3.10	3.5	29.7	36.6	26.8	30.1	5.2
18.4	14.8	12.0	10.0	13.5	12.8	10.6	7.5	6.7	2.7	7.0	11.4	4.5	4.5	1.6	5.0	3.6	6.1	3.0	3.15	2.5	30.1	36.0	26.5	30.0	4.7
18.9	15.7	12.8	11.6	14.3	11.4	13.2	6.8	5.7	2.6	8.1	10.6	4.0	4.6	1.0	4.0	3.4	5.9	3.7	3.00	3	32.3	36.0	28.3	29.6	4.8
18.3	15.2	12.5	10.5	14.0	13.8	11.0	8.0	6.9	2.8	7.5	12.0	3.5	5.1	1.3	4.0	3.6	6.4	3.3	3.20	5	31.4	37.2	28.2	30.6	5.3
18.1	15.1	12.8	10.5	13.6	12.1	10.3	7.0	6.2	3.0	8.3	11.0	4.0	4.2	2.1	4.4	3.5	5.6	3.3	3.00	3	33.0	35.2	28.8	30.2	4.3
18.8	14.6	11.5	10.4	13.3	12.6	10.2	6.8	6.2	2.5	6.3	11.0	3.4	4.6	1.7	4.6	3.5	6.2	3.1	3.15	3	30.3	36.0	27.7	30.0	4.6
18.6	14.7	12.5	10.0	13.7	12.4	11.2	7.6	6.9	2.8	6.9	11.0	4.3	5.0	2.3	4.6	3.4	6.2	3.2	3.05	3	31.4	36.0	27.5	29.4	4.7
19.3	15.2	12.7	11.2	13.3	13.1	11.0	7.2	6.2	3.0	8.0	11.6	4.2	4.6	2.0	4.6	3.7	6.4	3.4	3.10	2	31.8	38.4	28.5	32.0	5.1
17.3	16.0	12.3	11.0	14.2	13.9	11.4	6.9	6.2	3.2	6.8	11.1	4.1	4.8	1.7	4.9	3.5	6.3	3.4	2.70	2.5	31.6	38.0	27.0	29.8	4.8
18.6	14.4	12.3	11.0	13.6	12.3	11.1	7.4	6.6	3.0	7.0	11.4	4.2	4.6	2.2	4.8	3.7	5.9	3.5	3.05	2.5	29.6	35.7	27.0	29.5	4.7
18.6	14.9	12.3	10.5	13.5	12.7	9.8	7.2	6.5	2.6	7.0	11.0	3.7	4.6	1.9	4.5	3.5	6.5	3.5	3.10	2	31.0	33.6	29.0	29.2	5.3
16.6	15.5	12.2	10.2	13.8	12.8	10.0	7.2	6.5	2.2	7.4	11.1	3.9	4.7	1.8	4.8	3.5	5.9	3.4	2.85	4	30.1	36.4	26.7	27.8	4.8
17.7	15.5	11.2	10.6	14.2	13.5	11.0	6.6	6.6	3.0	7.7	9.4	3.9	4.8	1.2	5.1	3.9	5.8	3.6	2.95	---	29.2	34.3	26.5	28.0	5.0
20.2	14.7	12.8	10.7	13.8	13.4	10.3	7.7	7.0	3.2	8.2	12.2	3.9	5.3	2.4	4.7	3.7	6.3	3.4	3.35	4	32.1	35.6	29.5	30.1	5.2
18.1	14.8	12.4	9.9	13.7	12.9	10.7	6.8	6.2	2.8	6.0	11.2	4.3	4.5	1.6	4.8	3.6	6.3	3.2	3.15	2	29.4	35.6	25.7	29.6	5.2
19.5	15.1	12.6	10.7	13.5	13.0	10.4	7.5	7.θ	3.1	8.0	12.0	4.0	5.0	1.7	4.6	3.7	6.0	3.3	3.00	3.5	31.8	38.0	28.0	32.4	5.0
17.1	15.1	12.5	10.1	14.0	13.0	11.0	6.3	6.0	2.5	7.6	11.0	4.1	4.0	1.9	4.2	3.4	5.4	3.0	2.90	2	31.2	36.3	27.2	28.0	4.4
18.2	14.4	12.2	10.4	13.8	12.7	10.1	6.5	5.9	2.3	7.1	10.6	4.0	4.2	1.7	4.5	3.3	5.3	3.2	3.00	3	30.2	33.6	27.7	28.6	4.8
17.8	14.7	12.0	9.9	13.1	12.5	10.4	7.3	6.2	2.8	7.6	10.6	4.2	5.0	1.6	4.8	3.9	6.6	3.0	2.65	3	29.8	34.8	27.3	28.6	5.3
18.5	14.8	12.3	10.5	13.1	12.3	10.1	6.4	5.8	2.6	8.0	10.3	3.8	4.1	1.9	4.3	3.4	6.1	3.6	3.20	1	31.2	36.7	28.5	29.6	4.9
18.2	14.8	12.3	10.3	13.9	12.4	10.8	6.6	6.0	2.8	7.7	11.1	3.7	4.4	2.2	5.0	3.3	5.9	3.4	2.95	3.5	29.8	35.0	27.6	29.2	4.9

TABLE I.—*Men of Taytay*—

Type of individual.	Serial No.	Clinical No.	Age.	Body. Stature.	Sitting height.	Pubic height.	Umbilical height.	Sternal height.	Chin height.	Ear height.	Ankle height.	Knee height.	Trochanter height.	Finger tip.	Wrist height.	Elbow height.	Acromion height.
Blend	41	467	28	164.5	86.1	85.0	96.4	134.8	142.7	151.5	6.6	44.5	88.3	61.2	79.3	104.2	135.3
Blend	42	469	45	155.5	82.9	82.7	97.0	126.3	133.3	143.8	7.0	43.4	82.0	54.4	73.0	94.9	128.8
Iberian	43	-----	49	163.8	85.7	84.0	100.7	132.3	139.3	151.2	6.8	45.5	85.3	57.0	75.2	100.0	132.0
Australoid	44	395	50	155.3	82.5	78.6	88.7	127.3	133.4	141.5	7.5	44.0	79.8	53.4	72.6	97.0	127.2
Modified Primitive	45	1003	40	154.4	78.9	80.8	93.0	125.8	130.0	141.0	6.8	43.5	81.2	54.5	71.3	93.0	125.0
Blend	46	-----	22	152.0	81.7	75.2	90.0	123.0	129.5	139.8	6.0	39.0	77.0	52.0	70.0	92.2	123.2
Iberian	47	-----	35	154.5	85.9	76.6	89.3	123.5	132.5	141.3	6.2	40.6	77.0	55.0	71.3	95.7	123.5
Australoid	48	484	30	154.0	81.7	79.0	92.5	126.6	135.1	142.1	6.4	40.8	79.4	56.8	73.0	92.5	124.8
Blend	49	486	47	167.1	87.3	87.0	103.0	137.6	145.3	154.2	6.8	47.5	86.3	64.0	85.0	109.0	138.8
Iberian	50	17	66	158.4	82.3	81.5	95.5	128.6	131.5	143.4	6.3	44.0	84.0	53.0	71.0	95.5	128.0
Blend	51	465	30	157.5	83.7	81.6	94.3	128.5	135.0	143.0	5.8	41.5	82.2	57.4	74.1	95.1	128.5
Blend	52	-----	35	159.4	85.6	81.0	94.5	130.0	138.0	147.5	7.3	44.2	83.0	61.3	78.2	101.2	129.0
Cro-Magnon	53	360	35	170.7	88.8	92.0	106.0	139.8	147.3	158.5	7.2	48.2	95.3	61.2	81.5	105.8	138.7
Cro-Magnon	54	-----	35	166.8	84.7	86.3	101.0	136.2	142.8	153.0	6.9	47.0	87.0	61.0	80.5	103.8	137.5
Cro-Magnon	55	477	60	168.5	87.3	89.4	105.0	138.2	146.2	154.8	6.5	47.8	90.4	58.7	76.7	103.2	135.7
Blend	56	481	40	161.4	86.7	82.7	96.7	131.5	140.2	148.8	6.7	44.5	85.6	61.5	78.8	101.3	132.8
Blend	57	471	28	157.8	85.3	80.3	93.0	128.8	136.0	145.2	6.0	42.2	81.7	56.8	74.8	98.0	127.0
Blend	58	234	24	165.7	90.0	82.3	98.2	133.5	141.8	152.2	7.3	44.7	84.8	60.0	78.8	103.0	133.5
Blend	59	489	36	154.1	83.4	78.7	91.3	123.5	131.8	140.2	6.0	42.0	79.0	51.2	69.3	91.2	122.8
Blend	60	488	51	168.3	90.7	83.7	101.0	134.8	145.5	153.5	6.2	47.2	87.0	58.0	77.0	101.6	136.5
Blend	61	485	50	165.2	88.1	82.2	100.7	131.4	143.6	153.6	7.1	46.1	86.0	59.8	80.0	103.0	133.8
Blend	62	482	23	167.0	-----	85.0	101.7	136.0	146.3	155.6	6.6	46.2	88.2	61.2	78.6	105.0	136.0
Alpine	63	492	40	164.3	85.8	86.0	100.0	132.4	139.5	148.5	6.5	43.3	85.7	58.4	77.0	99.4	133.0
Blend	64	466	43	161.0	85.3	81.6	95.8	128.8	138.8	147.4	6.3	44.5	84.2	57.2	75.0	98.6	130.0
Iberian	65	514	60	160.6	84.1	84.8	97.0	130.0	134.3	146.2	5.8	42.8	83.5	59.6	76.8	100.4	132.2
Iberian	66	501	23	164.0	86.5	84.0	96.5	133.8	141.0	150.2	6.6	45.7	85.7	56.3	75.2	97.8	130.4
Blend	67	988	80	157.1	82.2	83.2	95.2	126.5	135.0	144.4	7.1	42.5	82.8	55.4	72.5	93.7	127.3
Australoid	68	462	17	157.2	83.9	80.0	94.2	130.0	137.5	146.3	7.0	43.2	80.8	60.0	76.7	98.6	129.0
Blend	69	-----	40	167.3	86.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Blend	70	-----	27	155.2	83.7	78.0	90.3	124.2	131.8	141.0	6.5	40.6	79.5	56.8	74.6	94.2	125.6
Blend	71	505	49	159.4	84.7	82.8	96.0	130.2	138.7	147.6	6.2	44.0	85.4	55.9	74.3	95.7	127.8
Blend	72	526	28	151.8	80.3	76.8	90.2	121.2	129.2	139.0	5.8	42.7	78.7	54.0	68.0	90.8	123.0
Blend	73	-----	37	163.3	87.2	82.7	100.0	132.2	140.5	150.3	6.3	44.3	84.5	59.5	77.6	102.0	133.3
Cro-Magnon	74	535	19	169.7	90.1	89.0	105.5	137.5	144.3	156.4	6.5	44.6	91.2	57.2	77.6	104.3	137.4
Blend	75	521	32	168.7	88.9	85.8	100.7	136.2	145.0	154.6	7.4	46.4	87.7	64.8	81.6	104.7	137.0
Blend	76	528	28	157.0	82.0	83.2	96.3	126.7	136.0	145.3	7.0	42.8	83.6	59.5	76.5	98.0	127.0
Blend	77	503	50	156.5	82.2	80.3	94.0	127.3	134.7	143.8	6.0	43.5	83.2	60.5	77.2	99.4	129.5
Modified Primitive	78	836	23	157.0	84.3	78.2	90.0	123.5	131.0	141.2	5.7	42.0	79.0	53.6	69.9	91.5	124.6
Australoid	79	529	23	151.8	85.1	75.0	88.0	121.4	130.0	140.0	6.7	42.4	75.7	57.6	74.0	95.7	125.0
Iberian	80	522	40	157.4	86.0	78.7	93.2	126.4	132.2	143.5	6.7	40.0	80.8	55.4	73.5	96.2	126.7

absolute measurements, in centimeters—Continued.

Head.																									
Maximum—																					Circumference.				
Length.	Breadth.	Height.	Forehead width.	Bizygomatic.	Bimastoid.	Bigoniac.	Naso buccal.	Naso alveolar.	Nose base.	Nasion hair line.	Chin nasion.	Nose width.	Nose length.	Mouth width.	Mouth length.	Ear width.	Ear length.	Interocular distance.	Eye length.	Eye color.	Frontal.	Parietal.	Forehead.	Occipital.	Ear cartilage.
18.2	14.8	11.8	10.5	14.0	13.3	11.0	7.1	6.3	3.0	6.8	11.2	4.0	5.2	2.2	4.7	3.5	6.0	3.7	3.05	1	29.0	36.5	27.0	29.5	4.8
18.1	14.4	11.4	10.5	13.6	12.6	10.5	7.8	7.0	2.3	8.2	11.2	4.0	5.2	1.2	4.2	3.8	6.0	3.7	3.10	3.5	29.0	33.8	27.6	28.2	5.2
18.0	14.1	11.7	10.7	13.8	12.7	11.4	7.0	7.5	3.1	6.9	11.8	3.9	4.8	2.0	4.9	3.6	7.0	3.5	2.70	1	30.5	33.7	28.0	28.2	5.0
18.0	14.2	12.7	10.2	14.4	12.9	11.5	7.1	6.2	2.6	6.2	10.4	4.2	4.3	1.4	4.7	3.7	7.1	3.4	2.75	4	29.4	34.2	27.2	29.0	5.7
17.1	15.5	12.2	10.3	13.4	12.8	10.7	7.0	6.7	3.1	7.8	11.0	4.2	4.5	2.0	5.2	3.3	5.3	3.3	2.90	4	30.6	32.7	27.1	28.0	4.7
17.6	15.2	12.5	11.2	13.3	12.7	10.5	7.0	6.4	2.7	6.4	11.3	4.0	4.3	2.4	4.4	3.4	5.3	3.7	2.80	2	32.3	35.8	27.6	26.7	4.5
19.3	14.7	12.3	11.0	14.5	13.2	11.0	7.0	6.0	3.6	7.0	10.6	3.7	5.1	0.8	4.4	3.6	5.9	4.0	2.90	4.5	31.2	35.6	29.0	30.5	5.0
17.8	14.2	11.3	9.8	13.1	11.6	10.2	7.3	5.6	2.8	7.9	9.3	4.0	4.3	1.0	4.5	3.6	6.1	3.5	2.65	2.5	28.5	31.8	26.4	27.3	4.9
18.0	15.8	12.6	10.8	13.9	13.9	10.6	7.3	6.4	2.7	7.4	11.1	4.1	4.6	1.0	5.4	4.0	6.6	3.6	2.75	4	29.8	37.5	26.7	29.7	5.5
18.7	14.7	12.7	10.4	14.0	13 0	10.0	7.3	6.7	2.8	7.0	12.0	3.9	4.9	2.0	4.7	4.0	6.6	3.4	3.00	4	31.0	35.5	27.8	28.7	5.5
17.7	15.3	12.6	10.5	14.0	12.7	10.6	6.2	5.6	2.5	7.5	10.3	3.5	3.8	2.1	4.1	3.6	5.0	3.4	2.90	3	32.0	35.8	26.8	28.5	4.4
18.4	15.6	12.5	10.0	14.1	13.2	11.1	8.1	7.5	3.0	6.9	12.7	4.6	5.2	2.8	5.2	3.4	6.4	3.8	3.10	3.5	31.3	36.8	28.7	29.4	5.0
18.5	14.3	12.0	10.3	13.2	13.6	10.8	7.1	6.6	2.9	6.5	11.8	3.7	4.5	2.0	4.3	3.6	6.2	2.8	3.30	5	29.6	35.6	26.2	28.1	5.2
18.8	15 0	12.5	10.1	14.8	13.0	11.4	7.5	6.8	3.3	7.8	12.0	4.4	4.4	1.8	5.0	3.8	6.2	4.0	3.10	1	32.0	35.5	29.2	27.7	5.3
18.1	15.0	12.7	10.0	13.8	13.0	10.1	7.1	6.4	2.9	6.8	12.0	4.1	4.3	2.2	4.4	4.1	6.1	3.4	2.95	4	30.6	35.8	28.2	28.0	5.4
18.0	15 0	12.2	10.0	13.2	12.4	10.8	6.5	5.8	2.6	6.6	10.4	4.0	4.3	2.0	4.2	3.6	6.1	2.9	3.05	2	28.3	36.1	25.8	28.2	5.2
18.4	15.3	11.7	10.1	13.0	13.0	9.1	7.6	6.3	2.7	6.1	12.0	4.1	4.7	2.0	4.5	3.5	5.8	3.2	3.00	2.5	29.3	35.7	27.2	28.3	5.0
18.1	15.8	12.4	10.5	13.7	12.8	11.1	7.8	6.9	3.1	8.0	12.2	4.1	5.1	2.5	4.5	4.0	6.1	3.1	3.30	1	31.5	38.2	28.3	29.0	5.2
17.7	15.7	11.8	10.2	13.4	12.7	10.4	7.1	6.3	2.4	7.6	10.9	4.5	4.5	1.4	4.6	3.3	6.6	2.8	3.10	1	30.0	36.8	26.5	27.0	5.0
19.5	15.9	12.3	10.8	15.0	14.3	12.0	8.0	6.3	2.8	8.0	11.4	4.5	5.0	2.3	5.0	3.7	7.3	3.4	3.15	3.5	31.4	36.6	29.1	29.7	5.9
18.9	15.0	12.3	11.0	14.8	13.4	11.7	7.1	6.0	2.8	8.2	11.2	4.3	5.1	0.8	5.7	3.5	6.1	3.5	3.05	2	31.2	35.2	28.3	28.4	4.8
17.7	15.1	12.4	11.4	14.2	13.2	11.1	6.3	6.2	2.3	8.2	10.5	3.7	4.4	1.9	4.6	3.1	5.5	3.5	3.30	4.5	31.2	34.6	28.3	25.8	4.7
17.5	14.9	12.6	11.0	14.8	13.2	10.1	7.0	6.9	2.8	7.7	11.3	3.3	5.0	1.4	5.0	3.5	6.6	3.0	3.15	4	32.0	34.4	27.5	28.6	5.3
18.9	15.2	12 5	11.0	13.6	12.6	10.6	7.6	6.8	2.4	7.5	11.8	4.2	5.0	1.0	4.6	3.6	5.7	3.4	3.05	2	31.8	36.0	28.2	30.0	5.0
18.5	14.1	11.9	10.2	13.6	13.0	9.7	7.0	5.6	3.3	8.6	11.3	3.7	4.7	1.8	4.6	3.5	6.5	3.4	2.95	4	30.6	34.4	27.0	29.0	5.1
19.8	15.3	12.5	11.1	14.2	13.6	10.5	7.2	6.6	2.6	9.0	11.5	4.1	4.8	2.8	4.6	3.5	6.0	3.7	3.10	1.5	31.3	37.0	28.2	30.0	4.8
17.3	14.8	12.0	10.6	13.9	12.9	10.9	6.9	6.3	2.6	6.4	9.9	4.0	4.6	0.5	5.0	3.9	6.7	2.8	3.10	4?	30.0	35.1	27.8	26.7	5.5
17.8	13.9	11.8	10.0	13.0	11.7	9.7	5.9	5.3	2.5	6.7	9.5	3.8	3.8	2.2	4.3	3.9	5.3	3.2	2.90	2.5	28.0	34.4	24.7	29.0	4.5
18.8	15.1	12.2	10.8	14.3	12.8	11.3	8.0	7.1	2.6	7.8	12.0	4.5	5.2	2.1	5.0	3.8	6.5	3.4	3.40	4	31.8	36.2	27.8	30.7	5.3
19.2	15.3	12.4	10.8	13.3	12.7	11.1	7.5	6.5	2.8	7.3	11.6	4.1	5.0	1.8	5.2	3.6	5.8	3.4	2.90	1	30.1	37.4	26.5	30.0	4.6
17.8	15.1	12.4	10.0	12.8	12.3	10.0	7.2	6.2	3.2	7.7	11.4	4.2	5.1	2.0	4.8	3.3	6.4	3.1	2.85	2	30.0	36.8	26.7	28 7	5.1
16.6	14 3	11.7	10.1	13.4	12.4	10.2	6.4	5.9	2.3	---	----	3.7	4.3	1.6	4.1	3.7	7.0	3.3	3.15	3	28.4	33.2	25.8	27.0	5.3
19.1	15.3	12.2	10.3	13.8	13.4	10.4	6.9	6.2	3.1	6.5	113	3.9	4.7	2.2	5.0	3.5	6.0	3.0	2.10	5	29.0	37.3	27.0	30.2	4.9
19.3	14.7	13.6	11.1	14.2	13.2	11.4	7.4	7.3	3.0	8.6	12.5	4.1	4.6	2.7	5.0	3.8	5.9	3.7	3.40	3	31.3	37.2	28.2	29.6	5.1
18.8	16.0	13.3	11.0	15.0	14.7	12.4	7.3	6.8	2.7	6.6	12.0	4.3	5.0	1.8	4.5	3.7	5.9	3.4	3.10	4.5	31.0	36.8	28.5	29.5	5.1
18.3	15.0	12.4	9.6	14.1	13.5	10.5	7.0	6.5	2.5	7.6	11.2	3.4	4.7	1.7	4.8	3.6	6.5	3.0	3.00	4	30.0	35.2	27.5	28.5	5.4
17.5	14.3	12.3	10.3	13.8	12.9	9.8	6.5	5.4	3.1	6.8	10.7	3.8	5.0	1.1	5.0	3.8	5.6	4.0	2.60	2	30.1	34.4	28.2	26.3	4.9
17.5	15.6	12.7	11.0	14.0	13.0	10.6	6.6	5.8	2.7	7.8	11.0	3.8	4.0	2.6	4.5	3.4	5.7	3.9	2.75	3	30.7	36.7	28.0	26.6	4.6
18.7	14.3	12.0	10.2	12.9	12.3	10.2	6.9	6.7	3.1	7.0	12.0	4.1	4 8	2.5	5.1	3.4	6.4	3.4	2.95	1	30.2	36.0	27.2	29.0	4.9
20.0	14.1	12.5	10.2	14.2	13.5	10.4	6.9	6.0	3.2	9.0	11.5	3.8	4.8	1.7	4.7	3.9	6.6	3.2	2.75	3	30.6	33.7	28.8	29.0	5.3

TABLE I.—*Men of Taytay*—

Type of individual.	Serial No.	Clinical No.	Age.	Stature.	Sitting height.	Pubic height.	Umbilical height.	Sternal height.	Chin height.	Ear height.	Ankle height.	Knee height.	Trochanter height.	Finger tip.	Wrist height.	Elbow height.	Acromion height.
									Body.								
Iberian	81	520	40	160.3	86.3	80.7	95.5	128.6	135.7	146.8	7.5	45.2	82.5	60.8	77.4	99.1	132.0
Blend	82	537	45	161.6	85.3	82.4	99.0	133.5	131.0?	148.2	6.0	44.7	83.7	59.4	77.8	100.5	133.4
Blend	83	225	30	160.4	83.3	83.2	98.0	131.0	137.0	148.5	5.7	42.3	86.2	61.3	77.5	100.8	131.2
Iberian	84	703	50	156.0	83.8	78.5	95.0	126.6	133.4	144.2	7.5	41.0	81.8	57.3	77.5	98.4	129.0
Australoid	85	-----	31	162.5	86.2	84.1	97.4	130.5	139.0	148.4	6.8	45.8	83.3	61.8	78.4	99.2	132.2
Australoid	86	566	32	159.2	85.0	80.4	95.0	130.5	(?)	(?)	6.2	43.8	83.0	57.2	74.0	97.7	129.6
Modified Primitive	87	-----	17	156.0	80.8	81.4	96.2	127.6	134.5	142.6	6.8	44.8	83.2	54.0	71.8	95.4	127.5
Alpine	88	180	27	157.0	84.0	81.4	95.5	129.2	135.8	145.6	7.0	44.5	83.3	53.8	72.0	96.6	128.6
Australoid	89	564	55	156.8	84.5	81.2	95.5	125.7	134.6	142.5	6.7	44.0	80.1	54.0	73.4	95.0	124.6
Cro-Magnon	90	560	40	170.7	88.2	90.5	105.6	139.8	148.8	158.3	7.1	49.3	91.7	59.2	80.7	103.2	138.7
Blend	91	551	23	150.8	80.2	78.7	92.0	122.3	129.0	138.4	6.4	40.2	78.4	50.0	67.7	90.4	123.5
Blend	92	556	30	152.2	79.5	79.7	92.2	123.3	129.5	139.7	6.3	40.2	79.8	55.0	72.8	93.8	124.4
Blend	93	558	23	162.2	83.3	86.5	97.8	131.0	138.5	148.8	7.1	45.0	86.4	57.0	75.7	99.4	129.8
Blend	94	474	40	148.5	80.0	72.4	86.0	118.0	125.4	136.5	6.0	38.4	74.0	53.8	70.2	90.6	119.0
Australoid	95	580	39	157.8	84.8	79.0	94.0	128.3	135.3	144.6	6.8	43.8	82.8	59.0	75.4	96.6	128.0
Australoid	96	-----	45	160.9	88.3	79.2	96.0	130.3	136.3	146.2	6.8	44.4	80.0	61.0	78.8	100,7	131.4
Blend	97	581	40	163.7	87.7	83.5	99.3	130.0	140.5	151.0	6.8	44.7	84.5	55.0	73.0	98.0	130.0
Australoid	98	-----	(?)	157.5	85.5	77.0	94.4	126.6	133.8	145.7	7.0	42.8	81.0	56.1	73.0	94.5	126.6
Australoid	99	176	25	156.8	84.0	82.0	95.2	128.8	137.0	145.3	6.3	43.6	83.2	56.8	75.5	98.5	131.4
Blend	100	584	66	155.7	82.6	80.7	93.5	125.2	133.0	143.0	6.5	43.0	80.3	56.0	74.6	96.2	126.7
Blend	101	596	37	162.5	87.8	82.4	96.5	131.3	140.2	149.8	6.5	45.8	83.8	60.7	78.0	100.0	131.0
Blend	102	589	22	164.3	85.1	86.0	101.0	134.0	141.5	151.7	6.7	44.8	87.0	57.2	76.0	102.5	137.0
Cro-Magnon	103	616	37	167.0	86.8	87.2	100.7	134.5	141.6	153.2	6.1	46.7	87.3	61.0	80.5	105.0	136.6
Blend	104	63	16	156.8	80.7	79.6	95.2	125.5	133.2	141.8	6.2	41.0	81.3	56.0	72.3	93.0	126.0
Blend	105	603	50	155.9	83.2	78.4	94.5	125.5	132.5	142.5	6.8	43.8	82.0	54.0	71.8	91.0	126.0
Blend	106	-----	22	159.7	-----	82.5	96.7	129.5	138.8	146.5	6.1	45.2	85.0	57.2	75.5	98.3	130.5
Blend	107	104	28	152.8	81.8	78.5	92.2	125.5	131.4	141.8	5.4	42.6	80.3	54.8	72.0	92.5	124.5
Blend	108	-----	32	159.5	74.3	84.0	96.4	127.0	135.4	145.5	6.6	45.5	85.0	58.2	76.4	99.0	128.5
Alpine	109	653	33	162.3	84.2	85.2	99.4	130.8	139.3	148.8	6.7	45.6	84.5	58.2	76.0	98.7	132.5
Primitive	110	-----	28	149.8	83.0	75.2	91.2	119.5	126.5?	136.8	6.2	41.7	72.8	54.0	69.4	90.0	120.3
Blend	111	638	28	159.3	84.4	82.2	97.2	128.0	134.7	145.5	6.1	45.5	83.8	58.5	75.5	99.4	128.5
Blend	112	-----	15	151.6	78.9	78.2	91.2	123.5	129.0	138.7	5.4	42.7	78.8	55.3	72.6	92.5	121.5
Australoid	113	628	35	155.3	84.2	77.6	89.8	126.0	132.8	142.0	6.3	42.8	80.0	54.7	73.0	94.8	125.0
Cro-Magnon	114	656	21	166.8	84.5	90.4	104.0	136.0	143.4	152.5	6.7	48.0	90.5	56.8	77.0	100.5	135.0
Blend	115	639	20	157.1	87.8	78.3	95.6	126.8	134 3	144.3	7.1	41.6	78.1	59.3	75.7	98.3	128.0
Blend	116	631	15	146.9	77.2	77.2	89.8	119.8	126.0	134.6	4.4	39.5	77.5	52.5	67.2	88.0	118.2
Blend	117	-----	47	162.4	85.7	84.2	98.0	131.0	139.0	149.0	5.7	45.5	84.4	58.0	76.8	99.0	131.8
Blend	118	316	27	163.0	86.5	87.2	101.4	133.0	141.8	152.0	6.2	46.0	86.2	58.6	75.3	100.0	130.0
Iberian	119	-----	30	156.4	81.2	81.8	97.0	128.5	134.0	144.2	6.3	45.4	83.2	56.6	74.4	97.7	128.3
Blend	120	654	42	153.2	80.3	79.0	92.7	122.8	130.5	139.8	6.3	42.6	81.0	53.2	70.4	95.3	123.4

absolute measurements, in centimeters—Continued.

Head.																									
Maximum—																					Circumference.				
Length.	Breadth.	Height.	Forehead width.	Bizygomatic.	Bimastoid.	Bigoniac.	Naso buccal.	Naso alveolar.	Nose base.	Nasion hair line.	Chin nasion.	Nose width.	Nose length.	Mouth width.	Mouth length.	Ear width.	Ear length.	Interocular distance.	Eye length.	Eye color.	Frontal.	Parietal.	Forehead.	Occipital.	Ear cartilage.
18.8	14.1	12.0	10.4	13.8	14.0	10.5	7.2	6.6	3.4	7.3	11.0	4.0	5.1	1.5	5.0	3.6	7.1	3.6	2.70	4	28.6	34.2	26.5	28.8	5.9
18.4	15.5	12.2	10.6	13.7	13.8	10.5	8.5	7.6	3.2	7.1	12.5	4.0	5.3	1.5	5.0	3.4	7.6	3.0	3.10	2	29.4	37.6	26.8	31.0	5.5
18 1	14.5	12.5	10.2	13.6	12.7	11.0	7.3	6.6	3.2	7.2	12.1	3.8	4.3	2.5	4.5	3.5	6.0	3.4	2.95	3	30.6	35.4	27.0	27.8	5.1
18.3	14.2	12.2	10.6	13.6	12.8	10.9	7.4	6.3	2.8	6.3	12.3	4.0	4.9	2.3	4.7	3.3	6.7	3.4	2.95	3.5	30.0	34.6	28.2	28.0	5.2
19.7	15.0	13.1	11.1	13.6	13.2	11.6	7.7	6.8	3.1	8.2	12.5	4.5	4.8	2.3	4.1	3.5	6.3	3.2	2.80	3	30.6	37.0	29.0	30.2	4.9
18.8	14.4	12.3	11.0	13.9	13.2	10.4	6.7	6.1	2.3	5.8	10.7	4.4	4.0	2.7	5.4	3.5	5.9	3.9	3.05	1	30.4	35.7	27.3	28.0	5.1
16.6	14.8	12.0	10.0	13.0	12.0	10.4	6.7	5.7	2.5	---	----	3.8	4.5	2.5	4.5	3.5	6.1	3.3	2.75	3	29.8	34.2	25.0	27.3	4.6
17.5	15.2	12.0	11.0	14.0	13.1	10.6	7.8	6.7	3.0	7.7	12.0	3.8	5.1	1.9	4.0	3.6	6.5	3.4	3.05	2	32.1	35.0	27.3	26.6	5.6
19.0	14.0	12.5	10.0	14.1	13.0	10.2	7.2	5.8	2.3	6.0	10.6	4.6	4.5	1.8	---	3.6	6.2	3.5	3.10	3	29.6	34.6	27.0	29.0	5.2
18.2	14.3	12.4	10.2	13.1	13.6	10.8	7.1	6.6	3.2	6.7	11.3	3 6	4.4	2.8	4.8	3.8	6.3	3.1	3.15	4	28.4	35.5	26.8	28.5	5.2
18.0	15 3	11.7	9.8	13.2	12.3	10.2	6.4	5.8	2.9	7.4	10.0	3.7	4.2	2.0	4.4	3.8	5.2	3.1	2.75	5	28.7	35.1	27.0	27.6	4.4
17.0	14.5	11.7	10.5	13.5	12.7	10.0	7.0	6.6	3.3	8.4	11.0	4.0	4.8	1.8	5.3	3.2	5.4	3.1	3.10	3	30 0	32.1	27.2	25.3	4.6
17.5	14.6	12.0	10.6	13.8	12.7	10.1	7.0	6.5	2.6	6.0	11.3	3.8	4.8	2.4	4.0	3.3	5.9	3.8	2.85	3	30.2	35.0	27.6	27.1	4.6
17.7	14.7	11.7	10.0	13.5	12.6	10.3	7.3	6.6	2.8	7.4	11.0	4.1	5.1	2.2	5.0	3.5	6.4	3.1	3.10	3	29.0	35.0	25 3	28.0	5.0
18.7	14.4	12.3	10.6	13.5	12.6	9.6	6.5	5.7	3.0	7.9	11.0	4.0	4.2	---	---	3.7	6.3	3.7	2.95	4	31.1	34.0	28.4	28.2	5.2
18.6	15.2	13.3	10.8	13.8	12.8	10.2	7.1	6.6	3.0	8.6	11.8	4.1	4.2	2.0	4.6	3.9	5.9	4.9	2.65	([a])	31.8	36.4	27.2	29.5	5.0
18.7	15.2	12.0	11 2	14.3	13.3	12.0	7.2	6.6	2.5	7.0	11.9	4.3	4.7	2.0	4.4	3.3	6.1	3.5	3.20	2	31.2	36.3	28.5	29.5	4.6
18.4	15.2	12.9	10.8	14.0	13.1	10.3	7.0	6.1	2.2	7.0	11.3	4.2	4.3	2.2	5.0	3.5	6.2	3.7	2.90	2	30.3	36.4	27.0	29.4	4.8
18.4	15.0	11.2	10.1	13.6	12.7	10.3	6.9	6.1	2.6	6.6	11.1	4.1	4.3	2.8	4.7	3.3	5.6	3.5	3.00	4	29.6	35.3	27.5	27.8	5.0
18.7	14.9	12.7	9.3	13.7	12.9	10.6	7.8	6.6	3.1	8.1	11.4	3.9	4.8	2.5	4.6	3.7	7.0	3.2	2.90	3	30.6	36.4	26.8	29.6	5
18.8	16.0	12.6	11.2	14.3	13.3	11.3	7.2	6.6	3.2	6.3	11.3	4.4	4.9	1.4	5.3	3.6	6.1	3.8	2.75	5	32.0	37.2	28.6	29.6	5.4
18.0	15.1	12.3	10.0	13.8	13.1	10.6	7.0	6.4	2.8	6.7	11.0	3.7	4.8	2.3	4.7	3.4	6.0	3.0	3.10	1	31.2	36.4	28.8	28.0	5.1
19.4	14.7	13.0	10.1	14.0	13.0	11.1	6.9	6.4	2.7	7.4	11.7	4.1	4.2	2.0	4.8	3.6	6.3	3.3	2.85	2	31.6	35.3	27.7	29.0	4.8
18.7	14.8	12.2	10.4	13.7	12.6	10.4	6.7	5.8	2.8	7.5	11.0	3.7	4.2	2.6	4.2	3.7	5.2	3.5	2.80	3	29.4	35.7	28.0	28.5	4.6
18.8	15.8	13.2	10.8	13.8	13.2	11.1	7.6	6.3	2.8	8.0	11.6	4.3	5.0	1.5	5.2	3.5	6.1	3.1	3.05	3.5	32.0	38.3	29.7	27.7	4.9
17.8	14.8	12.8	10.4	13.5	12.1	10.6	6.8	6.1	2.7	---	----	3.4	4.6	1.9	4.0	3.8	5.8	3.2	2.80	3.5	29.5	35.6	27.8	26.8	4.8
17.6	14.8	12.0	10.5	13.7	12.1	10.0	6.8	6.1	3.0	7.0	10.7	3.8	4.3	2.2	4.5	3.3	5.8	3.4	2.85	3.5	30.2	35.5	26.0	26.0	4.5
18.6	15.7	11.8	10.4	13.8	12.7	10.3	7.5	7.0	2.8	8.5	11.9	4.0	4.8	2.8	4.7	3.6	6.0	3.3	3.10	3	30.4	37.2	28.3	27.8	5.1
17.5	16.5	11.8	11.0	14.7	13.5	10.1	7.6	7.1	2.7	8.0	11.1	3.2	5.3	2.7	4.5	3.4	5.8	2.7	3.20	5	31.0	37.5	27.0	28.5	4.9
17.2	15.3	13.0	10.7	14.4	13.3	11.1	7.0	6.1	3.0	7.2	10.7	4.1	4.6	1.6	4.7	3.6	6.3	3.4	2.80	3	31.2	35.4	27.8	27.0	4.8
18.2	15.0	13.1	10.5	13.8	13.0	10.5	7.2	6.6	2.8	6.8	11.8	4.0	4.6	2.2	4.4	3.2	6.3	3.5	3.00	3	31.2	35.8	27.3	28.0	4.6
18.2	14.2	13.0	10.3	13.1	12.9	10.1	6.5	5.3	2.5	7.1	10.5	3.8	4.4	2.2	4.5	3.6	6.0	3.1	2.95	3	30.0	35.3	26.8	29.3	4.9
18.3	14.7	13.0	10.6	13.8	13.5	10.2	7.3	6.3	2.8	---	----	4.2	4.4	2.2	4.2	3.4	5.9	3.1	3.25	4	30.0	35.8	28.0	28.2	4.8
19.3	14.5	12.7	10.3	13.5	13.4	11.2	6.8	6.2	3.0	8.0	11.3	4.5	4.5	2.4	4.7	3.3	5.9	4.0	2.70	4.5	30.0	35.2	28.0	29.6	4.5
18.1	14.8	12.5	10.3	13.6	12.5	10.2	6.8	5.9	2.6	7.7	10.3	3.7	4.6	1.8	4.5	3.0	5.7	2.9	2.85	3	29.8	35.6	27.2	28.6	4.7
17.0	14.9	12.0	10.1	13.0	12.0	10.2	7.0	6.5	2.6	5.5	11.1	3.6	4.5	2.4	4.2	3.4	5.5	3.5	2.85	2	29.2	34.8	26.0	27.0	4.3
18.0	15.1	12.5	10.5	13.5	13.3	9.8	7.8	7.5	3.4	6.3	12.5	4.3	5.4	2.1	5.2	3.8	6.3	3.4	3.05	3	30.0	34.8	28.0	27.6	5.0
17.8	15.4	12.5	10.2	14.0	14.0	10.5	6.6	6.3	2.7	6.7	11.0	3.6	4.4	2.4	4.6	3.0	5.6	3.3	2.80	3	31.0	36.5	27.4	28.2	4.6
17.7	13.8	12.4	10.0	13.2	12.4	10.6	7.6	7.3	3.2	7.0	12.1	3.6	5.0	2.7	5.0	3.3	5.5	3.0	3.00	3	28.1	34.6	25.4	27.5	4.8
18.9	15.4	12.9	11.0	14.2	13.4	10.4	7.6	6.7	3.2	8.3	12.1	3.9	5.3	2.2	5.2	3.6	6.8	3.9	2.85	4.5	31.8	36.3	28.2	29.0	5.5

[a] Blind.

TABLE I.—*Men of Taytay*—

Type of individual.	Serial No.	Clinical No.	Age.	Body.													
				Stature.	Sitting height.	Pubic height.	Umbilical height.	Sternal height.	Chin height.	Ear height.	Ankle height.	Knee height.	Trochanter height.	Finger tip.	Wrist height.	Elbow height.	Acromion height.
Blend	121	662	34	164.7	83.2	87.3	100.6	134.5	142.8	153.0	7.0	47.4	89.7	54.3	73.6	100.3	134.0
Modified Primitive	122	657	29	161.2	89.9	80.3	96.4	130.4	138.0	148.3	6.0	43.5	80.0	53.5	72.6	97.6	129.5
Blend	123	651	62	163.5	84.3	84.2	100.0	132.5	140.0	149.0	6.5	45.6	87.3	59.4	77.0	101.0	132.5
Australoid	124	650	42	156.0	86.1	77.8	92.2	125.4	132.3	142.6	6.7	42.5	80.0	57.0	73.0	94.4	124.0
Blend	125	609	17	164.5	87.9	86.4	101.5	135.5	141.8	152.3	7.8	41.8	85.0	57.3	75.5	100.7	134.4
Blend	126	692	64	166.5	85.2	87.8	101.5	131.8	141.0	152.0	6.4	46.5	89.0	57.8	76.8	102.5	135.0
Australoid?	127	-----	30	153.5	80.5	80.4	95.8	123.5	132.0	140.0	6.1	44.0	79.0	57.7	72.5	94.0	125.5
Blend	128	708	70	158.7	84.2	82.3	96.7	130.0	137.5	145.5	7.1	45.0	84.0	55.3	72.6	96.0	127.5
Australoid	129	686	35	155.7	82.3	80.3	93.8	126.0	131.5	143.0	6.1	42.0	82.0	56.0	71.8	95.0	126.0
Cro-Magnon	130	710	28	167.7	88.9	85.4	100.0	135.3	145.0	154.6	6.4	46.8	86.8	64.5	82.5	106.0	138.0
Alpine	131	730	25	157.9	84.5	80.2	93.3	129.0	137.2	147.2	6.0	43.8	80.6	56.4	73.6	95.5	128.0
Blend	132	754	16	156.5	81.7	79.0	93.0	125.5	133.5	143.0	6.1	43.3	82.8	53.4	71.0	92.7	126.0
Blend	133	726	16	160.0	80.7	86.5	98.0	130.5	136.8	146.7	6.8	46.0	86.0	55.8	73.8	97.2	129.8
Blend	134	757	19	168.6	89.5	88.0	102.5	137.8	144.4	153.8	7.7	48.6	89.8	56.3	74.6	102.0	135.0
Australoid	135	758	63	161.6	86.7	81.5	97.5	131.7	138.0	150.0	6.0	44.3	84.2	56.5	74.6	97.8	133.2
Australoid	136	760	27	149.5	78.5	77.5	90.5	119.0	126.7	134.2	5.8	41.4	77.2	50.2	65.0	87.6	119.5
Blend	137	761	38	145.7	78.1	76.2	86.3	118.5	124.0	132.6	7.3	40.7	77.0	52.8	71.0	89.6	118.0
Iberian	138	756	20	158.3	80.8	83.4	98.3	130.0	138.5	148.7	6.5	45.2	84.0	56.0	74.0	96.8	128.8
Blend	139	-----	26	156.6	87.0	77.0	91.3	127.0	135.5	144.5	6.3	40.6	77.5	55.5	71.0	94.3	126.8
Australoid	140	-----	19	161.0	84.6	85.0	96.5	128.5	137.3	146.8	6.6	47.0	85.7	54.2	72.4	94.0	128.0
Iberian	141	-----	45	166.2	86.7	86.5	100.0	135.3	143.5	153.0	6.7	45.5	86.0	62.0	79.4	103.5	136.5
Australoid	142	784	70	164.0	86.7	83.0	94.0	131.4	139.0	149.8	6.6	46.5	86.2	59.5	79.0	104.5	135.5
Australoid	143	775	30	159.8	84.0	83.0	96.6	131.0	137.0	147.8	6.2	46.5	85.6	58.7	76.2	100.0	132.2
Blend	144	800	32	160.9	84.8	83.0	96.5	129.0	138.3	147.8	6.4	44.8	86.0	54.2	71.7	94.8	131.0
Blend	145	801	33	171.0	91.7	86.3	102.0	139.0	147.0	157.6	6.8	46.0	88.0	63.0	85.0	108.0	138.5
Blend	146	816	35	156.4	82.2	81.0	94.8	128.0	134.0	143.0	6.6	43.4	82.8	60.5	77.5	100.7	129.3
Blend	147	825	40	161.6	83.3	83.6	96.8	129.0	136.7	146.5	6.0	44.3	85.5	54.5	73.0	98.0	127.6
Cro-Magnon	148	833	53	166.8	90.3	84.5	99.0	134.0	142.6	153.5	6.5	44.0	88.0	58.0	76.5	101.0	134.0
Alpine	149	875	32	158.0	81.6	79.6	96.2	128.0	136.5	146.0	6.8	43.0	83.0	60.0	76.7	95.0	128.8
Iberian	150	-----	32	163.2	86.1	86.0	99.2	131.3	139.0	149.8	7.1	46.3	85.8	54.0	71.0	97.0	129.7
Blend	151	870	---	156.4	82.9	81.4	94.3	126.0	133.0	142.4	6.8	42.8	82.8	54.4	71.5	94.0	126.7
Blend	152	877	30	164.0	87.1	82.8	101.0	134.2	140.8	151.0	7.6	45.8	83.5	57.2	75.7	100.0	134.7
Australoid	153	-----	20	159.9	85.7	82.0	93.5	128.5	136.2	146.3	6.8	44.0	83.0	57.3	74.3	97.8	127.5
Alpine	154	885	60	162.8	85.0	82.0	97.0	132.5	139.5	150.8	6.4	44.6	83.2	57.8	75.4	100.0	132.5
Blend	155	886	80	153.7	80.7	79.4	89.7	125.2	130.0	138.8	6.3	42.5	81.0	54.0	71.0	93.0	124.0
Blend	156	222	26	156.8	82.8	81.6	94.7	125.0	134.1	143.5	5.9	43.5	81.5	58.2	74.2	94.7	125.6
Blend	157	915	40	151.5	81.5	76.6	90.8	122.0	130.0	138.6	6.2	42.5	78.5	56.0	72.2	95.8	124.2
Blend	158	1085	33	149.0	79.2	78.8	89.6	121.8	130.2	138.2	7.2	42.0	77.5	55.5	71.0	95.5	122.0
Alpine	159	921	42	162.6	90.7	77.6	94.0	131.5	136.5	148.5	7.2	44.6	79.3	58.6	76.0	100.0	129.0
Australoid	160	931	27	153.5	83.7	75.4	91.3	121.3	129.3	140.0	5.7	40.4	75.9	52.0	69.6	90.6	123.3

absolute measurements, in centimeters—Continued.

Head.																									
Maximum—																					Circumference.				
Length.	Breadth.	Height.	Forehead width.	Bizygomatic.	Bimastoid.	Bigoniac.	Naso buccal.	Naso alveolar.	Nose base.	Nasion hair line.	Chin nasion.	Nose width.	Nose length.	Mouth width.	Mouth length.	Ear width.	Ear length.	Interocular distance.	Eye length.	Eye color.	Frontal.	Parietal.	Forehead.	Occipital.	Ear cartilage.
18.1	15.5	12.5	10.0	13.8	13.0	11.6	7.5	6.9	3.2	8.4	12.0	4.0	5.3	1.7	5.0	3.8	6.1	3.2	3.00	3	31.0	36.8	27.8	28.0	5.0
17.0	15.2	13.1	10.0	13.8	13.6	11.2	7.3	6.9	3.4	6.5	11.3	4.2	4.8	2.0	5.0	3.6	6.0	3.3	2.80	2	29.4	37.0	27.0	26.0	5.1
17.5	15.5	13.0	10.5	13.8	13.1	10.1	7.4	6.8	3.3	8.1	11.6	4.3	5.2	1.7	5.1	3.6	5.9	3.6	2.70	3	32.0	36.6	28.3	27.0	4.9
18.4	14.7	13.5	10.0	14.0	12.8	10.2	7.7	7.3	3.0	5.7	11.7	4.4	4.7	2.2	5.2	3.7	6.8	3.4	3.05	3.5	29.6	35.6	26.8	29.7	4.8
17.9	15.7	12.8	10.7	14.1	13.1	11.3	7.1	6.5	3.0	6.6	11.3	3.9	4.5	2.6	4.6	3.7	5.7	3.1	2.85	2	29.8	37.2	27.8	27.5	4.7
18.2	14.9	12.7	10.0	14.0	13.6	10.5	8.0	6.8	3.7	7.8	12.2	3.8	5.4	1.5	5.0	4.0	7.3	3.4	2.85	4.5	28.8	35.5	26.6	27.7	5.7
18.0	14.6	12.5	10.0	13.5	13.2	11.0	7.1	6.8	4.0	7.4	11.5	4.0	4.3	2.3	5.0	3.4	5.9	3.3	2.70	2	30.7	35.0	26.4	28.0	5.1
18.4	15.9	12.8	10.3	14.5	13.8	11.0	7.7	6.5	2.8	8.5	11.5	4.7	5.0	.8	5.5	3.7	6.4	3.7	2.40	---	30.6	36.2	27.0	30.0	5.6
18.8	14.2	12.5	9.7	13.8	12.9	10.6	7.2	6.3	3.0	6.7	11.4	3.9	4.6	1.0	5.2	3.2	6.4	3.4	2.80	3	29.8	34.6	28.0	27.6	4.9
18.8	14.6	13.5	10.6	13.5	13.0	10.3	6.5	5.9	2.8	8.0	10.7	3.9	4.0	2.2	4.5	3.4	6.1	3.3	2.95	2	31.0	35.6	27.5	30.0	5.0
16.8	15.0	12.4	9.6	13.0	13.0	10.4	7.0	6.7	2.6	9.0	11.0	3.7	4.7	1.8	4.7	3.3	5.3	2.9	2.60	3	27.5	36.0	25 5	26.0	4.5
17.2	15.2	12.8	10.8	13.7	12.4	11.0	6.0	5.5	2.4	7.4	10.0	3.7	4.1	2.3	4.4	3.3	5.3	3.6	2.85	3	31.7	35.0	28.0	26.0	4.6
18.0	15.8	12.6	10.5	14.1	13.2	10.6	7.0	6.0	3.1	6.1	11.3	3.6	4.6	2.1	4.2	3.6	5.5	3.0	3.10	2	30.6	37.8	26.5	28.5	4.5
17.6	15.6	13.0	10.3	14.0	12.7	10.0	7.0	6.3	3.3	7.2	12.0	4.0	4.8	2.3	5.0	3.2	5.9	3.1	3.00	2	31.3	36.8	26.2	28.5	4.6
18.0	15.0	12.5	10.7	13.9	12.7	10.6	7.1	6.3	2.8	8.5	11.0	4.3	4.4	2.1	5.6	3.7	6.6	3.3	2.75	4	32.0	35.8	28.5	27.5	5.3
18.1	14.1	12.8	10.7	13.0	12.7	9.8	6.8	6.4	2.7	6.2	11.3	3.7	4.3	2.1	4.6	3.1	5.3	3.3	3.10	2	30.8	34.5	27.2	27.3	4.4
17.2	14.8	13.0	10.4	13.3	12.4	10.0	7.0	6.3	3.3	6.0	10.8	4.0	5.0	2.0	5.0	3.9	6.2	3.5	2.75	2	29.5	36.5	26.0	27.0	5.0
18.6	14.7	12.8	10.3	13.0	12.8	10.7	6.6	6.1	2.7	7.0	11.0	3.4	4.4	2.5	4.5	2.7	5.6	3.5	2.95	3	30.2	35.1	27.0	27.8	5.1
19.3	15.3	13.1	10.7	13.7	13.0	10.0	7.0	6.5	3.1	8.0	12.0	3.7	4.4	2.0	5.4	3.4	6.3	3.4	3.15	2	31.0	37.0	28.0	29.6	5.2
19.0	15.0	13.2	11.2	14.1	13.2	10.7	7.0	6.5	2.8	6.4	12.3	4.3	4.5	2.8	4.8	3.8	5.9	3.8	2.85	1	32.5	35.0	29.6	28.0	5.3
19.3	14.1	12.5	10.4	13.7	12.7	10.7	7.6	7.2	3.3	7.0	12.2	4.2	5.2	2.5	5.3	4.0	6.0	3.3	3.10	4	30.4	34.6	29.0	28.0	5.0
19.8	15.1	13.5	10.5	13.7	13.1	11.0	8.3	7.5	3.3	8.8	12.5	4.8	5.3	2.4	5.9	3.9	9.5	3.5	2.95	5	30.6	36.3	27.8	30.4	5.0
18.5	14.3	12.2	10.6	13.5	12.8	10.3	7.3	6.5	3.2	6.6	10.8	4.2	4.7	2.5	4.7	3.2	6.1	3.1	3.15	3	29.6	35.0	26.3	27.6	4.6
18.9	15.1	13.3	11.0	14.4	13.6	11.7	7.2	6.8	3.7	6.8	11.8	4.1	5.1	2.5	4.8	3.3	6.1	3.7	3.15	3	30.7	36.6	28.5	28.0	4.8
19.1	15.5	12.7	10.5	14.0	12.9	10.5	7.3	6.9	3.0	7.8	12.0	4.3	4.9	2.4	5.0	3.5	6.0	3.2	3.00	4	30.8	36.6	28.0	28.0	5.2
18.3	15.5	13.2	10.6	14.1	13.5	10.5	7.4	6.9	2.6	6.8	11.6	4.3	5.3	2.2	4.8	3.5	6.0	3.3	3.00	3	31.8	38.2	28.6	30.3	4.7
18.9	15.1	12.4	10.3	14.0	13.7	10 8	8.0	6.9	3.1	6.3	12.3	4.1	5.4	1.6	5.2	3.8	6.3	3.4	2.95	3.5	32.0	37.2	28.6	29.0	5.1
18.7	15.2	13.1	10.5	14.4	13.8	10.5	6.8	6.0	3.2	8.5	10.8	4.4	4.4	1.8	5.7	3.5	6.8	3.8	2.95	1.5	31.0	36.0	28.0	29.0	5.5
17.7	15.2	12.8	10.0	13.5	12.8	10.1	7.2	6.8	3.0	7.0	11.5	3.1	5.0	2.4	4.7	3.4	5.7	3.0	3.10	2.5	30.6	36.3	27.4	27.6	4.8
19.3	14.7	12.6	10.0	13.8	13.2	11.3	7.4	6.7	2.4	7.0	12.2	4.0	4.8	1.8	4.8	3.0	5.8	3.4	3.00	3	30.5	35 6	28.5	28.5	4.8
17.2	15.0	12.7	10.1	13.5	13.0	11.4	7.2	6.5	2.7	7.8	11.3	3.8	4.5	2.3	4.9	3.9	6.3	3.6	2.85	3	30.7	34.6	26.8	26.8	5.1
19.5	15.3	13.2	10.6	14.4	13.1	10.6	7.5	7.0	2.7	7.7	12.8	4.1	4.8	2.3	4.8	3.7	6.3	3.5	2.90	2.5	33.0	36.5	29.8	28.7	5.4
19.3	13.9	12.6	11.0	12.7	12.0	10.0	6.4	6.3	3.0	6.8	11.4	3.9	4.3	2.5	5.0	3.5	5.5	3.0	3.10	4	29.5	35.2	27.0	29.5	4.5
17.4	16.0	12.0	9.9	14.1	13.6	11.0	7.4	6.4	3.4	6.7	11.4	4.3	5.3	1.5	5.1	3.6	6.7	2.9	2.80	4	29.3	36.0	26.5	27.6	5.6
18.3	15.6	12.8	10.6	14.1	13.3	11.0	7.0	6.6	3.0	9.0	10.8	4.3	5.0	.3	4.5	3.7	7.8	3.1	3.30	4.5	31.6	36.0	28.0	27.0	5.7
18.5	14.6	13.0	10.0	13.4	12.4	10.0	7.1	6.3	2.8	8.0	11.0	4.0	4.5	2.1	4.2	3.1	5.2	3.4	3.15	2	28.3	35.2	27.0	27.7	4.3
17.7	15.5	12.8	10.6	14.3	12.8	10.7	7.0	6.0	2.3	7.4	10.2	4.0	4.5	2.0	5.0	3.5	6.9	3.5	3.00	3	31.0	35.6	28.0	27.5	4.9
17.1	14.3	12.5	10.0	12.5	11.7	9.6	6.4	5.8	2.3	8.0	10.4	3.7	4.3	2.0	4.6	3.4	5.9	3.5	2.65	2	29.4	35.6	26.7	27.2	4.5
18.5	15.6	12.9	11.0	14.5	13.2	12.0	7.6	6.7	3.0	7.4	12.3	2.8	5.1	2.5	5.3	3.3	6.3	3.3	3.25	4	31.8	35.0	28.3	28.0	4.3
18.7	14.5	12.8	10.2	14.2	12.6	11.2	7.3	6.6	3.1	6.0	12.0	4.3	4.6	2.0	5.5	3.1	6.3	3.0	3.15	1.5	30.0	35.7	26.6	30.0	5.0

TABLE I.—*Men of Taytay*—

Type of individual.	Serial No.	Clinical No.	Age.	Body. Stature.	Sitting height.	Pubic height.	Umbilical height.	Sternal height.	Chin height.	Ear height.	Ankle height.	Knee height.	Trochanter height.	Finger tip.	Wrist height.	Elbow height.	Acromion height.
Blend	161	935	30	157.2	83.8	80.6	92.0	128.0	134.7	144.0	5.0	43.0	81.0	----	----	----	----
Blend	162	934	30	148.2	80.7	73.6	86.5	120.8	126.2	135.3	5.6	39.2	75.7	46.5	63.8	87.5	118.4
Iberian	163	940	38	161.2	82.3	84.2	97.6	129.0	135.0	145.8	6.0	43.2	84.7	54.4	71.2	94.3	128.8
Iberian	164	129	30	159.5	85.9	82.0	96.2	130.0	136.5	145.6	7.5	43.4	83.6	54.7	72.5	95.9	130.0
Australoid	165	941	25	154.7	84.2	79.6	91.0	126.0	134.4	144.0	7.0	43.2	79.4	54.6	71.0	94.5	125.8
Alpine	166	954	30	160.1	84.6	83.3	96.0	131.0	138 0	147.8	6.5	45.3	82.7	57.0	74.8	100.0	131.0
Cro-Magnon	167	471	25	165.3	90.0	85.5	98.6	132.5	143.3	154.0	7.4	44.7	84.2	57.8	75.2	102.5	136.0
Australoid	168	----	25	158.4	84.0	81.4	95.7	127.2	134.3	145.3	5.9	43.5	82.5	54.3	74.2	95.8	127.5
Blend	169	543	42	163.4	85.2	87.0	101.0	133.0	142.4	152.0	6.3	44.7	87.0	61.2	79.4	103.7	134.7
Blend	170	----	18	157.1	84.2	79.0	93.5	127.3	136.6	144.2	7.1	44.0	80.8	54.7	71.0	93.0	127.0
Blend	171	----	40	162 4	86.9	82.6	95.6	132.0	141.3	151.0	6.7	43.6	84.3	60.4	77.2	101.7	133.0
Blend	172	----	18	152.1	81.7	77.0	89.4	122.2	129.5	140.5	5.3	42.0	79.0	53.8	71.0	93.3	122.7
Blend	173	----	60	156.6	83.0	82.6	95.0	127.0	135.0	144.5	6.2	43.0	83.2	55.0	73.0	99.0	128.0
Blend	174	1069	64	163.1	86.4	84.3?	97.7	131.0	139.0	150.0	6.1	44.0	84.3?	59.0	76.5	100.7	133.5
Blend	175	1048	20	164.9	84.8	86.2	100.0	133.0	141.4	151.5	6.2	45.6	88.0	56.0	74.6	101.0	134 6
Alpine	176	----	30	154.8	82.8	80.0	94.0	125.3	133 0	141.2	7.0	42.5	81.7	55.2	71.9	94.4	125.7
Blend	177	1077	29	148.8	79.7	74.5	87.5	120.0	127.5	138.0	6.8	40.0	76.0	53.5	69.6	93.0	121.0
Blend	178	360	31	159.0	84.6	----	----	----	----	----	----	----	----	----	----	----	----
Australoid	179	348	39	164.3	88.5	----	----	----	----	----	----	----	----	----	----	----	----
Blend	180	----	28	166.2	90.0	----	----	----	----	----	----	----	----	----	----	----	----
	181	----	(b)	159.9	83.8	81.8	99.0	129.0	135.5	145.4	7.0	44.2	85.0	58.2	77.0	98.6	132.5
Cro-Magnon	182	1086	28	167.2	89.4	86.6	101.0	135 0	145.0	154.6	8.2	45.5	88.2	62.0	79.6	104.0	137.0
Australoid	183	----	80	160.9	83.4	82.0	99.0	130.0	137.8	148.2	6.2	44.8	86.2	61.0	79.4	102.0	132.0

[b] Adult.

absolute measurements, in centimeters—Continued.

Head.

Maximum—			Forehead width.	Bizygomatic.	Bimastoid.	Bigoniac.	Naso buccal.	Naso alveolar.	Nose base.	Nasion hair line.	Chin nasion.	Nose width.	Nose length.	Mouth width.	Mouth length.	Ear width.	Ear length.	Interocular distance.	Eye length.	Eye color.	Circumference.				Ear cartilage.
Length.	Breadth.	Height.																			Frontal.	Parietal.	Forehead.	Occipital.	
18.2	14.8	13.0	10.4	13.7	13.1	10.6	7.0	6.7	2.8	7.1	12.0	4.0	4.6	2.3	4.6	3.5	5.6	3.9	2.85	3	31.0	35.2	26.7	28.0	5.0
17.5	14.9	12.0	9.8	13.1	12.4	9.8	6.2	5.3	2.4	7.3	10.2	3.6	3.7	---	---	3.0	6.0	3.2	2.50	4	30.0	34.6	26.4	27 0	4.8
19.0	15.1	13.0	10.9	14.4	12.9	10.9	7.6	6.7	3.1	7.1	11.6	3.9	4.9	2.0	4.3	3.3	6.6	3.4	3.35	2	32.0	35.4	30.3	28.4	5.0
19.3	15.0	13.0	11.0	13.9	13.3	11.3	7.7	6.7	3.2	8.0	12.3	3.9	5.3	2.4	4.7	3.4	6.2	3.2	3.25	3.5	31.4	36.0	28.7	28.7	5.1
17.7	13.4	12.3	10.0	12.0	11.6	9.7	7.3	6.8	3.0	6.6	11.2	4.1	4.6	2.5	4.5	3.3	5.8	3.5	2.75	3	29.1	33.0	25.6	27.0	5.0
17.6	15.8	12.6	10.7	14.3	14.0	10.8	7.4	6.6	3.1	5.6	11.5	4.0	5.1	2.1	5.0	3.3	6.1	2.9	3.15	1.5	31.2	36.3	27.4	28.5	4.9
18.7	14.1	12.5	11.0	13.8	13.6	11.0	7.0	6.5	3.0	7.1	11.2	4.1	4.6	2.4	5.0	3.4	6.6	3.7	3.00	2	30.0	33.0	27.5	28.7	5.6
19.4	14.8	12.5	11.1	14.3	13.3	11.3	6.8	6.2	2.8	7.7	11.4	3.9	4.6	2.4	5.2	3.3	5.7	3.4	3.15	4.5	31.7	35.6	29.0	29.0	4.7
18.3	14.9	12.4	10.0	13.1	12.8	10.3	7.0	6.4	2.5	7.5	11.1	4.0	4.4	2.3	4.7	3.1	6.0	3.4	2.70	4	30.0	34.0	27.0	29.9	5.1
17.8	14.2	12.5	10.2	13.1	12.7	9.6	7.4	6.8	3.0	6.6	12.0	3.9	4.5	2.5	4.5	3.2	6.6	3.3	3.00	1	28.6	34.0	26.2	28.2	5.1
17.4	14.1	11.5	9.2	13.4	12.6	10.1	7.4	6.6	3.0	6.0	11.0	3.7	4.8	1.7	4.8	3.7	6.2	3.3	2.85	4	27.4	32.3	26.0	27.0	5.3
18.7	14.9	12.2	10.1	13.0	12.8	10.1	7.0	6.3	2.8	7.4	11.6	3.8	4.3	2.4	3.8	3.0	5.6	3.4	2.95	4	30.5	34.6	27.0	28.3	4.3
17.8	14.7	12.3	9.8	13.2	12.7	10.3	7.6	7.4	3.2	5.8	11.6	4.2	4.8	2.0	4.3	3.5	6.4	3.0	3.25	4	29.4	35.0	25.8	28.4	5.4
17.6	15.4	12.2	9.8	13.7	14.0	11.0	7.6	6.3	3.1	---	----	4.1	5.0	.5	4.7	3.2	6.5	3.3	2.75	4	29.3	37.4	25.7	29.5	5.2
17.6	14.8	12.5	11.0	13.9	12.8	10.7	7.6	6.8	2.4	6.5	12.0	4.1	4.9	3.0	4.6	3.3	5.3	3.6	3.15	3	32.6	36.0	29.0	27.5	4.7
17.3	15.3	13.0	10.1	14.2	13.0	10.7	7.5	6.9	3.0	6.9	11.9	3.7	4.9	2.1	4.6	3.2	5.6	3.5	3.05	4	31.0	35.0	28.7	27.7	4.9
17.7	14.3	11.5	10.3	13.8	13.0	11.1	7.0	6.3	3.1	6.8	11.4	4.0	4.6	2.0	4.8	3.3	4.8	3.3	3.20	1.5	30.0	32.8	26.5	27.0	4.5
18.3	15.1	12.4	10.0	13.9	13.0	10.8	7.6	7.2	2.8	7.2	11.6	4.3	5.0	2.1	5.5	3.2	6.2	3.3	3.00	4	31.2	35.8	28.0	29.5	4.7
20.0	15.6	13.0	11.3	14.3	13.7	14.3?	6.8	6.2	2.5	8.0	11.6	4.3	4.7	1.8	5.0	3.2	6.2	4.0	3.05	4	33.5	37.2	29.8	30.4	4.9
19.4	15.5	12.3	11.5	14.5	13.6	11.5	8.0	7.2	3.0	7.6	12.0	4.4	5.2	2.5	5.5	3.2	5.9	4.0	3.20	2	32.0	36.8	28.7	31.5	4.7
18.9	14.8	12.8	10.7	14.2	13.1	11.1	7.3	6.5	3.1	7.5	11.6	4.2	5.0	1.9	5.0	3.4	6.3	3.5	3.35	3	30.3	36.0	27.9	29.4	5.2
18.7	14.5	12.7	10.3	13.9	12.7	10.2	7.0	6.2	2.7	6.2	11.2	4.2	5.0	.5	5.0	3.8	7.0	3.2	2.95	3	30.7	35.0	27.8	28.8	5.7

TABLE II.—*Men of Taytay*—

Species of individual. The true species is in parenthesis, except where no parenthesis is given.	No.	Clinical No.	Absolute lower leg length.	Relative lower leg length.	Absolute upper leg length.	Relative upper leg length.	Absolute hand length.	Relative hand length.	Absolute fore-arm length.	Relative fore-arm length.	Absolute upper arm length.
Australoid	1	8	-----	------	-----	------	-----	------	-----	------	-----
Alpine (Iberian)	2	293	-----	------	-----	------	-----	------	-----	------	-----
Cro-Magnon	3	366	-----	------	-----	------	-----	------	-----	------	-----
Blend Primitive	4	370	-----	------	-----	------	-----	------	-----	------	-----
Australoid	5	------	-----	------	-----	------	-----	------	-----	------	-----
Blend	6	755	-----	------	-----	------	-----	------	-----	------	-----
Blend Aipine	7	------	-----	------	-----	------	-----	------	-----	------	-----
B. B. B	8	353	-----	------	-----	------	-----	------	-----	------	-----
Australoid	9	390	-----	------	-----	------	-----	------	-----	------	-----
Blend (B. B. B.)	10	398	39.0	23.19	40.7	24.2	18.3	10.88	24.9	14.80	32.8
Primitive Australoid	11	384	35.3	23.45	34.0	22.59	16.0	10.63	23.3	15.48	30.5
Blend (Iberian)	12	------	36.9	21.81	43.0	25.41	19.3	11.41	27.9	16.48	30.3
Blend (Primitive)	13	385	-----	------	37.7	24.51	16.3	10.60	22.0	14.30	31.9
Blend (Iberian)	14	------	40.6	25.11	41.3	25.54	17.8	11.01	21.4	13.23	34.1
Blend Primitive?	15	405	34.2	22.48	39.1	25.71	16.1	10.58	20.3	13.35	31.6
Blend (Primitive)	16	380	38.5	25.07	37.2	24.21	15.9	10.35	23.1	15.03	32.5
Australoid?	17	390	35.6	21.81	36.2	22.18	16.8	10.29	25.7	15.75	29.5
Blend (Iberian)	18	376	34.7	22.72	33.2	21.74	14.8	9.69	21.1	13.81	29.5
Alpine (Iberian)	19	404	34.5	22.77	40.3	26.61	16.5	10.89	20.8	13.73	33.7
Blend (Adriatic)	20	315	39.5	23.45	41.4	24.59	17.2	10.21	25.8	15.32	36.0
Australoid	21	158	33.0	20.79	43.0	26.97	17.0	10.66	25.0	15.68	31.3
Blend	22	373	37.7	23.44	39.7	24.68	18.7	11.62	24.9	15.48	30.6
B. B. B.? (Alpine)	23	237	38.5	23.33	42.5	25.75	16.9	10.24	23.8	14.42	30.8
Primitive	24	303	30.7	20.87	39.2	26.65	15.7	10.67	21.3	14.48	30.0
Iberian	25	421	39.1	24.33	42.6	26.51	16.7	10.39	22.4	13.93	36.6
Blend	26	22	35.5	23.17	37.8	24.67	17.0	11.10	21.7	14.16	34.6
Australoid	27	238	38.2	23.38	40.7	24.98	17.6	10.77	22.7	13.89	31.8
Modified Primitive	28	------	36.5	22.97	37.5	23.59	18.0	11.32	21.7	13.65	31.6
Australoid	29	------	35.0	22.47	39.4	25.30	16.4	10.53	22.3	14.32	30.5
Blend	30	------	34.6	23.00	36.6	24.33	17.0	13.03	19.6	13.03	30.0
Primitive (Alpine?)	31	432	34.7	22.57	38.6	25.13	17.2	11.18	25.3	16.46	30.0
Blend (Iberian)	32	438	37.8	23.72	41.3	25.92	17.0	10.67	23.0	14.43	33.0
Iberian	33	431	40.6	23.98	43.6	25.75	20.6	15.71	23.8	14.05	34.1
Australoid	34	------	37.9	23.67	38.5	24.04	18.2	11.36	21.8	13.61	33.8
Iberian	35	430	37.0	22.63	41.0	25.07	17.8	10.88	22.0	13.45	33.1
Adriatic (Modified Primitive).	36	------	38.1	23.16	42.8	26.01	16.7	10.15	19.8	12.03	35.0
Australoid	37	169	38.7	24.12	38.8	24.82	17.1	10.94	23.8	15.22	35.1
Blend (Iberian)	38	448	39.2	24.74	40.9	25.82	18.0	11.36	25.4	16.03	32.3
Australoid	39	------	38.1	24.25	39.2	24.95	18.0	11.45	23.7	15.08	31.3
Blend	40	------	37.3	23.89	38.1	24.40	17.6	11.27	20.4	13.45	32.1
Blend (Iberian)	41	467	37.9	23.03	43.8	26.62	18.1	11.00	24.9	15.13	32.1
Blend (Iberian?)	42	469	36.4	23.41	38.6	24.82	18.6	11.96	21.9	14.08	34.9
Iberian?	43	-----	38.7	23.62	39.8	24.29	18.2	11.11	24.8	15.14	33.0
Australoid	44	395	36.5	23.50	35.8	23.05	19.2	12.36	24.4	15.71	31.2
Modified Primitive	45	------	36.7	23.76	37.7	24.41	16.8	10.88	21.7	14.05	33.0
Blend (Primitive)	46	------	33.0	21.71	38.0	25.00	18.0	11.11	22.2	14.60	32.0
Iberian	47	------	34.4	22.26	36.4	23.56	16.3	10.55	24.4	15.79	28.8

indices and relative factors—Continued.

Relative upper arm length.	Pubis to umbilicus.	Umbilicus to sternum.	Omphalic index.	Total head height.	Upper face height.	Cephalic index.	Nasal index.	Ear type.	Physiognomic face index.	Morphologic face index.
------	------	------	------	------	------	80.2	102.5	Primitive, Iberian A	89.8	67.3
------	------	------	------	------	------	84.94	67.30	Iberian A, Iberian D	75.1	77.7
------	------	------	------	------	------	81.90	104.65	Mixed, Primitive	76.5	80.5
------	------	------	------	------	------	82.85	93.02	Iberian A, Primitive	------	------
------	------	------	------	------	------	77.24	104.65	B. B. B., Iberian D	71.1	82.7
------	------	------	------	------	------	80.22	83.67	Iberian B., mixed	78.2	80.4
------	------	------	------	------	------	88.3	80.00	Odd type, mixed	68.8	84.6
------	------	------	------	------	------	82.5	66.6	B. B. B	71.5	89.0
------	------	------	------	------	------	75.90	91.5	Alpine, Primitive	71.6	81.9
19.50	17.0	35.0	48.57	23.7	13.1	84.23	74.0	Iberian A, Iberian D	74.4	75.7
20.26	12.5	32.6	38.34	24.5	14.7	82.0	100.0	Odd type, Primitive	72.3	74.7
17.91	18.7	33.3	56.15	28.2	16.2	79.50	77.77	Iberian D, B. B. B	79.7	84.5
20.74	13.0	31.0	41.94	25.8	14.9	86.20	82.00	Odd type, Primitive	73.8	85.8
21.09	13.0	32.8	39.03	23.0	11.5	84.15	74.0	Iberian B and C	70.7	83.3
20.78	13.2	34.0	38.82	24.1	13.7	86.74	95.65	Alpine, B. B. B., mixed	80.3	72.7
21.15	6.8	33.4	20.36	24.3	13.7	79.40	80.40	Odd type, Iberian D, B. B. B., mixed.	73.9	77.9
18.08	13.5	37.5	36.00	22.7	11.1	76.1	87.7	Alpine, Primitive	71.4	82.8
19.31	19.0	33.0	57.58	25.4	13.6	79.5	72.0	Iberian A	69.8	86.1
22.24	11.1	29.9	37.12	24.8	12.5	84.40	71.42	Iberian D	69.8	89.7
21.38	12.8	32.8	39.03	24.0	12.9	85.24	89.36	Iberian D, odd type	76.4	77.6
19.63	11.0	34.5	31.88	24.8	13.4	80.43	100.0	Mixed	73.3	84.4
19.02	14.8	33.6	44.04	22.0	11.8	83.07	86.95	Odd type, mixed	76.4	74.1
18.66	13.4	36.1	37.12	22.6	10.6	83.06	68.63	Iberian D, odd type	71.7	85.7
20.39	12.5	33.8	36.98	20.1	9.1	83.33	95.25	Iberian C, Primitive	70.4	80.8
22.78	13.4	29.4	45.57	21.2	10.2	77.66	73.90	Mixed, Alpine, Primitive, Iberian C.	76.8	82.7
22.58	14.5	32.5	44.61	22.9	11.9	79.03	86.00	Primitive, B. B. B	76.5	80.2
19.46	12.1	34.0	35.58	24.8	13.2	78.75	91.30	Mixed, B. B. B	67.8	87.1
19.85	15.0	35.1	46.15	23.4	12.3	92.48	85.41	Mixed	79.3	78.1
19.65	16.5	29.5	55.93	20.7	9.3	77.41	91.30	Mixed, Iberian A, Primitive	73.9	83.8
19.95	14.0	34.3	40.82	24.4	13.4	80.11	80.43	Alpine, Primitive	75.0	81.4
19.53	13.1	33.8	38.75	21.2	10.1	93.37	82.97	Mixed, Primitive	74.6	80.4
20.71	11.1	33.3	33.33	22.0	12.6	87.57	81.25	Iberian B	83.0	66.1
20.08	14.5	34.0	42.64	22.3	10.1	72.76	73.58	Iberian, mixed A and C	67.6	88.4
21.11	13.2	33.0	40.00	22.9	11.7	81.76	95.55	Modified Iberian B, and C, odd type.	79.6	81.7
20.24	14.3	37.4	38.23	23.8	11.8	77.43	80.00	Iberian A, Primitive	67.5	88.8
21.27	15.5	34.0	45.58	24.5	13.5	88.30	102.50	Malay, Chinese	75.2	78.5
22.45	13.2	31.8	41.50	22.1	11.5	79.12	95.23	Iberian B, mixed, Iberian C	77.9	76.8
20.39	11.0	30.6	35.94	20.4	9.8	82.58	84.00	Iberian D	71.9	80.9
19.92	14.6	33.4	43.71	21.3	11.0	80.00	92.60	Alpine	71.5	78.6
20.56	16.1	32.6	49.38	22.1	11.0	81.31	84.09	Modified Primitive	73.9	79.8
19.51	11.4	38.4	29.68	21.8	10.6	81.32	78.84	Iberian C and B	77.7	80.0
22.44	14.3	29.3	48.80	22.2	11.0	79.55	78.84	Odd type, B. B. B., Iberian D	70.1	82.3
20.14	16.7	31.6	52.84	24.5	12.7	78.33	81.25	Modified Iberian C	77.9	85.5
20.09	10.1	38.6	26.16	21.9	11.5	78.88	97.67	Iberian D, Iberian C	86.7	72.2
21.37	12.2	32.8	37.19	24.4	13.4	90.64	93.33	Odd type, Primitive	71.2	82.0
21.05	14.8	33.0	44.84	22.5	11.2	86.36	93.02	Primitive, Iberian C	75.1	84.9
18.64	12.7	34.2	37.13	22.0	11.4	76.16	72.54	Iberian A	82.3	73.1

TABLE II.—*Men of Taytay*—

Species of individual. The true species is in parenthesis, except where no parenthesis is given.	No.	Clinical No.	Absolute lower leg length.	Relative lower leg length.	Absolute upper leg length.	Relative upper leg length.	Absolute hand length.	Relative hand length.	Absolute fore-arm length.	Relative fore-arm length.	Absolute upper arm length.
Australoid	48	484	34.4	22.33	38.6	25.06	16.2	10.52	19.5	12.26	33.3
Blend (Adriatic)	49	486	40.7	24.35	38.8	23.22	21.0	12.57	24.0	14.36	30.8
Iberian?	50	17	37.7	23.80	40.0	25.25	18.0	11.36	24.5	15.46	33.5
Blend (Modified Primitive).	51	465	35.7	22.66	40.7	25.84	16.7	10.60	21.0	13.33	34.4
Blend (Iberian)	52	------	36.9	23.14	38.8	24.34	16.9	10.60	23.0	14.42	28.8
Cro-Magnon	53	------	41.0	24.07	47.1	27.59	20.3	11.89	24.3	14.23	33.9
Cro-Magnon?	54	------	40.1	24.04	40.0	23.98	19.5	11.68	23.3	13.96	34.7
Cro-Magnon	55	477	41.3	24.51	42.6	25.22	18.0	10.68	26.5	15.72	33.5
Blend	56	481	37.8	23.42	41.1	25.46	17.3	10.72	22.5	13.94	32.5
Blend (Iberian)	57	471	36.2	22.94	39.5	25.03	18.0	11.39	23.2	14.69	30.0
Blend (Iberian)	58	234	37.4	22.57	40.1	24.20	18.8	11.34	24.2	14.60	31.5
Blend (Modified Primitive).	59	489	36.0	23.98	37.0	24.10	18.1	11.74	21.9	14.21	32.6
Blend (Iberian)	60	488	41.0	24.36	39.8	23.64	19.0	11.29	24.6	14.61	35.9
Blend (Iberian)	61	485	39.0	24.21	39.9	24.15	20.2	12.22	23.0	13.92	31.8
Blend	62	482	39.6	23.71	42.0	25.14	17.4	14.19	26.4	15.80	32.0
Alpine	63	492	36.8	22.39	42.4	25.80	18.6	11.32	22.4	13.63	34.6
Blend	64	466	38.2	23.72	39.7	24.65	17.8	11.05	23.6	14.65	32.4
Iberian	65	514	37.0	23.03	40.7	25.34	17.2	10.70	23.6	14.69	32.8
Iberian	66	501	39.1	23.84	40.0	24.39	18.9	11.52	22.6	13.78	33.6
Blend (Iberian)	67	988	35.4	22.53	40.3	25.65	17.1	10.88	21.2	13.49	34.6
Australoid	68	462	36.2	23.02	37.6	23.98	16.7	10.62	21.9	13.93	31.4
Blend	69	------	------	------	------	------	------	------	------	------	------
Blend	70	------	34.1	21.97	38.9	25.06	17.8	11.46	19.6	12.62	32.4
Blend (Iberian)	71	505	37.8	23.71	41.4	25.97	18.4	11.54	21.4	13.42	33.1
Blend	72	526	36.9	24.30	36.0	23.71	14.0	8.56	22.8	15.01	33.2
Blend (Iberian)	73	------	38.0	23.27	40.2	24.61	18.1	11.08	24.4	14.94	32.3
Cro-Magnon	74	535	38.1	22.45	46.6	27.46	20.4	12.02	26.7	15.73	34.1
Blend (Iberian)	75	521	39.0	23.11	41.3	24.48	16.8	9.60	23.1	13.69	33.3
Blend (Alpine)	76	528	35.8	22.80	40.8	25.98	17.0	10.82	21.5	13.69	30.0
Blend (Alpine)	77	503	37.5	23.96	39.7	25.36	16.7	10.67	22.2	14.18	31.1
Modified Primitive	78	836	36.3	23.12	37.0	23.56	16.3	10.38	21.6	13.75	34.1
Australoid	79	529	35.7	23.51	33.3	21.93	16.4	10.80	21.7	14.29	30.3
Iberian	80	522	33.3	21.15	40.8	25.92	18.1	11.49	22.7	14.42	31.5
Iberian	81	520	37.7	23.45	37.3	23.26	16.6	10.35	21.7	13.53	33.9
Blend (Alpine)	82	537	38.7	23.94	39.0	24.13	18.4	11.38	22.7	14.04	32.9
Blend	83	225	36.6	22.81	43.9	27.36	16.2	10.09	23.3	14.52	31.4
Iberian	84	703	33.5	21.47	40.8	26.15	20.2	12.94	20.9	13.39	31.6
Australoid	85	------	39.0	23.99	37.5	23.07	16.6	10.21	20.8	12.80	34.0
Australoid	86	566	37.6	23.61	39.2	24.62	16.8	10.55	23.7	14.88	32.9
Modified Primitive	87	------	38.0	24.35	38.4	24.61	17.8	11.41	23.6	15.12	33.1
Alpine	88	180	37.5	23.88	38.8	24.71	18.2	11.59	24.6	15.66	33.0
Australoid (Typical?)	89	564	37.3	23.81	36.1	23.02	19.4	12.37	21.6	13.77	30.6
Cro-Magnon?	90	560	42.2	24.72	42.4	24.83	21.5	12.59	22.5	13.18	36.5
Blend (Primitive)	91	551	33.8	22.48	38.2	25.33	17.7	11.73	22.7	15.05	34.1
Blend (Iberian)	92	556	33.9	22.27	39.6	26.01	17.8	11.69	21.0	13.79	31.6
Blend	93	558	37.9	23.36	41.4	25.52	18.7	11.52	23.7	14.61	31.4

indices and relative factors—Continued.

Relative upper arm length.	Pubis to umbilicus.	Umbilicus to sternum.	Omphalic index.	Total head height.	Upper face height.	Cephalic index.	Nasal index.	Ear type.	Physiognomic face index.	Morphologic face index.
21.62	13.5	34.1	39.58	18.9	9.6	79.77	93.02	Primitive, Iberian C	76.1	70.9
18.43	16.0	34.6	46.24	21.8	10.7	87.77	89.13	Odd type, Iberian C, B. B. B	75.1	79.8
21.15	14.0	33.1	42.29	26.9	14.9	78.60	79.59	Iberian C, B. B. B., Iberian D (Cro-Magon).	73.6	85.7
21.84	12.7	34.2	37.13	22.5	12.2	86.44	92.10	Primitive	78.6	73.5
18.06	13.5	35.5	38.03	21.4	8.7	84.78	84.46	Iberian C	71.9	90.0
19.85	14.0	33.8	41.42	23.4	11.6	77.30	82.22	Iberian C	72.1	89.3
20.80	14.7	35.2	41.81	24.0	12.0	79.80	100.00	Mixed, Iberian D, Primitive, Iberian A and C.	74.7	81.0
19.88	15.6	33.2	46.98	22.3	10.0	82.90	95.30	Odd type, Primitive, Iberian D	73.4	86.9
20.13	14.0	34.8	40.46	21.2	10.8	83.33	93.00	Iberian A, odd type	77.6	78.7
19.01	12.7	35.8	35.49	21.8	9.8	83.15	82.23	Iberian B	71.8	92.3
19.07	15.9	35.3	43.04	23.9	11.7	87.29	80.39	Iberian C	67.8	89.0
21.15	12.6	32.2	39.13	22.3	11.4	88.70	100.00	Iberian D, mixed	74.4	81.3
21.33	17.3	33.8	51.18	22.8	11.4	81.53	90.00	Iberian D, Iberian B	77.3	76.0
19.24	18.5	30.7	60.26	21.6	10.4	79.36	84.31	Iberian B and C	76.2	75.6
19.16	16.7	34.3	48.69	20.7	10.2	85.31	84.09	Modified Primitive, Alpine	75.9	73.9
21.06	14.0	32.4	46.29	24.8	13.5	85.14	66.66	Odd type, Iberian B and C	77.9	76.3
20.12	14.2	33.0	43.03	22.2	10.4	80.42	84.00	Iberian B, Primitive	70.4	86.7
20.48	12.2	33.0	36.96	26.3	15.0	76.21	78.72	Iberian C, Iberian D (Cro-Magnon, (B. B. B.)	68.3	83.0
20.48	12.5	37.3	33.51	23.0	11.5	77.27	85.41	Iberian, mixed	69.2	80.9
22.02	12.0	31.3	38.33	22.1	12.2	85.54	86.95	Iberian D	85.2	71.2
19.97	14.2	35.8	39.66	19.7	10.2	78.08	100.00	Primitive	80.2	73.0
------	------	------	------	------	------	80.32	86.54	Primitive, B. B. B	72.2	83.9
20.87	12.3	33.9	36.28	23.4	11.8	79.70	82.00	Mixed, Primitive	70.3	87.1
20.76	12.3	33.9	36.28	20.7	9.3	84.83	82.35	Iberian D	67.0	89.0
21.86	13.4	31.0	43.22	22.6	------	86.14	86.04	Iberian C, Alpine, Primitive	------	------
19.77	17.3	32.2	53.73	22.8	11.5	80.10	82.97	Mixed, Iberian B and C	77.5	81.9
20.09	16.5	32.0	51.56	25.4	12.9	76.16	89.13	Modified Iberian A, Alpine	67.3	88.0
19.73	14.9	35.5	41.97	23.7	11.7	85.10	86.00	Iberian A	80.6	80.0
19.10	13.1	30.4	43.09	21.0	9.8	81.96	72.34	Iberian C, Primitive	75.0	79.4
19.87	13.7	33.3	41.14	21.8	11.1	81.71	76.00	Iberian A, Primitive, odd type	78.8	77.5
21.71	11.8	33.5	35.22	26.0	15.0	89.14	95.00	Primitive	75.0	78.0
19.96	13.0	33.4	38.92	21.8	9.8	76.47	85.41	Iberian B, Alpine, Primitive	67.9	93.0
20.01	14.5	33.2	43.67	25.2	13.7	70.50	79.19	Iberian D, mixed, Iberian A	69.3	80.9
21.14	14.8	33.1	44.71	24.6	13.6	75.00	78.43	Iberian B, Primitive, Iberian D	75.4	79.7
20.48	16.6	34.5	48.11	30.6	12.5	84.23	75.47	B. B. B	69.8	91.2
19.57	14.8	33.0	44.84	23.4	11.3	80.11	88.37	Iberian, mixed	70.4	88.9
20.25	16.5	31.6	52.21	22.6	10.3	77.59	81.63	Iberian D	73.1	90.4
20.92	13.0	33.1	39.27	23.5	11.0	76.14	93.75	Iberian C, Primitive	65.7	91.9
20.66	14.6	35.5	41.12	------	------	76.59	110.00	Iberian C, Primitive	84.2	76.9
21.21	14.8	31.4	47.13	21.5	------	89.15	84.44	Primitive, Alpine	------	------
21.01	14.1	33.7	41.83	21.2	9.2	86.85	74.50	Primitive, Iberian C	71.0	85.7
19.51	14.3	30.2	47.35	22.2	11.6	73.68	102.22	Odd type	84.9	75.1
21.38	15.1	34.2	44.15	21.9	10.6	78.57	81.81	Iberian C	72.7	86.2
22.61	13.3	30.3	43.89	21.8	11.8	85.00	88.09	B. B. B., Iberian A	75.8	75.7
20.76	12.5	31.1	40.19	22.7	11.7	85.29	83.33	Iberian A?	69.5	81.4
19.35	11.3	33.2	34.03	23.7	12.4	83.99	79.16	Iberian B, Primitive	79.8	81.8

TABLE II.—*Men of Taytay*—

Species of individual. The true species is in parenthesis, except where no parenthesis is given.	No.	Clinical No.	Absolute lower leg length.	Relative lower leg length.	Absolute upper leg length.	Relative upper leg length.	Absolute hand length.	Relative hand length.	Absolute fore-arm length.	Relative fore-arm length.	Absolute upper arm length.
Blend	94	474	32.4	21.81	35.6	23.97	16.4	11.04	20.4	13.73	29.4
Australoid	95	580	37.0	23.44	39.0	24.71	16.4	10.39	21.2	13.43	32.4
Australoid	96	------	37.6	23.36	35.6	22.12	17.8	11.06	21.9	13.61	31.7
Blend (Australoid)	97	581	37.9	23.52	39.8	24.31	18.0	10.99	25.0	15.27	33.0
Australoid	98	------	35.8	22.73	38.2	24 25	16.9	10.73	21.5	13.65	33.1
Australoid	99	176	37.3	23.78	39.6	25.25	18.7	11.92	23.0	14.66	33.9
Blend	100	584	36.5	23.44	37.3	23.95	18.6	11.94	21.6	13.87	31.5
Blend (Modified Primitive.)	101	596	39.3	24.1	38.0	23.3	17.3	10.6	22.0	13.5	32.0
Blend	102	589	38.1	23.2	42.2	25.7	18.8	11.4	26.5	16.1	35.5
Cro-Magnon	103	616	40.6	24.3	40.6	24.3	19.5	11.6	24.5	14.7	32.6
Blend (Iberian)	104	63	34.8	22.2	40.3	25.7	16.3	10.3	20.7	13.2	34.0
Blend	105	603	37.0	23.7	38.2	24.5	17.8	11.4	22.2	14.2	33.0
Blend	106	------	39.1	24.5	39.8	24.9	18.3	11.4	22.8	14.3	33.2
Blend	107	104	37.2	24.3	37.7	24.6	17.2	11.2	20.5	13.4	33.0
Blend	108	------	38.9	24.4	39.5	24.7	18.2	11.4	22.6	14.1	30.5
Alpine (Iberian)	109	653	38.9	23.9	38.9	23.9	17.8	10.9	22.7	13.9	34.8
Primitive?	110	------	35.5	23.7	31.1	20.7	15.4	10.3	20.6	13.7	31.3
Blend	111	638	39.4	24.7	38.3	24.0	17.0	10.7	23.9	15.0	30.1
Blend	112	------	37.3	24.6	36.1	23.8	17.3	11.4	19.9	13.1	30.0
Australoid	113	628	36.5	23.5	38.2	24.6	18.3	11.8	21.8	14.0	31.2
Cro-Magnon	114	656	41.3	24.8	42.5	25.4	20.2	12.1	23.5	14.0	35.5
Blend	115	639	34.5	21.9	36.5	23.2	16.4	10.4	22.6	14.3	30.7
Blend (Primitive)	116	631	35.1	23.8	38.0	25.8	14.7	10.0	20.8	14.1	(?)
Blend	117	------	59.8	24.5	38.9	23.9	18.8	11.6	22.2	13.6	33.8
Blend	118	316	39.8	24.4	40.2	24.6	16.7	10.2	24.7	15.1	31 0
Iberian	129	------	39.1	25.0	37.8	24.1	17.8	11.3	23.3	14.9	31.6
Blend (Iberian)	120	654	36.3	23.7	38.4	25.1	17.2	11.2	24.9	16.2	29.1
Blend	121	662	40.4	24.5	42.3	25.7	19.3	11.7	26.7	16.2	34.7
Modified Primitive	122	657	37.5	23.3	36.5	22.6	19.1	11.8	25.0	15.5	32.9
Blend	123	651	39.1	23.9	41.7	25.5	17.6	10.7	24.0	14.6	32.5
Australoid	124	650	35.8	22.9	37.5	24.0	16.0	10.2	21.4	13.7	30.6
Blend (Iberian)	125	609	34.0	20.7	43.2	26.2	18.2	11.0	25.2	15.3	34.7
Blend (Iberian)	126	692	40.1	24.1	42.5	25.5	19.0	11.4	25.7	15.4	33.5
Australoid	127	------	37.9	24.6	35.0	22.8	14.8	9.6	21.5	14.0	32.5
Blend	128	708	37.9	23.8	39.0	24.6	17.3	10.9	23.4	14.7	32.5
Australoid	129	686	35.9	23.0	40.0	25.6	15.8	10.1	23.2	14.9	32.0
Cro-Magnon	130	710	40.4	24.1	40.0	23.8	18.0	10.7	23.5	14.0	33.0
Alphine (Iberian?)	131	730	37.8	23.9	36.8	23.3	17.2	10.9	21.9	13.8	33.5
Blend (Modified Primitive).	132	754	37.2	23.8	39.5	25.2	17.6	11.2	21.7	13.8	34.3
Blend (Iberian)	133	726	39.2	24.5	40.0	25.0	18.0	11.2	23.4	14.6	33.6
Blend (B. B. B.)	134	757	40.9	27.2	41.2	24.4	18.3	10.8	27.4	16.2	34.0
Australoid	135	758	38.3	23.7	39.9	24.6	18.1	11.2	23.2	14.3	36.4
Australoid	136	760	35.6	23.8	35.8	23.9	14.8	9.9	22.6	15.1	32.9
Blend (Primitive)	137	761	33.4	22.9	36.3	24.9	18.2	12.5	18.6	12.7	29.4
Iberian	138	756	38.7	24.4	38.8	24.5	18.0	11.3	22.8	14.4	33.0
Blend	139	------	34.3	.21.9	36.9	23.5	15.5	9.8	23.3	14.8	33.5
Australoid	140	------	40.4	25.1	38.7	24.0	18.2	11.3	21.6	13.4	35.0
Iberian	141	------	38.8	23.3	40.5	24.3	17.4	10.4	24.1	14.4	34.0

indices and relative factors—Continued.

Relative upper arm length.	Pubis to umbilicus.	Umbilicus to sternum.	Omphalic index.	Total head height.	Upper face height.	Cephalic index.	Nasal index.	Ear type.	Physiognomic face index.	Morphologic face index.
19.79	13.6	32.0	42.50	23.1	12.1	83.05	80.39	Iberian C, Primitive	69.5	81.4
20.53	15.0	34.3	43.73	22.5	11.5	77.00	95.23	Iberian B, Iberian C	71.4	81.4
19.70	16.8	34.3	48.97	24.6	12.8	81.72	97.61	Primitive, Alpine	67.6	85.5
20.15	15.8	30.7	51.46	23.2	11.3	81.28	91.48	Iberian C, Alpine	75.6	83.2
21.01	17.4	32.2	54.31	23.7	12.4	82.60	97.67	Primitive, odd type, mixed	76.5	80.7
21.61	13.2	33.6	39.28	19.8	8.7	81.50	95.30	Mixed	76.8	81.5
20.23	12.8	31.7	40.37	22.7	11.3	79.67	81.25	Iberian A, Iberian D, mixed	70.2	83.1
19.6	14.1	34.8	40.5	22.3	11.0	85.10	89.79	Mixed	81.2	78.9
21.6	15.0	33.0	45.4	22.8	11.8	83.88	77.08	Mixed, subnothern	77.9	79.7
19.5	13.5	33.8	39.9	25.4	13.7	75.77	97.61	Iberian C	73.2	83.5
21.7	15.6	30.3	51.4	23.6	12.6	79.14	88.09	Iberian C	74.0	80.2
21.2	16.1	31.0	51.8	23.4	11.8	84.04	86.00	Primitive odd type	70.4	84.0
20.8	14.2	32.8	43.2	20.9	------	83.14	73.91	Mixed, Iberian, B. B. B	------	------
21.5	13.7	33.3	41.1	21.4	10.7	84.09	88.37	Mixed, Iberian A	77.4	78.1
19.1	12.4	30.6	40.5	24.1	12.2	84.40	83.33	Iberian A, B. B. B	67.6	86.2
21.4	14.2	31.4	45.2	22.0	10.9	94.28	60.37	Iberian C	76.9	75.5
20.9	16.0	28.3	56.5	23.3	12.6	88.95	89.13	Alpine, Primitive	80.4	74.3
18.9	15.0	30.8	48.7	24.6	12.8	82.41	86.95	Iberian B, mixed, Alpine	74.1	85.5
19.7	13.0	32.3	40.2	22.6	12.1	78.02	86.36	Primitive, subnothern	74.4	80.1
20.0	12.2	37.2	32.8	22.5	------	80.32	95.45	Odd type, Primitive	------	------
21.2	13.6	32.0	42.5	23.4	12.1	75.12	100.00	Mixed, subnothern	69.9	83.7
19.5	17.3	31.2	55.4	22.8	12.5	81.76	80.43	Modified Iberian A, Primitive	75.5	75.7
-------	12.6	30.0	42.0	20.9	9.8	87.05	80.00	Mixed, Primitive	78.3	85.3
20.8	13.8	33.0	41.8	23.4	10.9	83.88	79.62	Odd type, mixed, Primitive	71.8	92.5
19.0	14.2	31.6	44.9	21.2	10.2	86.51	81.81	Iberian C, mixed	79.0	78.5
20.2	15.2	31.5	48.2	22.4	10.3	77.96	72.00	Iberian A	69.1	91.6
18.9	13.7	30.1	44.0	22.7	10.6	81.48	73.58	Iberian D, mixed	69.6	85.2
21.1	13.3	33.9	39.2	21.9	9.9	85.63	75.47	Odd type Primitive	67.6	86.9
20.4	16.1	34.0	47.3	23.2	11.9	89.41	87.50	Mixed, odd type, subnothern	77.5	81.8
19.8	15.8	32.5	48.6	23.5	11.9	88.57	82.69	Mixed, Iberian A, (Iberian D,) B. B. B.	70.1	84.0
19.6	14.4	33.2	43.3	23.7	12.0	79.89	93.61	Odd type, mixed, Primitive	80.4	83.5
21.1	15.1	34.0	44.4	22.7	11.4	87.70	86.66	Iberian C	78.7	80.1
20.1	13.7	30.3	45.0	25.5	13.3	81.86	70.37	Iberian C	70.0	87.1
21.1	15.4	27.7	55.6	21.5	10.0	81.11	93.02	Mixed, subnothern	71.4	85.1
20.5	14.4	33.3	43.2	21.2	9.7	86.40	94.00	Mixed, odd type, Primitive	72.5	79.3
20.5	13.5	32.2	41.9	24.2	12.8	75.50	84.70	Iberian B and C, (Iberian D)	76.2	82.6
19.6	14.6	35.3	41.8	22.7	12.0	77.60	97.50	Iberian C, mixed	72.1	79.2
21.2	13.1	35.7	36.7	20.7	9.7	89.28	78.72	Iberian A and C	65.0	84.6
21.9	14.0	32.5	43.1	23.0	13.0	88.37	90.24	Mixed, Alphine	78.7	72.9
20.6	11.5	32.5	35.3	23.2	11.9	87.77	78.26	Iberian A	81.0	80.1
20.1	14.5	35.3	41.1	24.2	12.2	88.63	83.33	Mixed Primitive	72.9	85.7
22.5	16.0	34.2	46.7	23.6	12.6	83.33	97.72	B. B. B., mixed	71.2	79.9
22.0	13.0	(?)	-------	22.8	11.5	77.89	86.04	Iberian C, B, mixed	74.2	86.9
20.1	10.1	32.2	31.3	21.7	10.9	86.04	80.00	Odd type, mixed	79.1	81.1
20.8	14.9	31.7	47.0	19.8	8.8	79.03	77.27	Iberian C, odd type	72.2	84.6
21.3	14.3	35.7	40.0	21.1	9.1	79.27	84.09	Iberian A, mixed, Primitive	68.5	87.6
21.7	11.5	32.0	35.9	23.7	11.4	78.95	95.55	Iberian A, B, mixed	75.4	87.2
20.4	13.5	35.3	38.2	22.7	10.5	73.05	80.76	Mixed, odd type, Iberian A	71.3	89.0

TABLE II.—*Men of Taytay*—

Species of individual. The true species is in parenthesis, except where no parenthesis is given.	No.	Clinical No.	Absolute lower leg length.	Relative lower leg length.	Absolute upper leg length.	Relative upper leg length.	Absolute hand length.	Relative hand length.	Absolute fore-arm length.	Relative fore-arm length.	Absolute upper arm length.
Australoid	142	784	39.9	24.3	39.7	24.2	19.5	11.8	25.5	15.5	32.0
Australoid	143	775	40.3	25.2	39.1	24.4	17.5	10.9	23.8	14.9	33.2
Blend	144	800	38.4	23.8	41.2	25.6	17.5	10.8	23.1	14.3	36.2
Blend (Cro-Magnon)	145	801	39.2	22.9	42.0	24.5	22.0	12.8	23.0	13.4	30.5
Blend	146	816	36.8	23.5	39.4	25.1	17.0	10.8	23.2	14.8	28.6
Blend	147	825	38.3	23.6	41.2	25.5	18.5	10.8	25.0	15.4	29.6
Cro-Magnon	148	833	37.5	22.4	44.0	26.3	18.5	11.1	24.5	14.6	33.0
Alpine (Iberian)	149	875	36.2	22.9	40.0	25.3	16.7	10.5	18.3	11.5	33.8
Iberian	150	------	39.2	24.0	39.5	24.2	17.0	10.4	26.0	15.9	32.7
Blend	151	870	36.0	23.0	40.0	25.5	17.1	10.9	22.5	14.3	32.7
Blend (Iberian)	152	877	38.2	23.3	37.7	22.9	18.5	11.2	24.3	14.8	34.7
Australoid	153	------	37.2	23.2	39.0	24.3	17.0	10.6	23.5	14.7	29.7
Alpine (Iberian?)	154	885	38.2	23.4	38.6	23.7	17.6	10.8	24.6	15.1	32.5
Blend (Iberian?)	155	886	36.2	23.5	38.5	25.0	17.0	11.1	22.0	14.3	31.0
Blend	156	222	27.6	23.9	38.0	24.2	16.0	10.2	20.5	13.1	30.9
Blend (Primitive)	157	915	36.3	23.9	36.0	23.7	16.2	10.6	23.6	15.5	28.4
Blend (Primitive)	158	1,085	34.8	23.3	35.5	23.8	15.5	10.4	24.5	16.4	26.5
Alpine	159	921	37.4	23.0	34.7	21.3	17.4	10.7	24.0	14.7	29.0
Australoid	160	931	34.7	22.6	35.5	23.1	17.6	11.4	21.0	13.6	32.7
Blend (Iberian)	161	935	38.0	24.1	38.0	24.1	17.0	10.8	24.0	15.2	28.0
Blend (Primitive)	162	934	33.6	22.6	36.5	24.6	17.3	11.6	23.7	15.9	30.9
Iberian?	163	940	37.2	23.1	41.5	25.7	16.8	10.4	23.1	14.3	34.5
Iberian	164	129	35.9	22.5	40.2	25.2	17.8	11.1	23.4	14.6	34.1
Australoid	165	941	36.2	23.4	36.2	23.4	16.4	10.6	23.5	15.1	31.3
Alpine (Iberian?)	166	954	38.8	24.2	37.4	23.3	17.8	11.1	25.2	15.7	31.0
Cro-Magnon	167	471	37.3	22.5	39.5	23.9	17.4	10.5	27.3	16.5	33.5
Australoid	168	------	37.6	23.7	39.0	24.6	19.9	12.5	21.6	13.6	31.7
Blend (Australoid)	169	543	38.4	23.5	42.3	25.8	18.2	11.1	24.3	14.8	31.0
Blend	170	------	36.9	23.4	36.8	23.4	16.3	10.3	22.0	14.0	34.0
Blend (Iberian)	171	------	36.9	22.7	40.7	25.1	16.8	10.3	24.5	15.1	31.3
Blend	172	------	36.7	24.1	37.0	24.3	17.2	11.3	22.3	14.6	29.4
Blend	173	------	36.8	23.5	40.2	25.6	18.0	11.5	26.0	16.6	29.0
Blend	174	1,069	37.9	23.2	20.3	------	17.5	10.7	24.2	14.8	32.8
Blend	175	1,048	39.4	23.9	42.4	25.7	18.6	11.2	26.4	16.0	33.6
Alpine	176	------	35.5	22.9	39.2	25.3	16.7	10.8	22.5	14.5	31.3
Blend (Iberian)	177	1,077	33.2	22.3	36.0	24.1	16.1	10.8	23.4	15.7	28.0
Blend	178	360	------	------	------	------	------	------	------	------	------
Australoid	179	348	------	------	------	------	------	------	------	------	------
Blend	180	------	------	------	------	------	------	------	------	------	------
------	181	------	37.2	23.2	40.8	25.5	18.8	11.7	21.6	13.5	33.9
Cro-Magnon	182	1,086	37.3	22.3	42.7	25.5	17.6	10.5	24.4	14.5	33.0
Australoid	183	------	38.6	23.9	41.4	25.7	18.4	11.4	22.6	14.0	30.0

indices and relative factors—Continued.

Relative upper arm length.	Pubis to umbilicus.	Umbilicus to sternum.	Omphalic index.	Total head height.	Upper face height.	Cephalic index.	Nasal index.	Ear type.	Physiognomic face index.	Morphologic face index.
19.5	11.0	37.4	29.4	25.0	12.5	76.21	90.57	B. B. B., Alpine	64.3	91.2
20.7	13.6	34.4	39.5	22.8	12.0	77.29	89.36	Primitve, Iberian A	77.5	80.0
22.4	13.5	32.5	41.5	22.6	10.8	79.89	81.96	Primitive, odd type, Iberian A	77.4	81.9
17.8	15.7	37.0	42.4	24.0	12.0	81.10	87.70	Iberian, mixed	70.7	85.7
18.3	13.8	33.2	41.5	22.4	10.8	84.60	81.10	Primitive, mixed	76.6	82.2
18.3	13.2	32.2	40.9	24.9	12.6	79.80	75.91	Iberian D, odd type	75.2	87.8
19.8	14.5	35.0	41.4	24.2	13.4	81.20	100.00	Iberian D	74.6	75.0
21.4	16.6	31.8	52.2	21.5	10.0	85.87	62.00	Iberian A	71.9	85.1
20.0	13.2	32.1	41.1	24.2	12.0	76.16	83.33	Iberian A	71.8	88.4
20.9	12.9	31.7	40.7	23.4	12.1	87.20	84.44	Primitive, mixed	70.6	83.7
21.1	18.2	33.2	54.5	23.2	10.4	78.46	85.41	Primitive, mixed	70.2	88.8
18.5	11.5	35.0	32.8	23.7	12.3	72.02	90.70	Mixed, Primitive, Iberian A	69.7	89.7
19.9	15.0	35.5	42.2	23.3	11.9	91.95	81.13	Iberian D	77.9	80.8
20.1	10.3	35.5	29.0	23.7	12.9	84.15	86.00	Iberian D	71.2	76.5
19.7	13.1	30.3	43.2	22.7	11.7	78.91	88.88	Iberian A, Primitive	70.5	81.9
18.7	14.2	31.2	45.5	21.5	11.3	87.57	88.88	Alpine, Primitive	81.2	71.3
17.7	10.8	32.2	33.5	18.8	8.4	83.60	86.00	Mixed, Iberian A, Primitive	67.9	83.1
17.8	16.4	37.5	43.7	26.1	13.8	84.32	54.90	B. B. B., Primitive	75.1	84.8
21.3	15.9	30.0	53.0	24.2	12.2	77.54	93.48	Odd type, Primitive	78.8	84.5
17.8	11.4	36.0	31.7	22.5	10.5	81.87	86.95	Iberian B	71.7	87.6
20.8	12.9	34.3	37.6	22.0	11.8	85.14	92.30	Iberian A, mixed, Primitive, odd type.	74.8	77.7
21.7	13.4	31.4	42.6	26.2	14.6	79.47	79.59	Mixed, Iberian A, odd type, Iberian D.	77.0	80.5
21.4	14.2	34.8	40.8	23.0	10.7	77.72	73.56	Iberian A, Iberian D, odd type.	68.4	88.8
20.2	11.4	35.0	32.6	20.3	9.1	75.70	89.13	Mixed, Iberian A	67.4	93.3
19.3	12.7	35.0	36.3	22.1	10.6	89.77	78.43	Iberian D	83.6	80.4
20.2	13.1	33.9	38.6	22.0	10.8	75.40	89.13	Iberian C	75.4	81.1
20.0	14.3	31.5	45.4	24.1	12.7	76.29	84.80	Mixed, Iberian A	74.8	79.7
18.9	14.0	32.0	43.7	21.0	9.9	81.40	90.90	Mixed, Iberian C	70.4	84.7
21.6	14.5	33.8	42.9	20.5	8.5	79.60	86.60	Mixed, Primitive, Alpine, Iberian A.	70.4	91.6
19.2	13.0	36.4	35.7	21.1	10.1	81.03	77.08	Iberian C, Iberian D	78.8	82.0
19.3	12.4	32.8	37.8	22.6	11.0	79.67	88.37	Iberian A, mixed	68.4	89.2
18.5	12.4	32.0	38.7	21.0	9.4	82.50	87.50	Iberian B, C, mixed	75.8	87.8
20.1	13.4	33.3	40.24	24.1	------	87.50	82.00	Iberian D, (Cro-Magnon) odd type.	------	------
20.3	13.8	33.0	41.8	23.5	11.5	84.09	83.67	Iberian C, Primitive	74.0	86.3
20.2	14.0	31.3	44.4	21.8	9.9	88.43	75.51	Mixed	75.5	83.8
18.8	13.0	32.5	40.0	21.3	9.9	80.79	86.95	Iberian B	75.8	82.6
------	------	------	------	------	------	81.96	86.00	Mixed	73.9	83.4
------	------	------	------	------	------	78.00	94.49	Alpine	72.9	81.1
------	------	------	------	------	------	80.00	84.61	Mixed	74.0	82.7
21.2	17.2	28.0	61.4	24.4	------	------	------	------	------	(?)
19.7	14.4	34.0	42.3	22.2	10.6	78.30	84.00	Mixed, Alpine, B. B. B., Primitive, Iberian A.	74.3	81.6
18.6	17.0	31.0	54.8	23.1	11.9	72.20	84.00	Iberian D	79.8	80.5

TABLE III.—*Averages and extremes—physical characters of adult males at Taytay, 1909—body measurements.*

Character.	Minimum.	Mean.	Maximum.	Number of individuals.	Mean of first 100 individuals.
Age	(2) 15.00	**36.32**	(3) 80.00	181	38.40
Stature	145.70	**159.47**	171.00	183	159.60
Sitting height	74.30	**83.99**	91.70	181	84.60
Pubic height	71.00	**81.78**	92.00	170	80.90
Umbilical height	85.00	**95.75**	105.60	170	95.70
Sternal height	118.00	**128.88**	139.80	170	124.60
Chin height	124.00	**136.27**	148.80	169	136.40
Ear height	134.60	**146.10**	158.50	169	144.40
Ankle height	4.40	**6.52**	8.20	169	6.60
Knee height	38.40	**43.81**	49.30	170	43.60
Trochanter height	72.80	**83.08**	95.30	170	83.20
Finger-tip height	46.50	**57.04**	66.80	169	57.50
Wrist height	63.80	**74.65**	85.00	169	75.10
Elbow height	87.50	**97.69**	110.50	169	98.00
Acromion height	117.40	**129.59**	139.80	169	129.40

TABLE IV.—*Head measurements of adult male Filipinos at Taytay, Rizal, Luzon, P. I., 1909—averages and extremes.*

Character.	Minimum.	Mean.	Maximum.	Number of individuals.	Mean of first 100 individuals.
Maximum length	16.60	**18.30**	20.20	182	18.33
Maximum breadth	13.40	**14.96**	16.50	182	14.96
Maximum height	11.20	**12.47**	13.60	182	12.32
Minimal frontal breadth	9.20	**10.44**	11.60	182	10.47
Bizygomatic breadth	12.00	**13.77**	15.00	182	13.78
Bimastoid breadth	11.40	**12.91**	14.30	182	12.85
Bigoniac breadth	9.10	**10.69**	14.30?	182	10.72
Naso-buccal distance	5.90	**7.15**	8.50	181	7.10
Naso-alveolar distance	5.30	**6.47**	7.50	189	6.40
Nose height (base)	1.80	**2.86**	4.00	181	2.80
Nose breadth	2.80	**4.00**	4.80	182	4.02
Nose length	3.70	**4.71**	5.70	182	4.70
Chin-nasion distance	9.30	**11.20**	13.00	178	11.20
Nasion hair-line distance	5.50	**7.26**	9.00	177	7.40
Mouth breadth (lips)	0.30	**1.99**	3.00	180	1.88
Mouth length	3.80	**4.80**	5.90	179	4.60
Ear breadth	3.00	**3.51**	4.10	182	3.57
Ear length	4.80	**6.15**	9.50	182	6.15
Ear cartilage length	4.20	**4.96**	5.90	182	4.99
Interocular distance	2.60	**3.38**	4.90	182	3.39
Eye length (transverse)	2.50	**2.98**	3.40	182	3.00
Eye color (Martin)	1.00	**3.00**	5.00	179	3.03
Frontal circumference	27.40	**30.50**	33.50	182	30.50
Parietal circumference	31.80	**35.69**	38.40	182	35.70
Forehead circumference	24.70	**27.50**	29.80	182	27.47
Occipital circumference	25.30	**28.48**	32.00	182	28.96

TABLE V.—*Indices and relative factors of adult male Filipinos at Taytay—averages and extremes.*

Factors.	Minimum.	Mean.	Maximum.	Number of individuals.
Absolute length:				
Lower leg	31.00	**37.29**	42.20	175
Upper leg	31.10	**39.22**	47.10	176
Hand	14.00	**17.55**	22.00	176
Forearm	18.30	**23.05**	27.90	176
Upper arm	26.50	**32.37**	38.00	175
Pubis to umbilicus	6.80	**13.96**	19.00	175
Umbilicus to sternum	27.70	**33.14**	38.60	175
Total head height	18.80	**23.00**	28.20	175
Upper face height	8.40	**11.30**	16.20	169
Relative length:				
Lower leg	20.70	**23.37**	27.20	175
Upper leg	20.70	**24.60**	27.46	176
Hand	8.56	**11.05**	15.71	176
Forearm	11.50	**14.45**	16.60	176
Upper arm	17.70	**20.30**	22.78	175
Indices:				
Omphalic	20.36	**42.25**	60.26	175
Cephalic	72.02	**81.79**	94.28	182
Nasal	54.90	**85.20**	110.00	182
Physiognomic	86.70	**73.20**	64.30	178
Morphologic face	93.30	**81.30**	66.10	178

II. DESCRIPTIVE CHARACTERS.

Time and exact appliances forbade the measurement of certain characteristics such as skin color and minor deformities, but notes were made of such occurrences and they are utilized in the following pages for purposes of description.

SKIN COLOR.

The Taytayan has a brown skin, the shade of which depends largely upon whether the individual is an outdoor or indoor worker. As the majority of men are fishermen or farmers, the skin is usually a darker shade than the average Filipino of Manila where so many men work indoors. The skin color is somewhat relative for this reason. However, a few individuals were so dark in color as to appear almost black, and a few more individuals were so light in color as to appear almost white. Of these there were six of the former and eighteen of the latter. The light-colored individuals invariably exhibited evidences of recent European extraction, whereas the dark colored were similar to the Indians of Cainta from whom they were probably derived.

HAIR.

The color of the hair is almost uniformly black and straight, with an occasional fine brown, but no notes were made in reference to this factor.

Only three individuals had wavy hair and these gave evidence of modified Iberian characteristics. No association with the Negrito can be established from the hair form, and there is no evidence of any recent Negrito intermixture.

EYE COLOR.

The average eye color of 179 individuals determined with Martin's (17) artificial eyes is that of the intermediate brown No. 3, which occurred 74 times, a greater number than any other color. Number 1 occurred 18 times: in 6 Australoids, 7 Blends, 2 Iberians, 2 Cro-Magnons and 1 Alpine; and No. 5 occurred 16 times: in 8 Blends, 2 Alpines, 2 Cro-Magnons, 2 Australoids, 1 Iberian and 1 B. B. B. It may be significant that a greater number of Australoids and Iberians have dark eyes than light eyes, signifying an intensification of pigment due probably to the Iberian. I have referred before (4) to an intensification of skin pigment among Filipino Iberians, and this is hereby confirmed.

The condition of *arcus senilis* is prevalent and is not confined to old men.

Four blind individuals were noted among 183 men.

THE MONGOLIAN EYELID.

Observations were made on 116 individuals to determine the condition of the upper lid at the inner canthus, and only 10 were found with a well marked fold at this point, whereas 63 were found without the fold, and 43 had only a slight indication of it.

If this fold is a sign of Asiatic blood as distinguished from European and others, then almost half the individuals examined give indications of Asiatic extraction. However, this proportion is probably not true, but those individuals who have only a slight fold have no doubt as much other blood as Asiatic. Therefore the relative proportion of European and others to Asiatic should be as the ratio of 63 to 10, or 63 plus $\frac{1}{2}$ 43 to 10 plus $\frac{1}{2}$ 43, which is a ratio of 84.5 to 31.5, or somewhere between the two ratios.

When the types (species) are correlated with the three conditions of eyelid, not one type can be excluded from the Mongolian, but each type has some individuals with this condition as may be seen in the table below:

	Blend.	Australoid.	Iberian.	Cro-Magnon.	Alpine.	Modified primitive.
Straight	36	12	8	3	4	0
Slight Mongolian	24	8	0	4	4	3
Mongolian	5	2	2	1	0	0

Some types, however, have a greater number of straight upper lids, whereas others have the fold in greater number. Thus the Australoid and the Iberian have a greater number of individuals with straight lids, whereas the Alpine, Modified Primitive, and Cro-Magnon have a greater number with Mongolian lids, and the Blend has almost an equal number of each. May it be inferred from this that the Australoid and Iberian are other than true Asiatic types, whereas the Cro-Magnon, Alpine, and Modified Primitive are true Asiatics, also that each type is represented among the Chinese? None of the Primitive or B. B. B. were examined for lid formation.

HEAD OUTLINES.

Composite outlines of the three groups, brachycephalic, 74 individuals, mesocephalic, 69 individuals, and dolichocephalic, 22 individuals, are made in the same manner that similar outlines were made for the Igorots, negroes and white students described in former studies (3).

There are two dolichocephalic outlines because so few individuals did not produce one composite, there being enough large outlines to make an additional composite outside of the one where the greatest number produced the small outline.

A glance at the outlines (figs. 5, 6 and 7) will show the dorsal flattening marked in the brachycephalic, which at once differentiates the Taytayans from the Igorots, negroes or white students. This flattening in the brachycephalic (fig. 5) is accompanied by projection in the parietal region, prominence in the region of the bregma and bulging in the temporal region, which suggests artificial flattening by pressure from behind. Many of the heads were flattened toward one side rather than exactly in the middle, and when this condition existed the opposite side bulged in the parieto-temporal region more than the side on which the dorsal flattening was most marked. (See Plate XVIII.)

In several children this was more decided than in adults. One of these is given in fig. 8 where the two outlines are shown as taken with the cephalograph over the middle of the right and of the left eye respectively and parallel to the median line. Another is shown in fig. 9, with the median sagittal outline and one parallel to it 3 centimeters to the left. The first of these is of a boy, aged 4, whose father brought the child to me for consultation. The boy had slept invariably with his head on a hard board covered with only a thin matting, the *petáte,* with the head turned to the left at an angle of 45°, and I attributed the trouble to this cause. The head of the second boy, aged 10, was not so distorted but without doubt the condition was due to the same cause. These two cases illustrate a condition that is found frequently among the children and I believe it is nothing more nor less than the *petáte habit* that produces it.

The *petáte habit* is what I named the Filipino custom of sleeping on

Fig. 5.—Composite Outlines of 74 Brachycephalic Individuals.

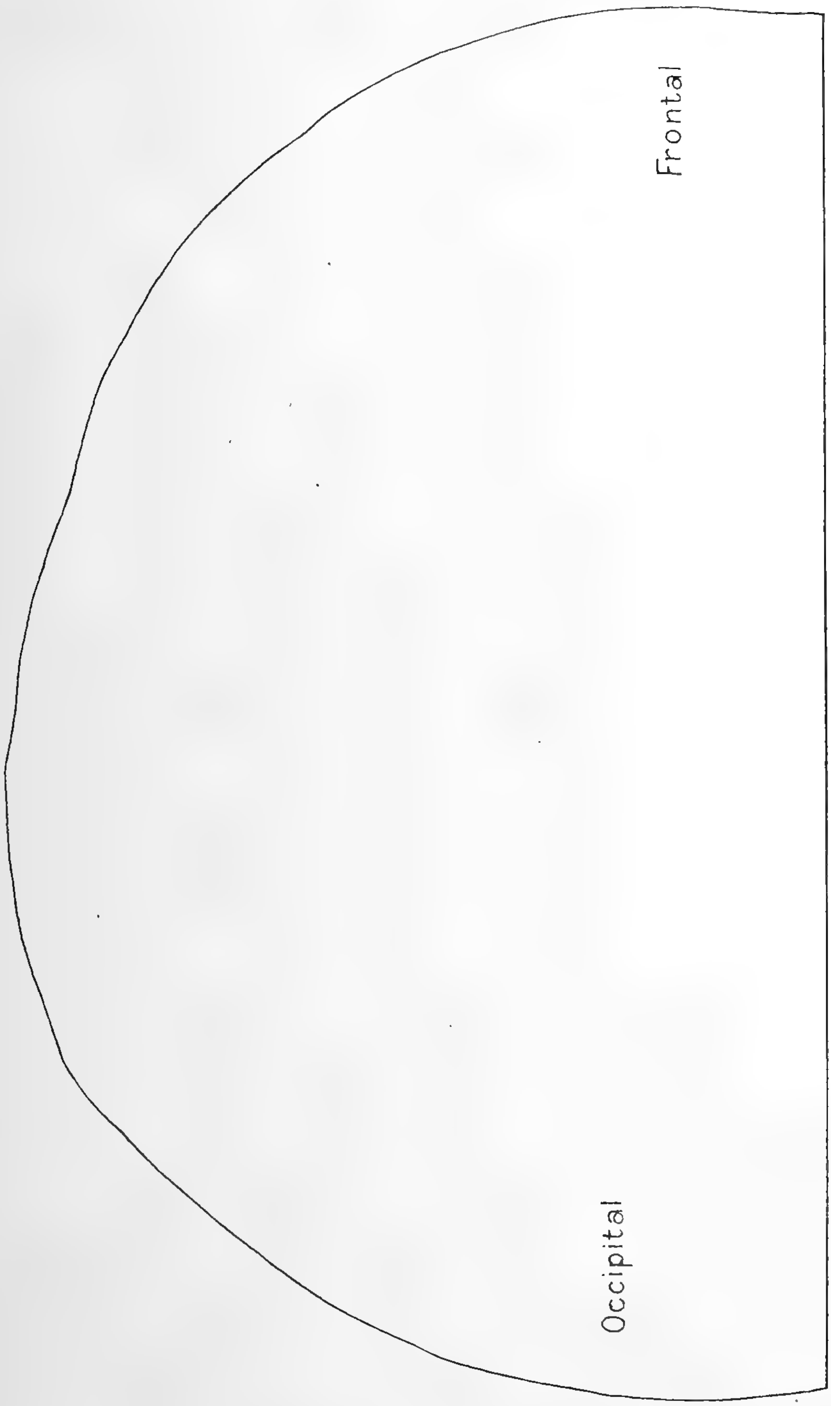


FIG. 6.—COMPOSITE OUTLINES OF 69 MESOCEPHALIC INDIVIDUALS.

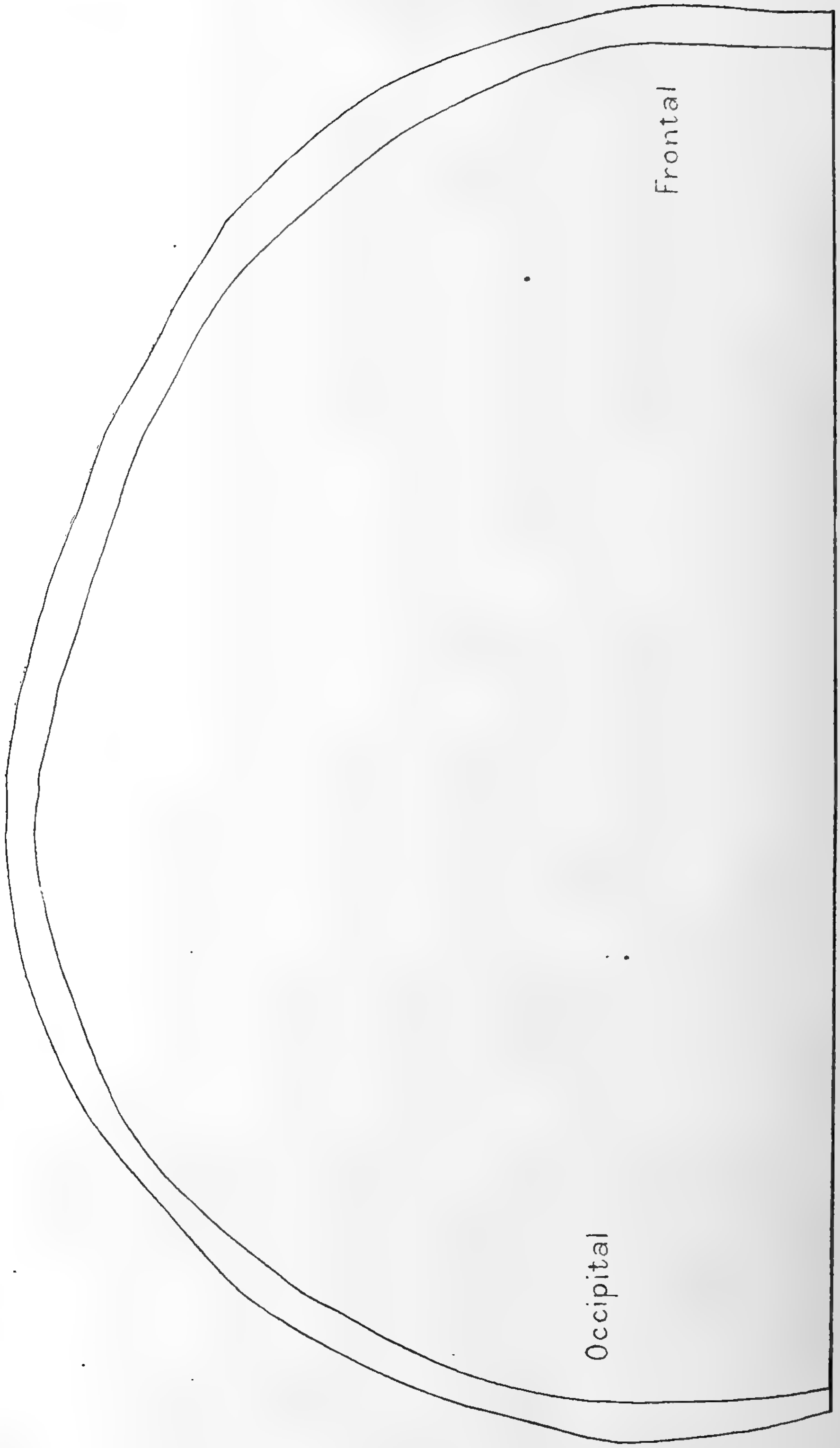


FIG. 7.—COMPOSITE OUTLINES OF 22 DOLICHOCEPHALIC INDIVIDUALS.

hard floors (bamboo or other material) with only the *petáte* or a small hard pillow between the head and the floor. This is the coolest way to sleep in the tropics, the soft pillow being particularly hot and oppressive. When the baby is placed upon a *petáte,* in acquiring the habit it normally lies flat upon its back and the head is either straight or turned slightly to one side. After a few months a flat place is formed on that part of the head resting on the *petáte,* and the child then lies on this flat place until the head becomes misshapen and sometimes badly deformed.

When my daughter was about one or two months old we kept her in a woven bed with only a sheet and a *petáte* beneath her until about the third month when I noticed a small flat place in the occipital region of the head, after which we used a small pillow and the head soon resumed its normal dorsal rotundity.

This matter is a subject of great interest and may be one of vital importance because such deformities may result in impaired mental ability by undue pressure and distortion of the brain when it is developing most rapidly. We would therefore suggest that a study of the school children be made by the teachers in the public schools, using the cephalograph (7) originated by Doctor Bean, one of which is owned by the Bureau of Education. The teachers are probably the only ones who can control the children sufficiently without the aid of the parents so that their head outlines can be made. Records should be kept showing the physical and mental condition of the child and from time to time the head outlines should be made, the parents having been instructed previously about the proper head rest for their children. The teachers may be able to induce the youngest children also to have their head outlines made in order that the study may begin in the cradle, or rather on the *petáte,* at which time the most good can be accomplished.

If the deformed condition of infancy persists during the adult life of the individual, then otherwise dolichocephalic or mesocephalic heads become mesocephalic or brachycephalic, and a part at least of the brachycephally and mesocephally of the Orient is not natural.

The vertical occiput and the *front bombé* may be only deformities and not racial or true morphologic characteristics. For this reason, I believe the cephalic index is not the best differential factor although it still may be of some service and should not be discarded entirely, but relegated to a subordinate position in racial anatomy.

Forty-two heads of Taytayans give evidence of dorsal flattening to a noticeable degree, and among these greatly distorted heads are included all those of the Primitives, 6 of the Australoid, 1 B. B. B., 1 Adriatic, 6 Iberian Blends (Alpine), 5 Primitive Blends (fig. 10), 3 Adriatic Blends, and the remainder are Blends of various sorts. In connection with the ear type, it is of interest to note that 13 of the 42 flat heads had ears of the odd type, although 16 odd type ears were not

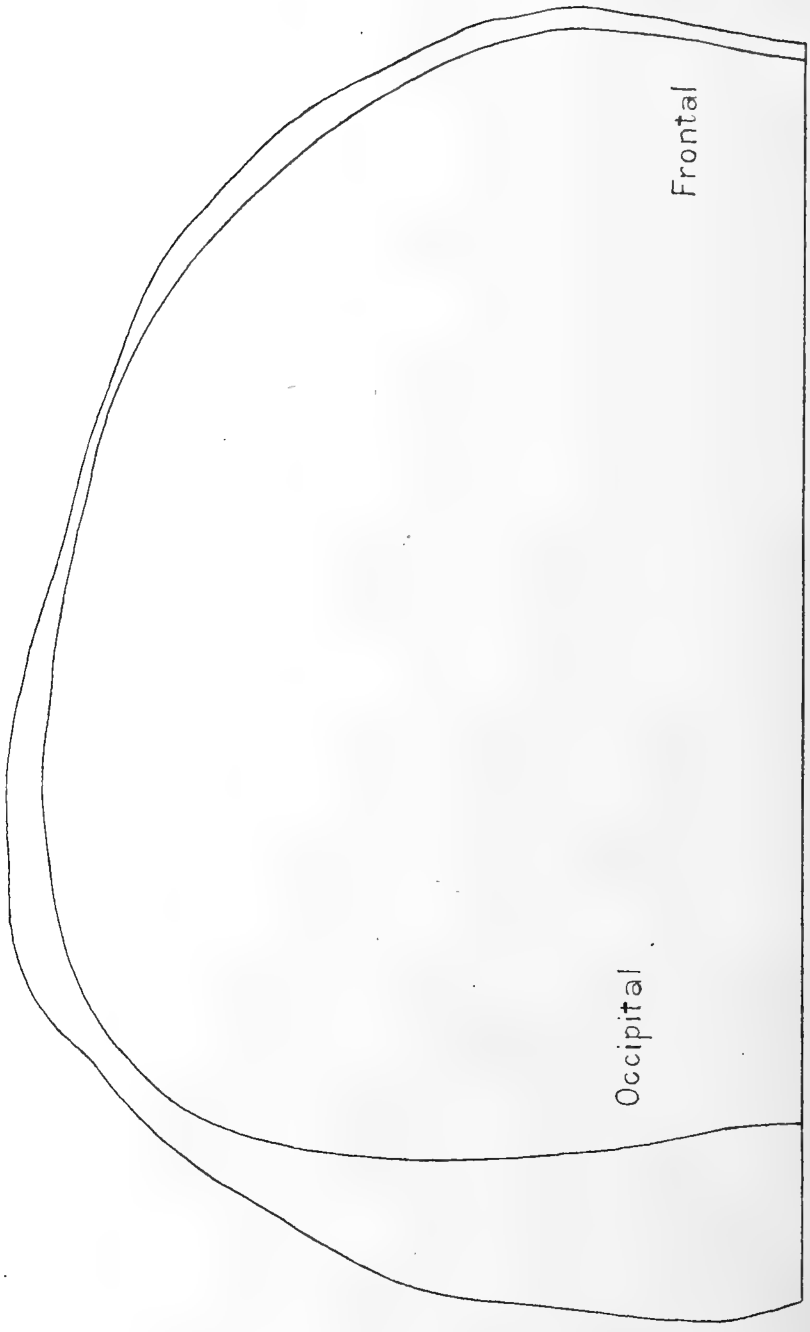


Fig 8.—Boy of Taytay Aged 4. The Small Outline is From the Left Side of the Head Over the Middle of the Eye. The Large Outline is From the Right Side of the Head a Little Nearer the Median Line.

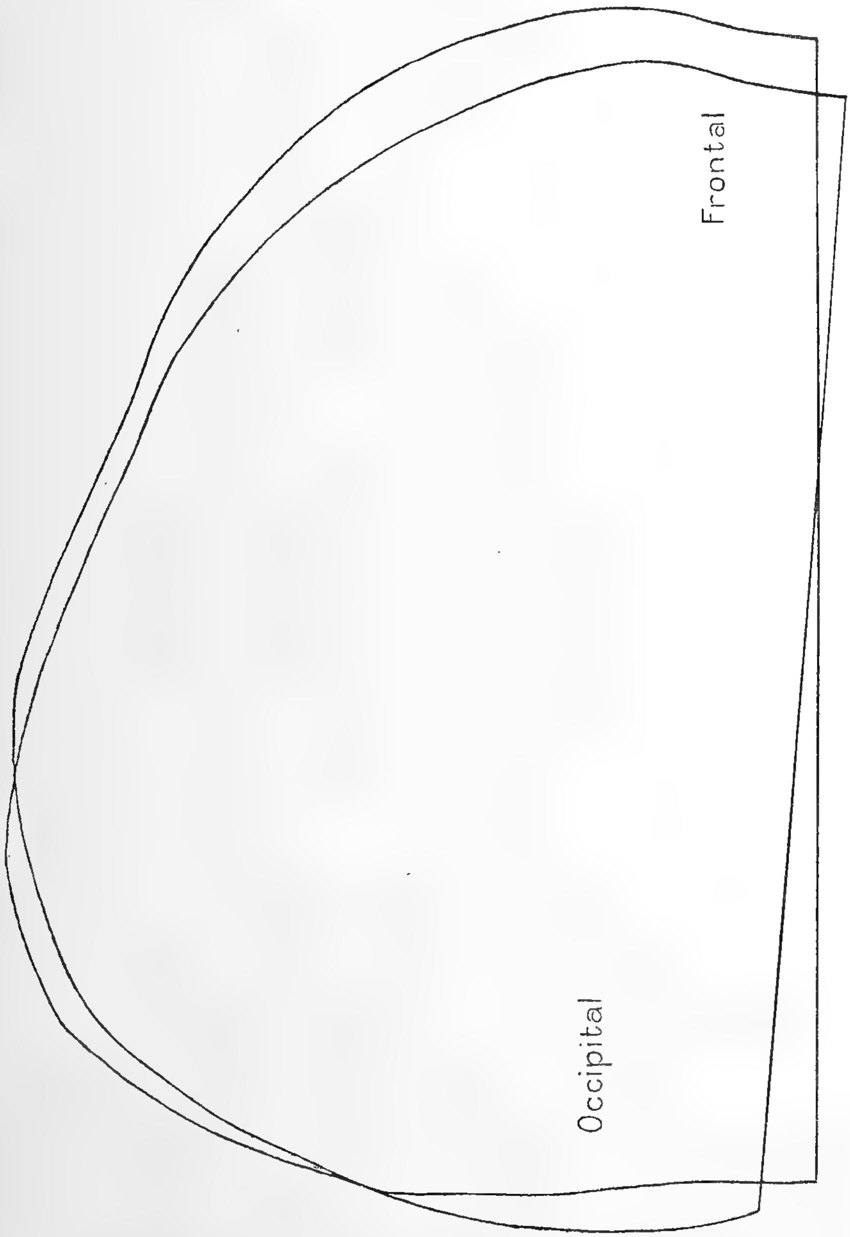


FIG. 9.—BOY OF TAYTAY AGED 10. THE SHORT OUTLINE IS 3 CENTIMETERS TO THE LEFT OF THE MIDLINE. THE LONG OUTLINE CIRCUMSCRIBES THE SAGITTAL PLANE.

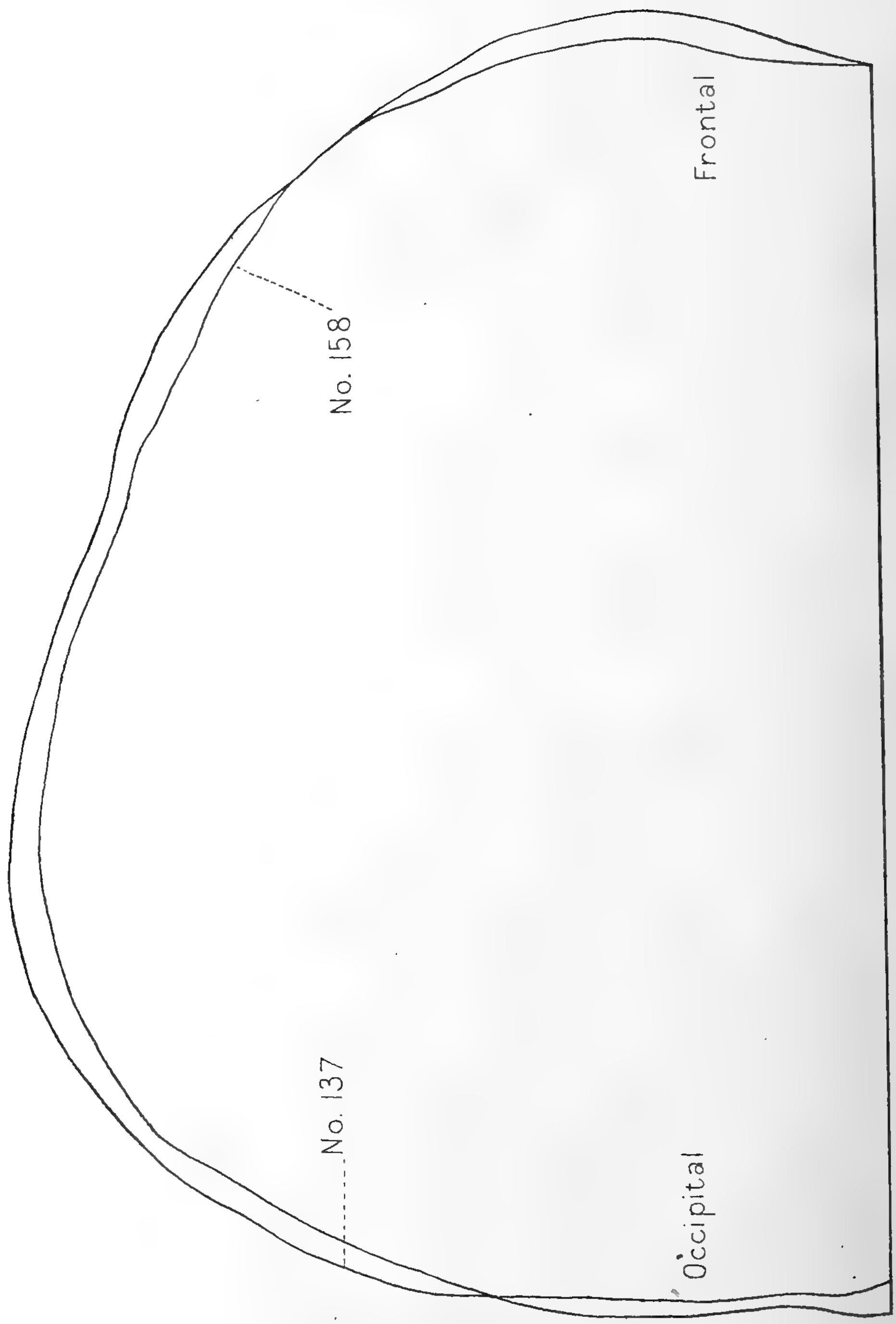


Fig. 10.—Head Outlines of 2 Primitive Blends With Flattened Occipital Region. Serial Nos. 137 and 158.

associated with dorsal flattening of the head. The individuals previously noticed with this ear type were distinguished by the flat occipital region. The questions immediately arise: Is the flat occiput a type of head or is it a deformity? Is the odd type ear a true type or is it due to the deformed head? The two are evidently closely associated, but what do they represent? The occurrence of the flat head with the Primitive and related types may be urged in favor of the odd type entity represented by the Primitive and its allied forms, and the absence of the flat heads among Cro-Magnon and Iberian favors this view. On the contrary, the flattening of the head increases the cephalic index and thereby types are classified as Primitive or related forms that would be otherwise different types because the cephalic index is the basis of the classification. For the same reason, neither the Iberian nor the Cro-Magnon have any flat heads, because if they did the cephalic index would be increased and they would be no longer Cro-Magnon or Iberian. The cephalic index should be replaced by some other factor in the differentiation of the types, or some other factor should be utilized in conjunction with it as the basis of the classification.

Therefore we have utilized the ear form in connection with the cephalic index, nasal index, and stature in an additional classification which is to be given when the ears are studied.

ADDITIONAL OBSERVATIONS.

Eleven left-handed individuals occurred among 175 observed, and this in spite of the fact that it is considered unfortunate to be left-handed and some stigma is attached to the condition. One square, box-shaped head suggesting previous rachitis was observed, and one platycnemic tibia (saber shin) was seen. Two cases of wry face (unilateral facial paralysis) were noted. One case of scaphocephaly (Plates I and IV) and one hare lip were seen.

The box-headed individual mentioned above, Serial No. 149, clinical No. 875, also had odd fingers. The lengths from the web to the tip of the fingers is given here:

	Right hand.	Left hand.
	cm.	*cm.*
Thumb	5.5	6.0
Forefinger	9.0	7.0
Middle finger	8.7	10.3
Ring finger	8.2	9.0
Little finger	7.7	7.5

The right forefinger is long and the left is short; and the middle finger and ring finger of the left hand are longer than the same fingers of the right hand. Apparently no bones are absent, and no history of similar deformities in the family could be obtained.

A peculiarity of the bones of the skull in the form of a ridge on the bone about the size of the finger and extending from mastoid to mastoid around the occipital region, was noted frequently; in two persons, both of the Iberian type, it was well marked. This ridge apparently followed the superior curved line and crossed the external occipital protuberance, terminating on each side in the mastoid process. It occurred on 12 Iberians, 3 Blends, 2 Australoids, 2 Alpines, 1 Cro-Magnon and 1 B. B. B., 21 times in all. The accompanying head outline illustrates this projection over the occipital protuberance, which itself was not large but seemed continuous with the ridge (fig. 11). Future studies of skulls may reveal the nature of this abnormality, because it was not superficial but appeared to be bony in character.

III. THE SEGREGATION OF TYPES.

In previous papers concerning the Filipino Types found among the Manila Students(4) and in Malecon Morgue(5), the suggestion was made that the types represent species, of which there are elementary or new, and systematic or old, present in both groups of individuals as well as among the Igorots and Japanese. The Primitive and Iberian are called systematic species, the Alpine, B. B. B., Modified Primitive, and Adriatic, elementary species, and the Australoid and Cro-Magnon, systematic species also, but not so definite as the Primitive and Iberian. The reasons for this classification and for the use of the word species have already been given in relation to Schulls'(4) work on corn, and the work of Price and Drinkard on the tomato(4).

The species of men at Taytay may be selected by the same method used to select those of the students and in the morgue. The species so selected are then differentiated as follows:

The Primitive is brachycephalic, platyrrhine, and small in stature.

The Iberian is dolichocephalic, leptorrhine, and below medium size.

The Australoid is dolichocephalic, platyrrhine, and small or below medium size.

The Cro-Magnon is dolichocephalic, platyrrhine, and above medium stature.

The Alpine is brachycephalic, leptorrhine, and below medium size.

The B. B. B. is brachycephalic, leptorrhine, and above medium size.

The Modified Primitive is brachycephalic, platyrrhine and below medium stature.

The Adriatic is brachycepahlic, platyrrhine, and above medium stature.

The Blend is moderately brachycephalic, moderately platyrrhine and small in stature, corresponding with the Primitive and Modified Primitive more nearly than with any other type.

THE PRIMITIVE.

Only three individuals of this type were observed among the men at Taytay, although a majority of the Blends conform to the Primitive. The three men are characterized by a stature of 150.1 centimeters, a cephalic index of 88.5 and a nasal index of 89.1, in addition to which may be given the morphologic face index 78.5, the omphalic index 44.1,

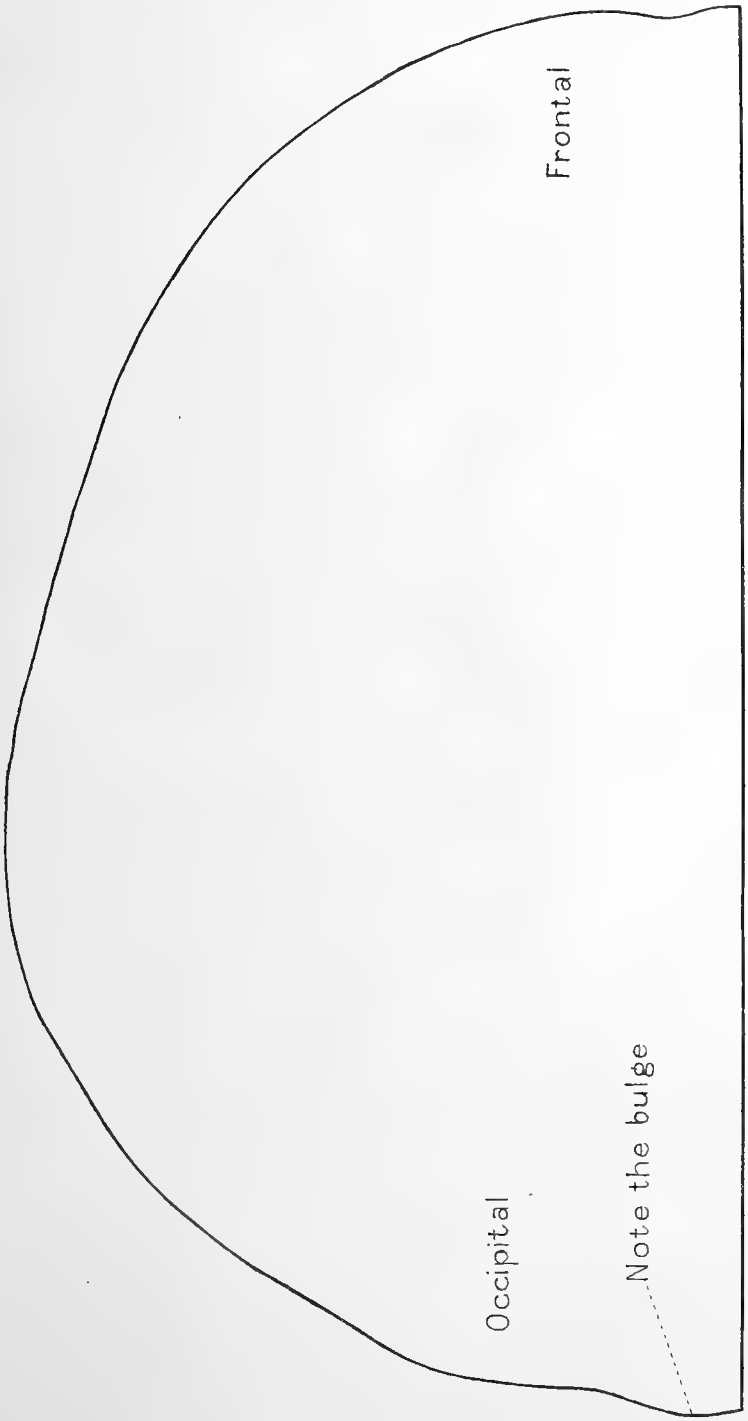


Fig. 11.—Head Outline Showing an Unusual Bony Band About the Occiput.

the tibio-femoral index 92.6, the radio-humeral index 73.7, and the intermembral index 75.5. Other characters need not be mentioned because they are neither distinctive nor differential in nature.

Type N of the Igorots has a stature of 150.8, a cephalic index of 84.3, and a nasal index of 89.4 which indicates a close relationship to the Primitive of Taytay. They are practically identical with the Primitive of the Manila Students and of Malecon Morgue, although relatively fewer individuals of this species are found at Taytay.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	153.6	**150.1**	147.1	3
Absolute lower leg length	35.5	**33.6**	30.7	3
Absolute upper leg length	39.2	**36.3**	31.1	3
Absolute forearm length	25.3	**22.4**	20.6	3
Absolute upper arm length	31.3	**30.4**	30.0	3
Omphalic index	56.5	**44.1**	37.0	3
Cephalic index	93.4	**88.5**	83.3	3
Nasal index	95.3	**89.1**	83.0	3
Morphologic face index	80.8	**78.5**	74.3	3

Attempts were made to obtain photographs of one or more Primitive men, but unfortunately the individuals could not be prevailed upon to submit to the ordeal of sitting for their portraits, therefore descriptive characterization and measurements must suffice. However, a few photographs of the Primitive type as found among the Moros, Igorots, and other peoples of the Islands are taken from the Bureau of Science collection for purposes of inspection and comparison. These may be seen in Plates II to VI.

The head outline from glabella to inion of a Primitive man, Serial No. 110, is given in fig. 12 with that of an Iberian for comparison. The depression of the lambda and the elevation of the bregma are very noticeable, and the *front bombé* is exaggerated. The head is short and high. Whether or not this is due to pressure on the occipital pole can not be known. It is possible that pressure on the occipital bone after it is thoroughly ossified would produce a depression of the lambda. There is the counterbalancing elevation of the bregma and the frontal region, although the three characteristics may be normal. It is a question whether the Primitive is a species or type, or whether it is a condition due probably to malformation of the head during infancy.

The individuals are small, with small round head (A 19), broad, flat, short face and nose, lips full but small, chin small and somewhat receding, forehead narrow but bombé (15), and directed almost vertically from

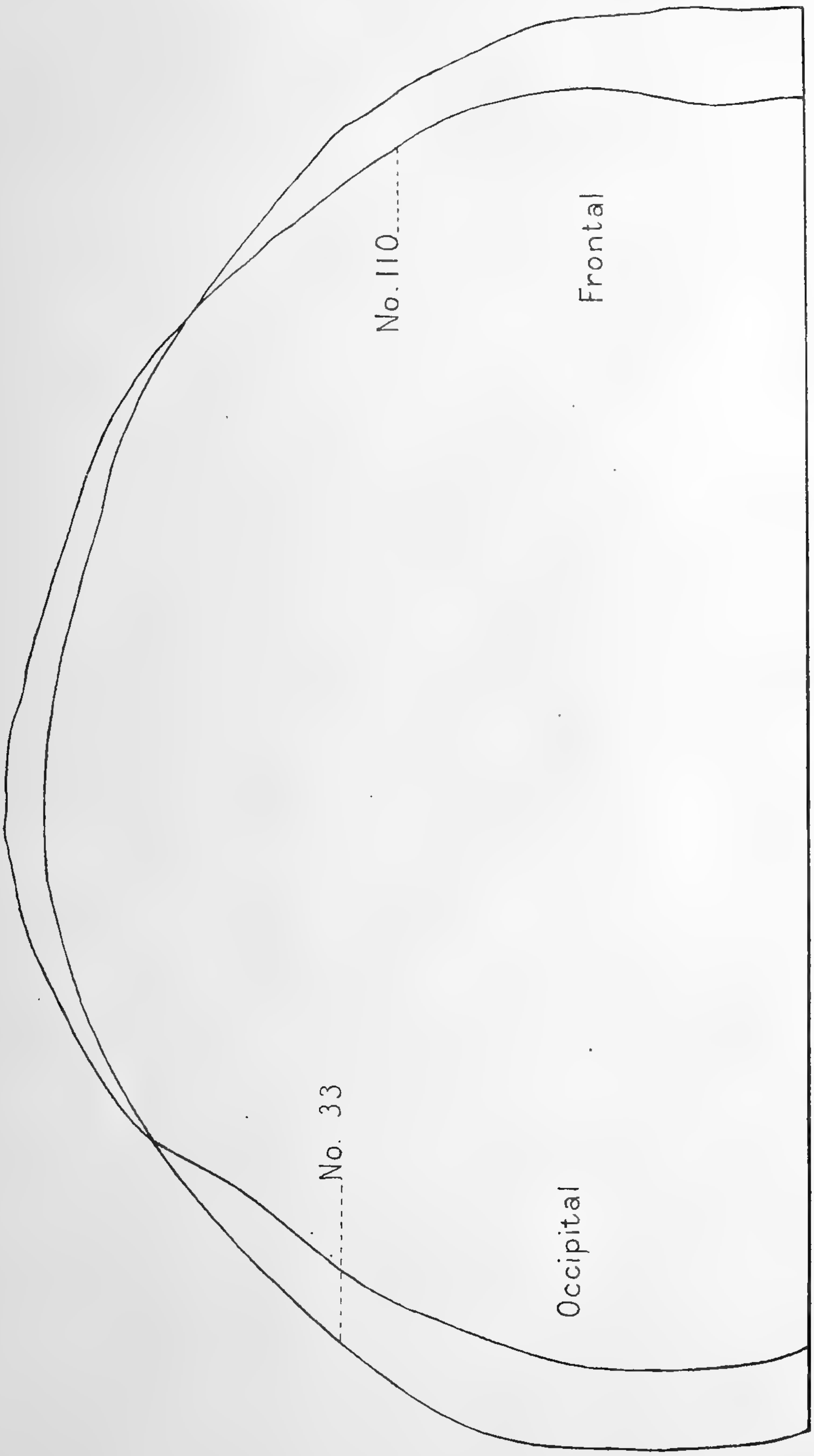


FIG. 12.—PRIMITIVE AND IBERIAN HEAD OUTLINES. IBERIAN SERIAL NO. 33. PRIMITIVE SERIAL NO. 110.

the brows which are not prominent but somewhat flattened. In truth the type is infantile(26).

It is easily associated with Hagen's(12) *"infantile Gesichts Bildung": "niederes Gesicht, stumpfe, breite, niedere Nase, breite, wenig erhebene Nasenwurzel dann Neigung zur sogenannten mongolenfaltenbildung der Augenlider, vorwölbte Stirn, die sogenannte Front bombé."—"so haben wir einen ziemlich umfangreichen Komplex von Merkmalen, innerhalb dessen sich die Zusammenhängen und Gemeinschaftlichkeiten der aus den heutigen Menschenrassen herauszuschalenden Urform bewegen müssten, wenn diese wirklich auf den Namen einer 'primitiven' anspruch haben soll."* However, Hagen includes the Senoi, the Aeta, the Indian of South America, the Papuan, the Veddahs of Ceylon, the Battaks of Sumatra, the negro of Guinea and the Bushman of Africa under the term "*primitiven*," some of whom are dolichocephalic and others brachycephalic; therefore, it is evident that more than one somatologic type is included in his "*primitiven*."

The Primitive of Taytay conforms in bodily dimensions to a type of Negrito found in the Philippines and to types found in other Asiatic island groups, as well as on the mainland in the Malay Peninsula(4). The Kubus of Sumatra(37), the Taradjas of the Celebes(24), the Semangs and Senoi of the Malay Peninsula(18), the Orang Akett of Sumatra(19) and the Veddahs of Ceylon(18), have in their composition a form similar to the Primitive. This form has almost invariably associated with it another which I call the Australoid, the chief differences being that the latter has a dolichocephalic head and a wider nose than the Primitive(32).

THE AUSTRALOID.

There are two forms of the Australoid, one a *primary*, or remote, the other a *secondary*, or recent; the first found among the Igorots, the second among the students and morgue subjects. Physical measurements do not differentiate them, except that the more recent is taller. Very few of the *primary* appear among the men of Taytay, but among the women more are found. However, a few men are noted with stature about 150 centimeters and with very wide nose and narrow head. No photographs could be obtained of these *primary* Australoids because of their shyness, or aversion to having their picture taken; an indicator, as in the Primitive, of elemental nature. Snap shots of other Australoids were taken with the only camera at hand, a Brownie pocket kodak, but the pictures are not reproduced on account of their poor quality.

The man represented by Serial No. 89, Clinical No. 564, resided some distance from Taytay, but came to be treated at the dispensary; he was probably suffering from sexual neurasthenia. His features are large and heavy except the lower jaw, which is short, square and receding. The brow ridges protrude, the cheeks are large and prominent, the nose is wide, straight, heavy and depressed at the nasion, and the lips are full and thick. The brow ridges are noticeably prominent. This is a form somewhat apart, although one other was noted like him, and it is a not unusual Filipino type. It is nearly related to the remains of the earliest paleolithic man (Homo Heidelbergensis—Homo Mousteriensis) recently discovered in Europe, if indeed it is not exactly the same form (15).

The upper lip is broad from its border to the nasal spine, a distance of 2.7 centimeters, although broader lips are seen. The peculiarity is in the rounded contour between the nasal spine and lip margin as seen in profile. The facial angle 70°—glabella, nasal spine, external auditory meatus—is not greater nor less than many others, although it is 7° to 8° less than that of the Igorots measured in the same way. Nevertheless, about 30 per cent of the Igorots have the same index and 4 per cent an index less than 70°. The nasal index is 73.68, the cephalic index is 102.2, and the stature is 156.8. The head height is 12.5 centimeters. The ear is similar to the odd type previously described. The physical characters of this man resemble those of the Taytayan Cro-Magnon, but the stature is much less and other factors as well differentiate the two. The sagittal head outline is of sufficient interest to be given (fig. 13). It is low, long, and somewhat flat over the lambda. The forehead is not high, and the glabella is prominent. The occipital region is full but not projecting, although the occipital circumference is 2 centimeters greater than that of the forehead. The outline might very well represent an Iberian and Primitive combined.

Another man of similar form is represented by Serial No. 103, Clinical No. 616, and although the stature of this man is 12 centimeters greater than that of the other there is a similarity in many respects that associates the two forms. Both of these men belong rather to the Cro-Magnon than to the Australoid group because of greater stature, straight nose, wide, long face and prominent occipital region, but they also partake of the Australoid characters.

They are not secondary Australoids, however, which are represented by two other men whose photographs were obtained without difficulty. (Plates I, XVI, and XVII.) These two men show evidences of recent Iberian mixture, but retain the Australoid characters to some extent.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	164.3	**158.01**	149.5	37
Absolute lower leg length	40.4	**37.00**	33.0	33
Absolute upper leg length	43.0	**38.04**	33.3	33
Absolute forearm length	25.7	**22.60**	19.5	33
Absolute upper arm length	36.4	**32.11**	29.5	33
Omphalic index	55.9	**41.40**	26.2	32
Cephalic index	83.3	**78.00**	72.0	35
Nasal index	102.2	**93.30**	84.0	35
Morphologic face index	93.3	**82.30**	70.9	34

FIG. 13.—AUSTRALOID HEAD OUTLINE. SERIAL NO. 89. CLINICAL NO. 564.

The mean stature of 37 Australoids of Taytay is 158.0 centimeters, the cephalic index is 78 and the nasal index 93.3. The morphologic face index is 82.3, the omphalic index is 41.4, the radio-humeral index is 70.4, the tibio-femoral index is 97.3 and the intermembral index is 72.9. Compared with the Primitive, the stature is greater, the head is narrower, the nose is wider, the face is higher, the umbilicus is lower, the forearm is shorter, the lower leg is longer, and the lower extremity is shorter. The form is intermediate in general, between the Primitive and the Iberian.

The stature of the Australoids of Taytay is 0.7 centimeters less than that of the Morgue Australoids, 11.5 centimeters greater than that of the Igorots, 2.9 centimeters less than that of the students, 5.75 centimeters less than the Japanese previously measured. The cephalic and nasal indices of all groups are practically identical—dolichocephalic or slightly mesocephalic, and platyrrhine—except that of the Igorots who are frankly dolichocephalic, and markedly platyrrhine. The Igorots are the *primary* Australoids, whereas the other groups contain Blends that simulate them, and represent recent mixtures of the Filipino Iberian and Primitive, both of which are somewhat blended.

The physiognomy of the *primary* Australoid resembles that of the Senoi, the Aeta, the Battak, the Veddah, and the Indian of Peru, as given by Hagen, whereas the physiognomy of the *secondary* Australoid represents distorted Primitive and Iberian. For purposes of comparison the Iberian will be described next.

The Iberian.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	169.3	**160.7**	154.5	17
Absolute lower leg length	40.6	**37.6**	33.3	15
Absolute upper leg length	43.6	**39.9**	36.4	15
Absolute forearm length	26.0	**23.3**	20.9	15
Absolute upper arm length	36.6	**32.9**	28.8	15
Omphalic index	52.8	**42.9**	33.5	15
Cephalic index	79.0	**76.2**	70.5	15
Nasal index	85.4	**78.5**	72.0	15
Morphologic face index	91.6	**84.8**	73.1	15

The stature of 17 Iberians is 160.7 centimeters, the cephalic index is 76.2 and the nasal index is 78.5. The omphalic index is 42.9, the morphologic face index is 84.8, the radio-humeral index is 70.8, the tibio-femoral index is 94.2, and the intermembral index is 72.5. Comparing this with the Australoid and Primitive, it may be said that the Primitive and Iberian have blended to produce the Australoid in stature, face height and width; the broad nose of the Primitive has been retained and is somewhat broader; and the cephalic index and limb and body measurements of the Iberian have been retained to some extent. The tibio-femoral index of the Australoid is greater than that of the Iberian or Primitive.

The stature of the Iberian of Taytay is but little less than that of the student Iberian, or the Iberian of Malecon Morgue, and is the same as the Japanese Iberian. The cephalic index is practically the same in all groups although the Japanese are slightly more dolichocephalic than the others. The nasal index is also about the same in all the groups, although the 5 Morgue males have an index of only 68.14, but the flare of the nostrils may not be so great in death as in life, which may account for this.

The fact is significant that the Iberian is present in all the groups of Littoral Filipinos so far observed, and is also found among the Japanese and Igorots. It can easily be accounted for among the Filipinos, through recent European (Spanish) immigrants, but an earlier migration from Europe must have occurred to have impregnated the Japanese and Igorots. The alternative is that the Iberian is a fundament of primary man and is found as an element in all the groups. Keane's hypothesis of the eastward migration of the early Europeans explains their presence in the heart of Luzon and in Japan. A northern branch reached these Islands, while the main body pushed on through the central Pacific to Hawaii. This is substantiated by a study of the ears of the natives throughout the Philippines, which has been undertaken and will be rapidly prosecuted.

For the purpose of illustrating the different Iberians, examine Plates I, and VII to XII. The different Iberian types will be discussed when the ears are described.

The sagittal outlines of two Iberian's heads are seen in fig. 14, and the two are almost identical. One, however, is slightly flattened in the occipital region. (See also fig. 12.) These outlines may be studied best by comparison with the outlines of the heads of two Primitive Blends in fig. 10. The forehead of the Iberian is almost vertical, that of the Blend is bombé; the occipital region of the Iberian is full and rounded, that of the Blend is vertical and flat; the parietal region of the Iberian is well rounded, whereas that of the Blend is prominent and bulging; the bregmatic region of the Iberian is almost flat, whereas that of the Blend bulges, especially in the superior frontal region. There is evident distortion by flattening in the occipital region of the Blends, but the Iberians appear to be normal in this particular, although one is slightly flattened.

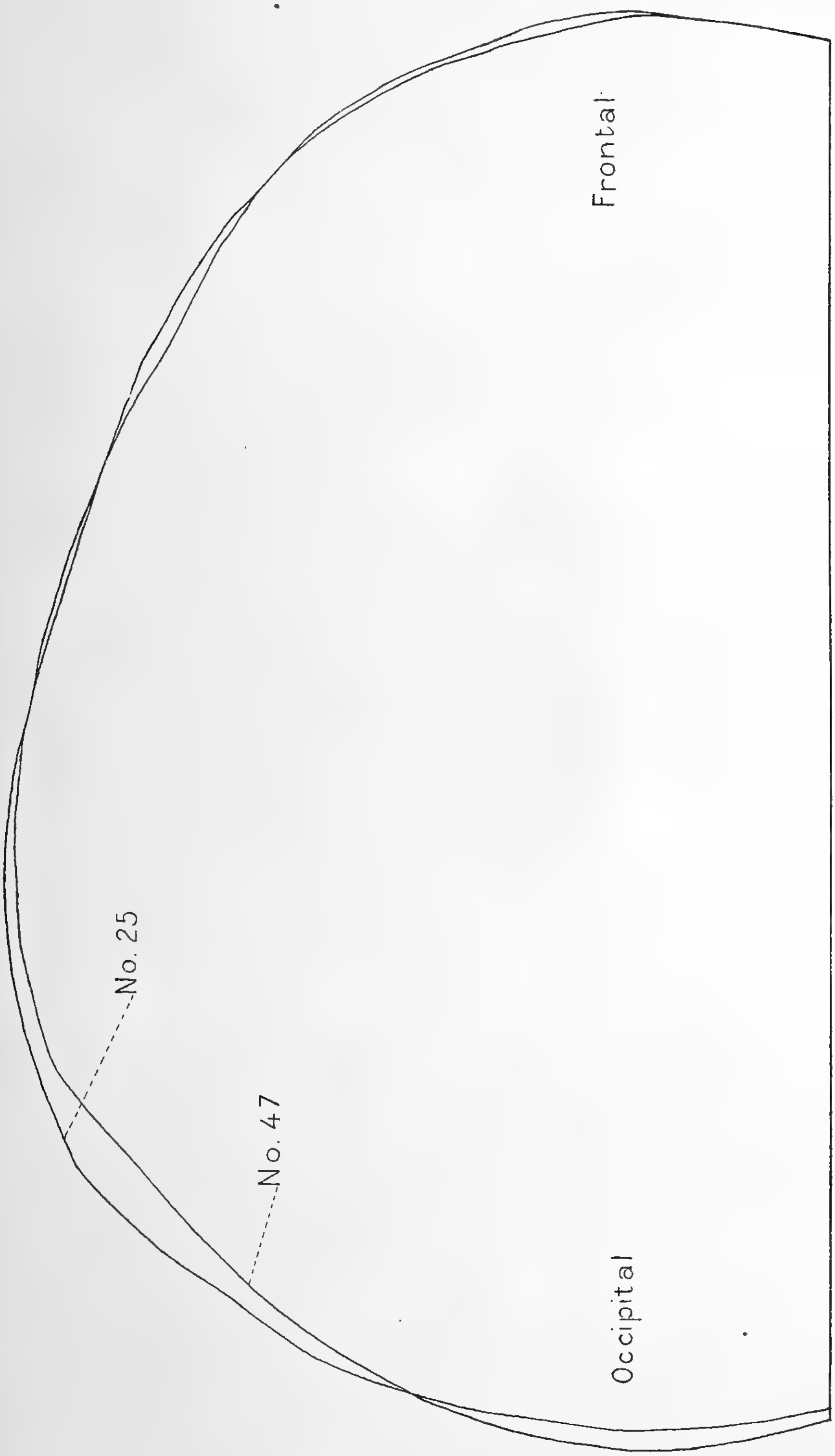


FIG. 14.—IBERIAN HEAD OUTLINES. SERIAL NOS. 25 AND 47.

The Cro-Magnon.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	170.7	**167.7**	165.3	12
Absolute lower leg length	42.2	**39.7**	37.3	11
Absolute upper leg length	47.1	**42.5**	39.5	11
Absolute forearm length	27.3	**24.6**	22.5	11
Absolute upper arm length	36.5	**33.9**	32.6	11
Omphalic index	51.6	**42.9**	38.6	11
Cephalic index	82.9	**78.3**	75.1	12
Nasal index	104.7	**93.4**	81.8	12
Morphologic face index	89.3	**83.0**	75.0	12

The stature of 12 men called Cro-Magnon is 167.7 centimeters, the cephalic index is 78.3, and the nasal index is 93.4. The omphalic index is 42, the morphologic face index is 83.0, the tibio-femoral index is 93.4, the radio-humeral index is 72.5, and the intermembral index is 71.2.

The stature is 8.2 centimeters greater than that of the average Taytayan, the cephalic index is 73.5 less, the nasal index is 8.2 greater, the omphalic index is practically the same, the morphologic face index is 1.7 greater, the radio-humeral index is 1.3 greater, the tibio-femoral index is 1.7 less and the intermembral index is 1.2 less. The lower leg is 2.4 centimeters longer, the upper leg is 3.3 centimeters longer, and the forearm and upper arm are each 1.5 centimeters longer.

The Cro-Magnon of Taytay is therefore an individual above the average in stature but not tall, with mesocephalic head and platyrrhine nose, although the nose is not flat but straight, long and wide. The face is large in both vertical and transverse directions. The limb parts are long, especially the forearm and upper leg, and the lower extremity is relatively longer than the upper. (Plate XV.) These factors indicate a relationship with the prehistoric Cro-Magnon of Europe.

For the sake of comparison, the measurements of the skeleton of the old man of the cavern of *less Eyzies*(9), from the sepulchre of the troglodytes of Périgord in the valley of the Vézere, in the region of Dordogne, France, described by Broca, and those of a skeleton of the cavern of *less Enfants*(35), from the sepulchre of the troglodytes of Grimaldi, on the Mediterranean, in Italy near Monaco, described by Verneau, will be presented, together with measurements of two individuals from Taytay. To make the comparison more interesting, with these are given the measurements of two Nilotic Negroes, of two Negroid skeletons of Grimaldi, of two blonde Americans now living in the Philippines, and of another Cro-Magnon skeleton from the grottoes of Grimaldi.

Comparison of Cro-Magnons, Negroes, Americans and Taytayans.

Body character.	Living.			Skeletons.						
	Taytayan serial No. 74, absolute.	Taytayan serial No. 103, absolute.	Average Taytayan, absolute.	Cro-Magnon (Broca) les Ezzies, absolute.	Cro-Magnon (Verneau) Grotto des enfants, absolute.	Cro-Magnon (Vézère), absolute.	Grimaldi Negroes, absolute.	Grimaldi Negro boy, absolute.	Europeans (Broca), absolute.	Negroes (Broca), absolute.
Stature	167.7	167.0	159.5		189.0	177.0	159.5	156.0		
Upper leg length	46.6	40.6	39.2		52.2	49.1	43.4	41.9		
Lower leg length	38.1	40.6	37.3		45.0	40.2	36.4	35.1		
Upper arm length	34.1	32.6	32.4		36.5	35.0	29.1	27.1		
Forearm length	26.7	24.0	23.1		27.9		23.3	21.5		
Head:										
Maximum length	19.3	19.4	18.3	20.2	19.8	20.6	19.1	19.2		
Maximum breadth	14.7	14.7	15.0	14.9	15.1?	14.2?	13.1	13.3		
Total face length	21.1	19.1	18.5	22.7?	24.5?	23.0?	16.0?	18.0?		
Total face breadth	14.2	14.0	13.8	14.4	15.5?	15.2	10.3?	11.2?		
Cephalic index	76.2	75.8	81.8	73.8	76.3	71.4	68.6	69.3		
Face index	67.3	73.3	74.6	63.4	63.2	66.5	63.6	61.5		
Preauricular circumference	28.2	27.7	27.5	27.2	26.9		24.0	23.1		
Post auricular circumference	29.6	29.0	28.5	29.6	29.1		28.2	29.2		
Nasal index	89.1	97.6	85.2	45.1	56.9	47.2	63.6	54.4		
Tibio femoral index	81.8	100.0	95.2		85.4	81.5	83.9	83.8	79.7	81.3
Radio humeral index	78.3	73.6	71.3		76.4		80.1	79.4	73.9	79.4
Intermembral index	70.6	69.7	72.5		66.1		65.7	63.1	69.7	68.3

Body character.	Living.							
	A blonde American No. 1.		A Nilotic Negro (A Burum).		A Nilotic Negro (A Nuer).		A blonde American No. 2.	
	Absolute.	Relative.	Absolute.	Relative.	Absolute.	Relative.	Absolute.	Relative.
Stature	182.0	100.0	190.0	100.0	165.0	100.0	189.2	100.0
Upper leg length	47.0	25.8	51.0	26.8	46.0	27.8	51.5	27.2
Lower leg length	42.0	23.1	51.0	26.8	40.0	24.2	45.0?	23.8
Upper arm length	35.5	19.5	34.0	17.9	32.0	19.3	37.0	19.5
Forearm length	27.5	15.1	33.0	17.4	29.5	17.9	26.7	14.1
Head:								
Maximum length	20.0		19.7		20.0		19.3	
Maximum breadth	15.0		15.0		14.0		14.3	
Total face length	18.0		18.9				17.7	
Total face breadth	13.3		14.0				13.5	
Cephalic index	75.0		76.1		70.0		74.1	
Face index	73.9		74.1				76.3	
Preauricular circumference	27.0							
Post auricular circumference	32.0							
Nasal index	66.0		95.0		95.0		56.1	
Tibio femoral index	89.4		100.0		87.0		87.3	
Radio humeral index	77.5		97.1		92.2		72.2	
Intermembral index	70.8		65.7		71.5		66.0	

It is to be noted that the stature of the Taytayan Cro-Magnons is only 167.0 and 169.7 centimeters. The calculated stature of the Cro-Magnon from Grimaldi is from 175 to 189 centimeters, of the Americans 182 and 189.2 centimeters, and of the Nilotic Negroes from 165 to 190, whereas the stature of the Grimaldi Negroes is only 156.0 to 159.5 centimeters. The last two measurements, however, are of an old woman and a boy.

The absolute upper leg length of the two Taytayans is 40.6 and 46.6 centimeters, the length of femur of the Cro-Magnon of Grimaldi is from 47 to 52.6 centimeters, the upper leg length of the Americans is 47 and 51.5 centimeters, the Nilotic Negroes are from 43 to 51 centimeters in upper leg length, and the Negroes of Grimaldi have a femur length of 41.9 and 43.4.

The absolute lower leg length of the Taytayan Cro-Magnon is 38.1 and 40.6 centimeters, the tibia length of the Cro-Magnon of Grimaldi is from 40.4 to 45.0 centimeters, the lower leg length of the Americans is 42 and 45 centimeters, that of the Nilotic Negroes is from 39 to 51 centimeters, and of the Negroes of Grimaldi 35.1 and 36.4 centimeters in length of tibia.

The absolute upper arm length of the Taytayans is 32.6 and 34.1 centimeters respectively, the length of the Cro-Magnon humerus is 34.2 to 37.9 centimeters, the upper arm of the American is 35.5 and 37.0 centimeters long, that of the Nilotic Negroes is 31 to 34 centimeters long, and the humerus of the Grimaldi Negroes is 27.1 and 29.1 centimeters in length.

The absolute forearm length of the Taytayans is 24 and 26.7 centimeters, the radius length of the Cro-Magnon is from 26.1 to 28.6 centimeters, the forearm of the Americans is 26.7 and 27.5 centimeters long, that of the Nilotic Negroes is from 29.5 to 33.0 centimeters in length, and the radius of the Grimaldi Negroes is 21.5 and 23.3 centimeters long.

Certain contrasts and parallels may be deduced from the foregoing: Whereas the stature of the Taytayan Cro-Magnon is less than that of any except the Grimaldi Negroes, yet the limb parts of the Taytayan are about as long as the Cro-Magnon of Europe or the Nilotic Negro, except the forearm of the latter which exceeds that of any other. The upper arm of the Taytayan is also relatively long, but in spite of these differences the evidence is such that the Taytayans selected are considered to be modified Cro-Magnons, and the Nilotic Negroes are also modified Cro-Magnons; the first with decreased stature and increased relative upper arm length due to the union with a type of that nature pertaining to the East, the other with about the same stature but with increased relative forearm length due to mixture with African types.

Verneau(34) has demonstrated the presence of Cro-Magnon types in the living population of Europe, and the measurements of the two Americans are given to show their relationship to the early Cro-Magnon of that country.

Head and face measurements corroborate the limb measurements and, if anything, are more emphatic in associating the Cro-Magnon with the Taytayan, and with the Nilotic Negro. The head length and breadth are greater in the Cro-Magnon than in the others, and the cephalic index is less, the face dimensions of the Cro-Magnon are also greater than in the others, but the head is dolichocephalic and the face is large in all alike. The nose of the Negro and of the Taytayan are more platyrrhine than the Cro-Magnon but in all it is similar: large and straight. The head, nose and face of the Americans are smaller than of the Cro-Magnon and indicate affinities to the Mediterranean Race of Sergi, or Iberian, as it is called in the present work.

Dr. Pirrie(38) noted that the occiput of the Nilotic Negro is prominent—projects boldly backwards—and this is characteristic of the Cro-Magnon. The Taytayan is not so marked in this feature but the occiput of one American exceeds all others in this respect. Figures 161 and 168, pages 368 and 370, in the Third Report of the Wellcome Research Laboratories, represent modified Cro-Magnon heads.

Undoubtedly, the Cro-Magnon has become dissipated by fusion in Europe and Africa, and I believe in Asia as well. Cro-Magnon characteristics may be noted among the Chinese of Manila(6), and among the Filipinos of many provinces. This may be accounted for through Spanish intermixture, but earlier infiltrations from Europe can not be excluded.

Cro-Magnon characteristics may be seen by examining Plates I, VIII, IX, X, XI, XII, and XV, although obscured by other types. Plate XV represents the nearest approach to the Cro-Magnon that could be photographed at Taytay, although partly Australoid and recent Iberian. The dorsal flattening of the head in the latter is, I believe, a relic of infancy when the head rested a great deal on the *petáte* with a hard flat surface beneath.

The sagittal head outlines from glabella to inion of the two Taytayan Cro-Magnons and of one American Cro-Magnon are given for comparison and contrasts. (Fig. 15.) The height of the two Taytayans is greater than the American, and, as a matter of fact, the auricular bregmatic height of the American is 12.4 centimeters whereas that of the Taytayans is 13 and 13.6 centimeters. The two Taytayan outlines were made with the cephalograph and are exact, but the outline of the American was made with electric fuse wire and is therefore not so exact, but it does not vary more than a few millimeters at any point and the general contour is a true representation of the head shape.

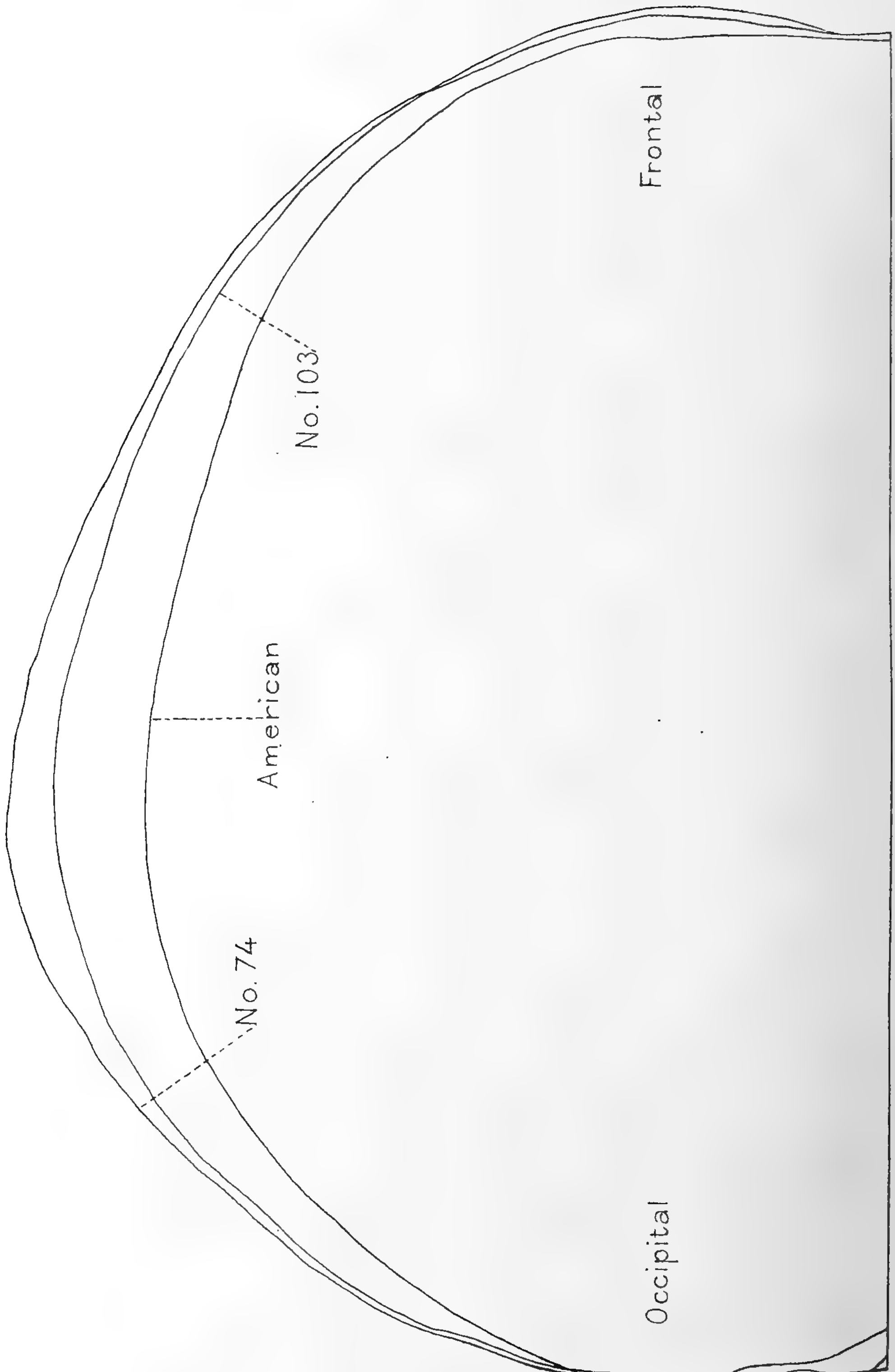


Fig. 15.—Three Cro-Magnon Head Outlines. Blonde American No. 2. Taytayan Serial No. 74, Clinical No. 535; Serial No. 103, Clinical No. 616. American Outline Made with Lead Fuse Wire, the Others with the Cephalgraph.

The same difference between the American and Filipino outlines is seen as that noted between the American students and Igorots (3). The American is long and low, the Filipino is of equal length but high. Notwithstanding the differences, the three outlines resemble the outlines of the Cro-Magnon skulls of prehistoric Europe. This is especially true of the American outline which has the vertical forehead, the long straight superior part of the fronto-parietal region, and especially the projecting occiput, that makes it identical with the masculine cranium of the Grotto des Enfants portrayed in Plate III of Verneau's "*Grottes de Grimaldi.*" The heads of the Taytayans have probably been somewhat flattened dorsally and thereby projected upward and pressed forward by the *petáte habit* of infancy; otherwise the shape may be due to crossing with the Primitive and other types.

Compare with these outlines the heads of two Nilotic Negroes (38) (figs. 161 and 168) and a striking similarity is seen, although the Negro heads show the flat superior frontal region previously described by me (Negro brain) which differentiates them from other peoples.

The Alpine.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	164.3	**159.34**	151.5	11
Absolute lower leg length	38.9	**37.16**	34.5	10
Absolute upper leg length	42.4	**38.71**	34.7	10
Absolute forearm length	25.2	**22.54**	18.3	12
Absolute upper arm length	34.8	**32.72**	29.0	10
Omphalic index	52.2	**42.59**	36.3	10
Cephalic index	94.3	**87.74**	84.3	11
Nasal index	81.1	**70.08**	54.9	11
Morphologic face index	89.7	**82.21**	75.5	11

The characteristics of the Alpine may be emphasized by contrast with the Cro-Magnon. The difference is great. The Alpine is small, the Cro-Magnon is almost tall; the Alpine is brachycephalic, the Cro-Magnon is dolichocephalic; the Alpine is leptorrhine, the Cro-Magnon is platyrrhine; the Alpine is short, squat and fat, the Cro-Magnon is long, lanky and lean; the lower leg of the Alpine is relatively long, that of the Cro-Magnon is not; the forearm of the Alpine is relatively shorter than that of the Cro-Magnon; and the face of the Cro-Magnon is relatively longer than that of the Alpine. The physiognomy and the ear are different as may be seen by an examination of the plates representing the Cro-Magnon characteristics, and of Plate XIII.

The Alpine is probably a mixture of Primitive and Iberian in which the head form of the Primitive is retained with the physiognomy and stature of the Iberian. The nose is even more leptorrhine than the Iberian and the morphologic face index is between that of the Primitive and Iberian but nearer the latter. Further observations on the ear are convincing and will be discussed further on in the present work.

The Alpine is therefore the complement of the Australoid which is supposed to represent the mixture of Primitive and Iberian in which the head form is Iberian and the physiognomy Primitive. This confirms in a measure the suggestion that human types conform to tomato hybrids suggested in a previous paper on Manila Students.

The B. B. B.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	166.8	**165.9**	165.0	2
Absolute lower leg length		**38.5**		1
Absolute upper leg length		**42.5**		1
Absolute forearm length		**23.8**		1
Absolute upper arm length		**29.8**		1
Omphalic index		**37.1**		1
Cephalic index	82.2	**81.7**	81.2	2
Nasal index	68.6	**67.6**	66.6	2
Morphologic face index	89.0	**87.4**	85.7	2

The evident characteristics of this species are stature slightly above the average, relatively short lower legs and short upper arms, low omphalic index, very narrow nose, and very long face with slightly brachycephalic head.

The species is fairly well illustrated in Plates XIV and XV, and in Plate I in the full figure on the right. It conforms in actual dimensions to the Students and Morgue subjects of the same species. The head outline is given in fig. 16 in contrast with the head outline of an Alpine.

As previously noted, this species is a large edition of the Alpine, but the two are different in many ways. It seems to be a combination of Alpine and Iberian. If the Alpine is a result of Iberian and Primitive blending, the two species, Alpine and B. B. B., are derived from the Primitive and Iberian by a process of crossing and re-crossing. Re-crossing the Primitive and Alpine should produce a species similar to the Alpine but more like the Primitive, and such a species is the Blend—at least that part of it that resembles the Primitive.

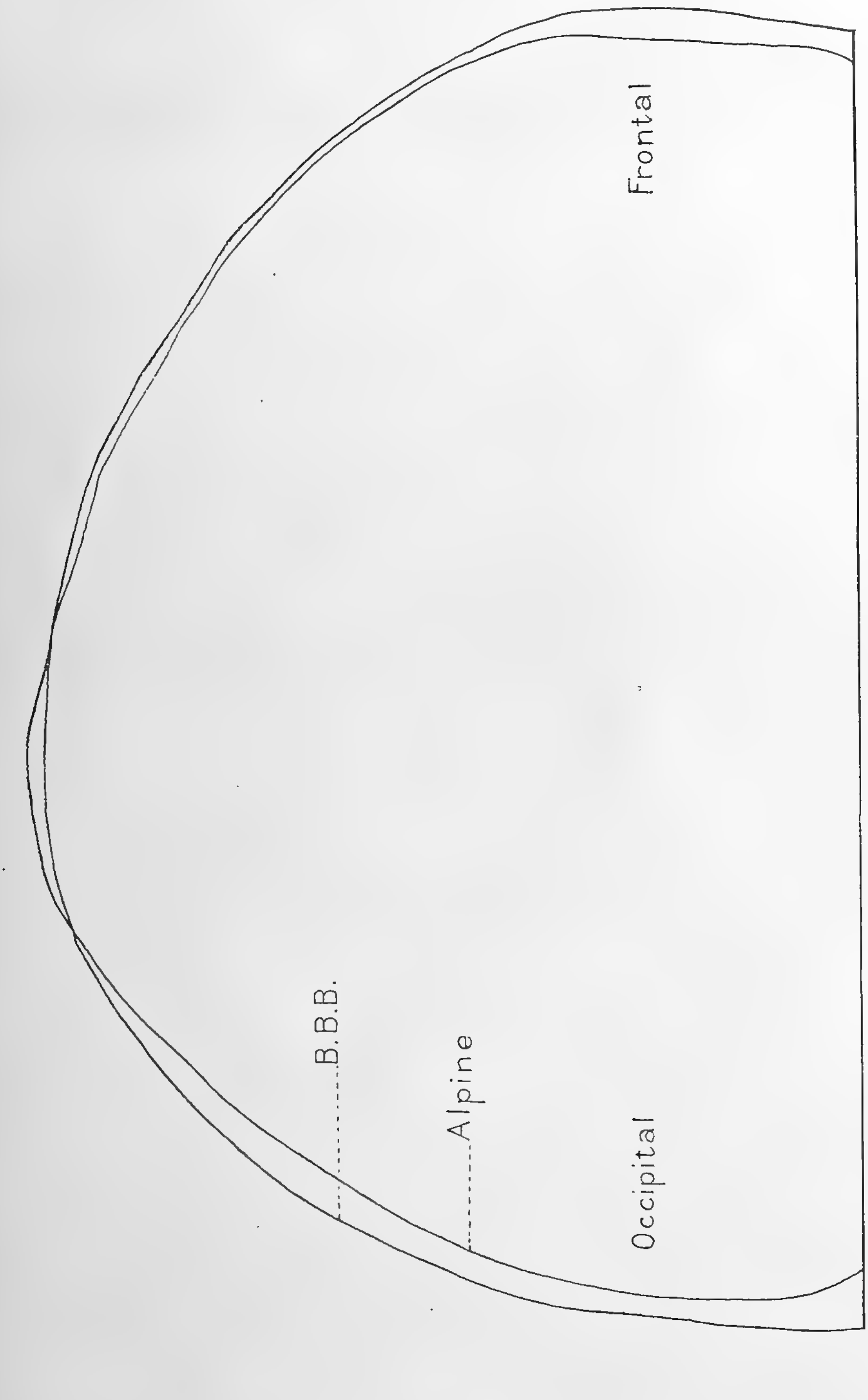


FIG. 16.—SAGITTAL HEAD OUTLINES OF ALPINE AND B. B. B. ALPINE IS SERIAL NO. 88, CLINICAL NO. 180. B. B. B. IS SERIAL NO. 8, CLINICAL NO. 353.

The Blend.

Character.	Maximum.	Mean.	Minimum.	Number of individuals.
Stature	171.0	158.8	145.7	94
Absolute lower leg length	41.0	37.2	32.4	87
Absolute upper leg length	43.9	39.1	33.2	88
Absolute forearm length	27.9	26.5	18.6	88
Absolute upper arm length	34.9	33.2	26.5	87
Omphalic index	57.6	42.2	20.4	88
Cephalic index	88.7	83.3	78.0	91
Nasal index	100.0	83.8	70.4	91
Morphologic face index	92.5	82.05	66.1	88

The Primitive, Modified Primitive and Adriatic enter largely into the Blend and one is tempted to constitute this as a definite species, embodying the Primitive and Adriatic. Two important differential characters that are Primitive in nature are noted: the high radio-humeral and tibio-femoral indices, the latter 95.1 and the former 79.8. The close relationship of the Taytayan Blend and the Primitive Morgue subject and Primitive Student in these particulars is noteworthy. The intermembral index is also high, being 78.2, as against 71.2 for the Cro-Magnon of Taytay. These three characters are Negroid or Negritic, and the inference is that the Negrito forms a large part of the composition of the Blend.

A review of the Blends reveals 55 of the 94 that resemble the Primitive. A similar review of the Igorots reveals 70 of the 104 that resemble the Australoid. The contrast needs no comment. Among the Blends there are also 10 that resemble the Iberian, 7 the Australoid, 5 the Modified Primitive, and 5 the Adriatic; the remainder are Alpine and B. B. B., and among these some Cro-Magnon that resemble the Iberian.

It is true that the majority among the Igorot Blends resemble the Primitive so that a similarity exists between the two peoples in this respect, but the differences between the groups are otherwise considerable.

The differences are slight when compared with the Blends of the Morgue subjects and the students. The stature of the student is greater, and the intermembral index of the morgue subject is less, but otherwise the Blends of all three form a somewhat stable composite that may be called a species. This species would be characterized by small stature, and would be brachycephalic, messorrhian, mesoprosopic, mesomphalic, with Negritic limb parts. All the characteristics are more Primitive than otherwise, the indications point to a dominating influence for the Primitive, and the Blend truly represents a Modified Primitive. The Adriatic and Modified Primitive will not be treated because of the small number of each and the Blend may be taken in their place as having absorbed them or modified them. However that may be, they are seldom seen in Taytay.

The head form of the Alpine, B. B. B., and Blend, as determined by the sagittal outlines, may be seen in figs. 10 and 16. The Alpine and B. B. B. are almost identical, except that the Alpine is shorter and higher as if it had been flattened more in the occipital region. The Blends appear to be exaggerated Alpine outlines exhibiting greater occipital flattening.

IV. EAR TYPE AND SPECIES.

In a previous monograph on Filipino Ears(6), an attempt was made to classify types of ears with concomitant morphologic types by general observations in a casual manner. The present work is an extension of the classification to a small number of individuals who are examined closely, in which more time is given, an exact study is made, and a more critical analysis of each individual's ears is possible. The result is a more exact classification of the ear types and the association of these with more definite types of men.

THE PRIMITIVE EAR.

This ear was previously named Malay, but there is now sufficient evidence of its association with the Primitive and allied forms to change the term Malay, which is an indefinite one at best, to that of Primitive, which represents not only the form of the individual but the characteristics of the ear as well. Both are infantile throughout. The description of the ear is altered somewhat from that of the Malay as follows:

The Primitive ear is small, round and somewhat flaring, cup shaped, and with depressed concha, in contrast with the everted concha of the Iberian. It is intermediate in form between that of a four month foetus as described by Schwalbe(27), and the adult European as exemplified by the Iberian. It is well illustrated in Plates I to V of the present work and in Plate IV of the monograph on Filipino ears(6). It may also be seen in Martin's work on the inland stem of the Malay Peninsula(18), as in the Senoi boy of fig. 31, page 317, the Senoi boy of fig. 47, page 359, the Senoi maiden of fig. 48, page 360, the Senoi of fig. 54, page 391, and probably in fig. 57, page 397, and fig. 96, page 708, (although there it is not so clear), in fig. 98, page 712, figs. 100 and 101, pages 717 and 719, and in Tables XII and XVI, in all of whom there are Primitive characteristics of physiognomy with Australoid heads. Other Senoi men and women illustrated in the same work do not have the Primitive ear and their physiognomy and other characters indicate other than Primitive features. Martin's Senoi and the Australoid herein described are of the same nature. Some forms partake of the Primitive except in head shape, whereas other forms are not Primitive, but Iberian or Negrito. The former are the *primary* Australoids, the latter the *secondary* Australoids.

(See pp. 414 and 439.) The Primitive ear appears pure or mixed at Taytay (see Table on p. 433) on 35 Blends, 15 Australoids, 3 Primitives, 3 Modified Primitives, 5 Cro-Magnons, 2 Alpines, 2 Iberians, and 1 Adriatic. The types partake of the Primitive in ear form to the extent represented by the number given with each. All the Primitive, Modified Primitive and Adriatic have Primitive ear forms, and the form occurs often in the Australoids and Blends. There is no Adriatic or Modified Primitive ear, but these themselves are altered Primitives. There is no Australoid form, but it may be of interest to note the forms of ears that appear upon the Australoid. As already stated, there are 15 that resemble the Primitive, in addition to which 26 resemble the Iberian, 7 the Alpine, 6 the odd type, 5 the B. B. B., and 32 are mixtures of either two or more of those already mentioned or of unknown type. The Australoid ear is largely Iberian and Primitive, thus corroborating the supposition of its origin as a result of the crossing of these two.

THE IBERIAN EAR.

The types of this ear have been increased to include the Cro-Magnon and the Igorot, in addition to which another type has been added, making five in all, to which may possibly be added the B. B. B. and Alpine, leaving all the ear forms thus far segregated either Iberian and Modified Iberian, or Primitive and Modified Primitive. The morphologic types become narrowed down to the European and the Eastern. But this is too simple, and the Alpine is more like the Primitive than like the Iberian, and the B. B. B. is distinct from either. The Igorot ear has resolved into the Iberian (C), a modified B. B. B., and the Subnorthern (Chinese), all three of which have similarities, but each of which is different from the other. The Igorot ears will be presented in a subsequent publication. Good photographs were secured of all the Iberian types except C.

THE IBERIAN A EAR.

This ear is represented somewhat modified in Plate II and it may also be seen in Plate VIII of the Filipino ears(6), and in the Plates I, V, VI, and VII of the Theory of Heredity(2) in an Iberian from Madrid, Spain. It is a round or elliptical ear, usually flaring slightly and often standing out from the head. The helix and lobule are symmetrical, and the helix is inrolled until it almost touches the everted concha.

This ear, or modifications of it, occurs on 25 Blends, 9 Iberians, 6 Australoids, 3 Cro-Magnons and 2 Alpines. It is found more often among the Blends than is any other except the Primitive, and it is in greater proportion among the Iberians than is any other ear form.

THE IBERIAN B EAR.

The Iberian B is the most distinct of all the Iberian ears, and probably represents the true type. When it appears on an individual it is clear cut, as a rule, indicating a lack of blending, or it may be that the other Iberian ears are blends, whereas this is the original type. The ear is well illustrated in Plate VIII of the present work and in Plate IX of the Filipino Ears (6). The description given in that paper can hardly be more exact. The eversion of the concha, the direct attachment of the lobule to the cheeks with the absence of the lobule, and the peculiar spiral twist as seen from any point are unmistakable and emphasize the ear as a most distinct type.

It is found pure or impure on 12 Blends, 7 Australoids, 2 Iberians and 1 Alpine. Its numbers are relatively small compared with the other Iberians. The 4 individuals in which the ear is comparatively pure are all Blends with small stature; they are mesorrhinean and brachycephalic, but three of them have the flat occiput that is probably due to distortion; therefore the heads would probably have been dolichocephalic with the absence of the dorsal flattening, the Blends thus becoming Iberians.

The ear is frequently associated with the Iberian C ear which is apparently a modified form of the Iberian B.

THE IBERIAN C EAR (IGOROT).

This ear resembles the Igorot ear because it has a square inferior margin without lobule, but it is smaller, more slender, and the lower margin is narrow, whereas that of the Igorots is broad. Undoubtedly this form of ear is present among the Igorots and could readily be mistaken for the Igorot ear, but the above-mentioned qualities differentiate it. The Iberian C also resembles a form of Chinese ear, except that the latter stands almost at right angles to the head, whereas this form does not. The Iberian C ear is small, slender and delicately molded, and either stands close to the head or flares very little. The lobule is absent, and in its place the lower part of the ear is square, joining the cheek at right angles. It occurs more or less pure on 22 Blends, 7 Australoids, 6 Cro-Magnons, 5 Iberians, 4 Alpines and 1 Primitive: 45 times in all.

The relatively pure Iberian C ear appears on 5 Cro-Magnons, 4 Blends, and 1 Alpine. Two of these individuals are small, 2 are below medium height, 4 are above medium height, and 2 are tall. Three heads are decidedly flat behind, which, were the flattening absent, would remove the individuals from the group of Blends to the Iberian. The middle figure in Plate III and in Plate VI of the monograph on the Igorots (3) shows Iberian C ears.

THE IBERIAN D EAR (CRO-MAGNON).

This ear is so well illustrated in Plates IX and X that it needs no description. It is the long ear previously portrayed and described as the Cro-Magnon(6). Its leading characteristics are the large pendant lobule, large open concha somewhat everted, and straight external margin of the helix.

The ear appears pure or mixed on 20 Blends, 7 Iberians, 6 Australoids, 4 Alpine, 3 Cro-Magnons and 1 B. B. B. None of the individuals with relatively pure type ears are tall, and only two are above medium height, but 4 are below medium height and 7 are small. This is therefore not a Cro-Magnon physique, but an Iberian. The individuals with Iberian C ears resemble the Cro-Magnon in size more than those with Iberian D ears. The Cro-Magnon ear has become disseminated apparently among the Iberian types to such an extent as to lose its identity; and for this reason it can not be located and described. However, at rare intervals an ear appears that is similar to that shown in figure 12 of the monograph on Filipino Ears(6), and also to that in No. 3202 in Plate VII and No. 14964 in Plate X of the same paper, in which the ear is long and resembles the Iberian D; but its position is almost at right angles to the head, the lobule is not pendant, and the helix is much inrolled with everted concha. This was named the Cro-Magnon, but, as may be recognized, the characters are largely Iberian, and most frequently appear in association with one or another Iberian type.

THE IBERIAN E EAR.

This type is rare, and a doubtful entity, although a similar ear form has been seen on at least 3 men in Manila recently: one a German, one an Englishman, and one a Filipino. The ear stands straight from the upper part of the base, and the helix tends to roll over above, giving a drooping appearance. Otherwise, the ear is similar to the Iberian A in form. The individuals have very long heads, small stature, and their physiognomy is characteristic. The nose is aquiline, the lips are full, the eyes are large and wide open. One hesitates to assign this ear to the Iberian or to designate it as a specific form, and future investigations may clear up its relationships. For the present it remains Iberian E, and may be seen in modified form in Plate XII.

THE ALPINE EAR.

This ear, unfortunately, does not appear on a single individual of the Alpine species, and occurs only twice in relative purity, the two individuals being Australoids. The ear is found on 9 Blends, 7 Australoids, and 1 each Cro-Magnon, Iberian, Primitive, and Modified Primitive. The ear in absolute purity was not seen once in Taytay, but was present only in modified form resembling the Primitive, as may be seen in Plate XIII. This confirms previous observations. However, as the study of this ear continues, it looks more and more like a blend of Iberian and Primitive. The front view can with difficulty be differentiated from the Primitive. The lateral view shows the concha somewhat everted and the absence of lobule, suggesting the Iberian B. The Alpine ear and the Alpine species will be found purer and more often in conjunction wherever the Philippine population is not so mixed as it is at Taytay.

THE B. B. B. EAR.

This ear, like the Alpine, was not found in purity at Taytay. Modified forms may be seen, however, in Plates XIV and XV, where it resembles the pure type, but it is by no means pure. Oblong shape and almost flat surface characterize the ear when pure. These characters are present in the two individuals portrayed, but only in a modified way.

The ear appears more or less pure on 11 Blends, 5 Australoids, 2 Iberians, 1 B. B. B., 1 Cro-Magnon, and 1 Alpine.

THE COMPARISON OF EAR TYPE AND MORPHOLOGIC TYPE.

The table is presented showing the number of each kind of ears found on the individuals of the different species.

Comparison of ear and morphologic types.

Morphologic types.	Ear types.												
	Primitive.	Iberian total.	A.	B.	C.	D.	B. B. B.	Alpine.	Odd type.	Pure ear forms.	Mixed ear forms.	Total ear forms.	Total number of individuals.
Blend	35	79	25	12	22	20	11	9	17	20	74	161	94
Australoid	15	26	6	7	7	6	5	7	6	5	32	59	37
Iberian	2	23	9	2	5	7	2	1	4	5	12	32	17
Cro-Magnon	5	12	3	0	6	3	1	1	1	5	7	20	12
Alpine	2	11	2	1	4	4	1	0	1	5	7	15	12
B. B. B	0	1	0	0	0	1	1	0	1	1	1	3	2
Primitive	3	1	0	0	1	0	0	1	0	0	3	5	3
Modified Primitive	3	0	0	0	0	0	0	1	2	1	3	6	4
Adriatic	1	0	0	0	0	0	0	0	0	0	1	2	1
Total	66	153	45	22	45	41	21	20	32	42	140	302	182

The last four columns of the table need some explanation. The pure ear forms are those in which the ears resemble only one type, and the mixed ear forms are those in which more than one type is combined. The two columns (pure and mixed ear forms) equal the total number of individuals. The total ear forms are obtained by adding the number of Primitive, Iberian, B. B. B., Alpine and odd Type ears.

The Blend has more than twice as many Iberian as Primitive forms, and a relatively large number of the odd type. The mixed ear forms and the total ear forms are in relatively greater abundance than among the pure types.

The Australoid has less than twice as many Iberian as Primitive ear forms, and a relatively large number of Alpine ears. The number of pure ear forms is small and the number of mixed ear forms is almost as great as the total number of individuals. The Australoid and the Blend are evidently impure types.

The Iberian species has only two ears that resemble the Primitive form and 23 that are Iberian, whereas the Primitive species has only one resembling the Iberian, and 3 that are Primitive in form. The Iberian has a relatively large number of pure ear forms, and few mixed ear forms. The Primitive and Iberian species are evidently purer than the Australoid and Blend in ear form. Each Cro-Magnon individual has some Iberian ear form, although 5 resemble the Primitive. The pure ear forms are relatively great and the mixed are relatively small.

The Alpine species also has a large number of Iberian ear forms and only two that resemble the Primitive. The pure forms are also relatively more frequent than the mixed.

The Modified Primitive has Primitive ears, and the Adriatic has the same form.

The B. B. B. species has B. B. B. and Iberian ears.

There are seven ear forms that are called mixed because no resemblance to any recognized form could be seen.

SUMMARY.

The ear form is established beyond doubt as a differential factor in racial anatomy, and among the Filipinos of the littoral it should be placed above the cephalic index in importance, because of the apparent distortion of the head in many individuals. By the ear alone, the derivation of the majority of people may be determined, and in conjunction with the nasal index and stature, assisted by the cephalic index, more definite species can be segregated than by using the last three without the ear type. The table of ear types and morphologic species demonstrates that the species segregated by means of the three morphologic factors are not entirely homogeneous in ear form, and this lack of homogeneity is probably due to the distorted heads. The Iberian species as segregated is relatively pure, although this is the Filipino-Iberian, a mixed species in reality. The Cro-Magnon is partly Iberian and partly Primitive, but the Cro-Magnon characters have been positively proved. The Australoid is segregated as a mixed species in process of formation and the ear form substantiates this. The three species are dolichocephalic, and although their heads might be longer if no dorsal flattening appeared in any individual, yet the flattening is a negligible factor. Not so, however, with the remaining species, except the Primitive, Modified Primitive and Adriatic, whose heads are so hyper-brachycephalic that if there were no dorsal flattening the heads would probably still be brachycephalic. The Blend, the Alpine and the B. B. B. are not so hyper-brachycephalic, and if the heads that are flattened dorsally could be made natural, some of the individuals of these types would be Iberians. This is indicated by the relatively large number that have Iberian ears.

Therefore I would alter the terminology of the species of some individuals where the ear type is significant. This is done in the table of indices in the first column (Table II, pp. 390–397) by placing in parenthesis the alteration. The species, as selected by the three factors, cephalic index, nasal index, and stature, is placed first in this column, after which in parenthesis, come the true species as determined by a consideration of the ear form and other characteristics.

The number of individuals in each species becomes altered as shown in the following table:

	Iberian.	Blend.	Australoid.	Alpine.	Cro-Magnon.	B.B.B.	Primitive.	Modified Primitive.	Adriatic.
Original classification	17	94	37	12	12	2	3	4	1
Altered classification	50	41	39	11	13	4	14	9	1

In the original classification, the number of individuals constituting the Blend exceeds that of all the species combined, which was obviously too great a number in so mixed a population. The altered classification reduces the Blends more than one-half by placing a large number of them with the Iberian, Primitive and Modified Primitive. The other species remain practically unaltered except the B. B. B., which is increased by two individuals, thus doubling the former number. This is a more exact classification and represents real conditions.

The Taytayans would therefore be placed in the scheme for heredity (2) between 2 and 3 under Spurious Mendelism, and they would be nearer 2 than 3 because the number of species greatly exceeds the number of Blends, and at least two species, the Iberian and the Primitive, are relatively pure.

In concluding the discussion of the ear form, it may not be out of place to criticize the types selected by Folkmar and presented in his Album of Philippine Types (11). The majority of them are Blends with evident Iberian characteristics, but many of them are sufficiently pure in type to be classified as species exactly by their ear form.

Plate 56 of Folkmar, represents a typical Primitive with a typical Primitive ear. This is a Visayan with a stature of 148.5 centimeters, a cephalic index of 92.17 and a nasal index of 91.49. The head has the flat occipital region said to be characteristic of the Malay, and this probably accounts for the high cephalic index. The ear presents the double roll aspect so often seen in the Primitive, caused by the helix and concha lying close together.

The Negrito-Tagalog, in Plate 76 of Folkmar, has Modified Primitive ears but would be classed as Australoid by other characteristics. Likewise the Negrito of Plate 78 of Folkmar, has Modified Primitive ears but is Australoid by the cephalic index of 78.45, nasal index of 102.38 and stature of 135.7 centimeters. Other Modified Primitive ears may be seen in Plates 14, 34, 66, and 67 of Folkmar.

The Alpine ear may be seen in Plate 44 of Folkmar, where the individual (a Tagalog of Laguna Province) is also of that species, with a stature of 163.5 centimeters and cephalic index and nasal index of 88.24 and 83.67 respectively. Other Alpine ears somewhat modified and resembling both Primitive and Iberian, may be seen in Plates 1, 17, 20, 21, 25, 37, and 66 of Folkmar.

Plate 60 of Folkmar, a Visayan of Masbate, represents a secondary or recent Australoid, with typical Iberian A ears.

Plate 41 of Folkmar, a Tagalog of Bulacan Province, has Iberian C ears, and the physiognomy is mixed Iberian, the individual being a Blend.

Other more or less pure Iberian ears may be seen in Plates 4, 5, 8, 12, 15, of Folkmar, many others throughout the Album have some Iberian characteristics, and only a few have no Iberian characters in ear form.

Plate 59 and plates 50 and 75 of Folkmar represent modified B. B. B. ears, and types with oblong face and head resembling the B. B. B. species.

A man simulating the Cro-Magnon and having Iberian (Cro-Magnon?) ears is seen in Plate 32 of Folkmar.

Folkmar may have classified Filipinos to his own satisfaction, and others may see the Tagalog, or Ilokano or Visayan type, but I can not find sufficient uniformity of characteristics to justify the classification into such groups although there may be a slight superficial resemblance in facial expression, attitude, manner of action, etc. Folkmar's divisions are therefore unjustified, whereas by the ear type and its associated physical type, much may be obtained from the plates of his Album.

There can be no doubt of the two species, Primitive and Iberian, among the Filipinos, and it is possible that the various manifestations of these and the union of their different characters in many combinations result in the other species, although the B. B. B. when pure is unlike either the Primitive or Iberian.

V. DISEASE AND SPECIES.

The association of tuberculosis and beriberi with the Iberian and Primitive species respectively, was previously determined in a study of the types found in Malecon Morgue(5). The present study corroborates the association of the Iberian species with tuberculosis, but adds nothing to substantiate the association of beriberi with the Primitive species, because only one case of beriberi is noted and that in a Cro-Magnon, although the ears of this individual showed Primitive markings.

The afflictions of the Iberian were 9 with intestinal parasites, 4 with tuberculosis of the lungs and 1 with other lung or pleural affections, 1 with heart or arterial disease, 2 with fever and 1 with neurasthenia. Such few observations would mean little, but they corroborate previous findings in the morgue, therefore their meaning is significant.

The Primitive, 3 subjects, have 2 with animal parasites, 1 with lung or pleural affections and 1 with some acute infection.

The Australoid is affected in 18 cases with animal parasites, 6 with tuberculosis, 2 with other lung or pleural affections, 2 with heart or arterial disease, 1 with neurasthenia, and 3 with the kidneys or genito-urinary organs affected. The large number of cases of tuberculosis is probably due to Iberian influence.

Among the Blends are 60 cases of animal parasites, 12 cases of tuberculosis, 8 cases of lung or pleural affections other than tuberculosis, 18 alimentary affections other than animal parasites, 5 heart and arterial diseases, 4 cases of fever, 5 of acute infections, 3 with skin diseases including 1 case of leprosy, 3 with diseases of the kidneys and genito-urinary organs, 1 case of rheumatism, and 1 of splenic affection.

The diseases group themselves in a similar manner when the ear type alone is the differential factor, as in the following table:

	Intestinal parasites.	Respiratory.	Circulatory.	Nervous.	Fevers.	Urinary.	Alimentary.	Others.
Mixed ears	49	17	4	1	1	6	8	4
Iberian ears	26	13	3	1	2	0	5	3
Iberian-Primitive ears	11	2	1	10	3	1	1	1

The mixed ears include those that are not of any distinct type and whose affinites are obscure or of many kinds. Probably the majority of these have Iberian characteristics.

The Iberian has a greater proportion of lung affections and fewer urinary troubles than the mixed. The Iberian-Primitive has fewer lung troubles and a greater number of intestinal parasites than either the Iberian or mixed.

Other forms are not considered because there are too few for comparative purposes.

The Iberian and the Primitive are next compared by taking every individual in which either type of ear occurs, be it pure or not, there being 59 in the Iberian group and 29 in the Primitive. The diseases are then found to be as follows:

	Number.	Intestinal parasites.	Lung.	Tuberculosis.	Alimentary.	Circulatory.	Malaria.	Others.	Beriberi.	Total.
Iberian	59	48	18	12	10	8	4	7	0	107
Primitive	29	19	3	1	2	1	0	3	1	29

This again corroborates previous findings, and signifies that by the ear alone the susceptibility to tuberculosis may be indicated. There are also indications that malaria is more frequent among the Iberian Filipinos, and that the heart and arteries are affected more often than in the Primitive. Indeed, all diseases are associated more frequently with the Iberian than the Primitive, except beriberi, and only one case of this disease is reported among the men measured.

No absolute conclusions would be justified from the facts exposed, but the inference is strong that the Iberian is more susceptible to all diseases but more especially to tuberculosis than the Primitive. This may be indicative that the European and Filipino blend, or its resulting off-spring of the Iberian type, is less resistant to disease in the tropics than is the aboriginal type on its own soil and in its natural environment.

The records of disease may be found in the statistics of the Medical Survey of the town of Taytay in the Biological Laboratory, Bureau of Science, from which the data are drawn.

CONCLUSIONS.—THE SEPARATION OF THE TYPES INTO SYSTEMATIC AND ELEMENTARY SPECIES.

The time has come when the types of men found in the Philippine Islands may be designated without doubt as elementary and systematic species. It is entirely without the province of anthropology to define these terms so that they will apply to all zoölogical forms, but the studies of the past few years among the Negroes, the students, and the school children in America, among the Igorots, the Manila students from all parts of the Philippine Islands, the morgue subjects and the people of Taytay, as well as a study of Filipino ears, justifies a classification of the types of man into two definite groups. One contains the types that are stable and have been stable for many hundreds if not thousands of years, and that do not blend readily when crossed with other stable types; these are called systematic species. The other group contains the types that are unstable, that have not been in existence so great a time, and that blend readily, especially with nearly related types; these are called elementary species.

Each species may have subspecies or varieties. The elementary species are cross sections of variable species which have been formed by the union of two diverse species, whereas subspecies or varieties are cross sections of systematic species that are variable through inherent changes not due to actual crossing but to the interplay of heredity and environment. Elementary species and subspecies or varieties may sometimes be the same, and ultimately may prove to be synonymous terms. Varieties may become systematic species when they shall be sufficiently differentiated, and shall have become stable. Elementary species may become systematic species when the blending elements have reached a stage of slight variability and have become a pure blend. The difference between elementary species and variety is that the first is the beginning formation of a systematic species by the blending of two others, whereas the second is the beginning formation of a systematic species by the differentiation and disintegration of an old systematic species.

The proper use of the terms, systematic species, elementary species and variety, may be illustrated by the Filipino types of this and previous studies.

The Iberian type became isolated many hundreds of years ago and became a systematic species of man, and, in the course of time, developed varieties which Sergi (28), under the title of the Mediterranean Race, has differentiated and designated by their skull form. The varieties of this type spread over the face of the earth, and as they came to the Orient they encountered an entirely different type, another systematic species, the Primitive with its varieties. The commingling of the varied forms resulted in several new types which are elementary species or variable blends of the varieties of the two original systematic species. This will probably account for every people of the East except the Negrito, and it may prove useful in unravelling their varied forms, because the Negritos are not homogeneous, as will be evident from forthcoming studies.

The present and previous studies reveal at least four types of Iberian ears, which differentiate the Iberian varieties, and to this extent the division of the Mediterranean Race by Sergi is corroborated. The Primitive may also be subdivided into at least three types; the Primitive proper, the Modified Primitive, and the Adriatic, and also the Blends, all of which have ears of similar form that have not yet been differentiated, but the three varieties of men are none the less evident.

The union of the Iberian and Primitive species as constituted by their varieties, has produced in the Philippines the Australoid, Alpine, and B. B. B., if not the Cro-Magnon. Their union to form the Australoid had resulted in the type A of the Igorots,—the *primary* Australoid—at the time the Spaniard's came to the Islands, after which a new infusion of modified Iberians caused an alteration of the *primary* Australoid and the formation of the *secondary* Australoid. The *primary* Australoid is an elementary species, and the *secondary* Australoid is also an elementary species but different from the *primary.*

The Alpine represents the union of the Iberian and Primitive as a complementary form to the Australoid but without subdivision, although the B. B. B. probably stands in the same relation to the Alpine as the secondary Australoid to the primary.

The Cro-Magnon has Iberian qualities and also Primitive, but not so definite as the Iberian. This form is probably the result of recent and remote Cro-Magnon elements which came with the Iberian from Europe. Its relation to the Australoid is similar to the relationship of the B. B. B. to the Alpine.

The question of race naturally suggests itself here and may be considered in relation to the varied forms that constitute the Filipino people.

The definitions of *species, variety* and *race* are given by Quatrefages(21) as clearly as one may hope to have them:

"*Species* is a collection of individuals more or less resembling each other, which may be regarded as having descended from a single primitive pair by an uninterrupted and natural succession of families."

Variety is "An individual or a number of individuals belonging to the same sexual generation, which is distinguished from the other representatives of the same species by one or several exceptional characters."

Race is "A number of individuals resembling each other, belonging to one species, having received and trasmitting, by means of sexual generation, the characters of a primitive variety."

There is nothing in the above definitions that is incompatible with the ideas formulated and expressed in the preceding pages as to systematic species and varieties, but Quatrefages gives no definition of a type that is formed by the union of two other types, therefore room is left for the term elementary species as defined above.

The use of the word *race* may well apply as indicated by Quatrefages, except that such an entity becomes again a *species* as soon as it is established as a *race*. Derivatives of the primary races are termed secondary races, and derivatives of these tertiary races by Quatrefages, but when many of these become fused the term race is used no longer. Would it not be better to continue the terms *species* and *variety,* or to give the name *type* to the primary, secondary, tertiary, etc., *races* of Quatrefages, and to dignify each nationality that has developed characteristics that differentiate it from other nationalities by the term *race,* as the German race, the French race, the Filipino race? Otherwise, the word race becomes lost or relegated to designate remnants of humanity such as the Esquimo and the Negrito, which are only types or varieties.

The term *race* should apply to any composite body of individuals who are becoming or may have become a distinct type by a natural or an artificial process. A race may contain systematic species, varieties and elementary species in profusion. A Filipino race at present exists under this terminology but not under that of Quatrefages, nor would more than a few of the world's living peoples be races according to his definition. Race would apply also to the Cro-Magnon of early Europe, the Mediterranean of Sergi and to other forms that have become dispersed and diffused or remain as fragments such as the Basque, the Esquimo and the Negrito. There would be a German race and an English race, a Dutch race and a Spanish race, but not a white race or a black race or a yellow race, because elements of each color are fusing in different ways in various places, and the color markings do not constitute a definite factor of differentiation, although color may be useful as an adjunct. Color markings have been of no value in the differentiation of Filipino types. Hair form has been of little avail in the study of the Filipinos, because they all have straight black hair, with an occasional wave. The cephalic index has been found unreliable because of possible distortion of the head. In the place of this, however, the ear form has been found a better indicator, and by this alone much can be known as to the individuals' component elements. In conjunction with the other physical factors, nasal index, facial index, stature, brachial and crural indices, etc., the ear form is of great service.

By means of these factors the men of Taytay have been separated into groups that are called species and varieties in the following classification:

Systematic species.	Varieties.	Elementary species.
Iberian	Iberian A	
	Iberian B	
	Iberian C (Igorot)	
	Iberian D (Cro-Magnon)	
		Cro-Magnon (?)
		B. B. B. (?)
Australoid (?)	Primary Australoid	
	Secondary Australoid (Negrito)?	
		Australoid.
		Alpine.
Primitive	Primitive	
	Modified Primitive	
	Blend (?)	
	Adriatic	

Two processes are supposed to have been active, a differentiation of the Iberian and Primitive into diverse forms, producing varieties, and a fusion of the varieties to make the elementary species. It can not be absolutely determined that the Primitive and Iberian did not arise by the fusion of other forms, but if so, they had so completely fused as to be true systematic species, unless the varieties represent the forms that previously fused. The Australoid furnishes an interesting example of the fusion of two forms, and at the same time the production of two different forms, although the *secondary* Australoid may represent Negrito elements.

There seems to be in man a life cycle of the following nature: The crossing of diverse types induces a condition of Mendelism more or less pure, depending upon the amount of resemblance between the types, following which comes spurious Mendelism when the types begin to blend and later no Mendelism but a tendency to blend and a tendency to remain true to type until a perfect blend is formed. This is the first cycle, and the perfect blend becomes a systematic species when sufficiently stable. After this, the systematic species becomes diversified through inherent variation acted upon by the environment, until differentiation results in the formation of varieties with any one of which or all together the cycle may be repeated.

There is first a period of alternate inheritance, then a period of blending followed by a period of stability, after which differentiation begins. The four periods are not clear-cut but overlap, and more than one may be going on at the same time.

Fusion of the mass of Filipinos throughout is evident in the formation of a blend that will probably be largely Primitive, or between that and the Adriatic, because in the course of time the Iberian elements will be eliminated to a great extent by disease, especially tuberculosis.

The Filipinos of Taytay are therefore in the blending period, but at the same time some of the types may exhibit alternate heredity, some are in a condition of stability, and others are undergoing differentiation. There is, no doubt, an exemplification of Galton and Pearson's ancestral heredity and reversion to mediocrity, yet fusion of all the elements seems to be the ultimate goal.

BIBLIOGRAPHY.

(1) BEAN, ROBERT BENNETT. A Scheme for Type Heredity in Man. *Science*, N. S. (1909), No. 754, 942.

(2) IDEM. A Theory of Heredity to Explain the Types of the White Race. *This Journal, Sec. A*, (1908), **3**, No. 4, 215.

(3) IDEM. The Benguet Igorots. A somatologic Study of the Live Folk of Benguet and Lepanto-Bontoc. *This Journal, Sec. A*, (1908), **3**, No. 6, 413.

(4) IDEM. I. Filipino Types: Manila Students. An Attempt to Classify the Littoral Population of Luzon and Adjacent Islands. *This Journal, Sec. A*, (1909), **4**, No. 4, 263.

(5) IDEM. II. Filipino Types: Found in Malecon Morgue. *This Journal, Sec. A*, (1909), **4**, No. 4, 297.

(6) IDEM. Filipino Ears. A Classification of Ear Types. *This Journal, Sec. A*, (1909), **4**, No. 1, 27.

(7) IDEM. A Cephalograph. *This Journal, Sec. A*, (1909), **4**, No. 5. 447.

(8) BIRKNER, F. Beiträge zur Rassenanatomie der Chinesen. Part I. *Arch. f. Anthrop. Braunschweig* (1906), **4**, 1.

(9) BROCA, M. Sur les cranes et ossements des Eyzies. *Bull. Soc. d' Anthrop., Paris* (1868), Series II, **3**, 350–391.

(10) DENIKER, J. The Races of Man. An Outline of Anthropology and Ethnography. New York (1906).

(11) FOLKMAR, DANIEL. Album of Philippine Types. Manila (1904).

(12) HAGEN, B. Hofrat: Kopf-und Gesichtstypen ostasiatischer und melanesicher Völker. Herausgegeben mit Unterstützung der Königlich Bayerischen Akademie der Wissenschaften. Stuttgart (1906).

(13) HRDLICKA, A. Physiological and Medical Observations among the Indians of the Southwestern United States and Northern Mexico. Washington (1908).

(14) KEANE, A. H. Man. Past and Present. Cambridge: At the University Press. (1900).

(15) KLAATSCH, HERMANN. Die neuesten Ergebnisse der Paläontologie des Menschen und ihre Bedeutung für das Abstammungsproblem. *Ztschr. f. Ethnol.* 41 Jahrgang (1909) Heft III u. IV.

(16) LUSCHAN, VON V. Die Konferenz von Monaco. *Korresp.-Blatt d. deutschen Ges. f. Anthrop., Ethnol. u. Urgeschr.* (1906), **38**, 53–62.

(17) MARTIN, R. Augenfarbentafel, Versammlung der deutschen Anthropologischen Gesellschaft in Worms. (1903), 34.

(18) IDEM. Die Islandstämme der Malayischen Halbinsel. Wissenschaftliche, ergebnisse einer Reise durch Vereinigten Malayischen Staaten. Jena. (1905), 283.

(19) MOSZKOWSKI, MAX, (Berlin) Die Urstämme Ostsumatras. *Korresp.-Blatt d. deutschen Ges. f. Anthrop., Ethnol. u. Urgesch.* (1908) **39**, Nos. 9 and 12.

(20) PAPILLAULT, G. Entente internationale pour l'unification des mesures cranometriques et cephalometriques. *Anthrop. Paris* (1907), February.

(21) POLL, HEINRICH. Ueber Schädel und Skeleteder Bewohner der Chatam-Inseln. *Ztschr. f. Morphol. u. Anthrop.* (1903), **5**, 1–134.

(22) QUATREFAGES, A. DE. The Human Species. New York (1879).

(23) RIPLEY, W. Z. The Races of Europe. New York (1899).

(24) SARASIN, FRITZ. Versuch einer Anthropologie den Insel Celebes. Zweiter Teil: Die Varietaten des Menschen auf Celebes. Materialen zur Naturgeschichte der Insel Celebes: V Band., II Teil. Wiesbaden (1906) *Man, London* (1908), **8**, No. 8.

(25) SCHLAGINHAUFEN, OTTO. Ein Beitrag zur Craniologie der Semang, nebst Allgemeinen Beitragen zur Craniologie. Leipzig (1907).

(26) SCHMIDT, W. Ueber die entwickelungsgeschichtliche Stellung der Pygmaenstämme. *Korresp.-Blatt d. deutschen Ges. f. Anthrop. Ethnol. u. Urgesch.* (1908), **39**,

(27) SCHWALBE. G. Das Darwinsche Spitzohr beim Menschlichen Embryo. *Anat. Anzeig.* (1889), **4**, No. 6, 176–189.

(28) SERGI, G. The Mediterranean Race. A Study of the Origin of European Peoples. New York. (1901).

(29) SOULARUE, G. MARTIAL. Recherches sur les dimensions des os et les proportions squelettiques de l'homme dans les différentes races. *Bull. Soc. d' Anthrop. Paris* (1899) Ser. IV, **10**, 328.

30) STRATZ, C. H. Natürgeschichte des Menshen. Grundriss der Somatischen Anthropologie. Stuttgart (1904).

(31) TOPINARD, P. *Eléments d'Anthroplogie Générale.* Paris. (1885).

(32) TURNER, W. A Contribution to the Craniology of the natives of Borneo, the Malays, the natives of Formosa and the Tibetans. *Trans. Roy. Soc. Edinburgh* (1907), **45**, Part III, No. 28, 781–813, 5 plates.

(33) IDEM. *Man, London* (1908), **8**, No. 3.

(34) VERNEAU, R. Contribution á l'etude des caracteres céphaliques des Birmans. *Anthrop. Paris* (1904) **15**, 1–23.

(35) IDEM. Les Grottes de Grimaldi (Baousse-Roussé) Monaco. (1906). Part III. Anthropology.

(36) VIERORDT, H. Anatomische, Physiologische und Physikal. Daten und Tabellen zum Gebrauche für Mediziner. Jena (1906).

(37) VOLZ, Prof. Dr. WILHELM. Beiträge zur Anthropologie und Ethnographie von Indonesien. III. Zur Kenntnis der Kubus in Südsumatra. *Arch. f. Anthrop. Braunschweig* (1908), **7**, 89–109.

(38) WATERSTON, DAVID. Report upon the Physical Characters of some of the Nilotic Negroid Tribes. *Third Report Wellcome Research Laboratories. London* (1908).

(39) ZWAAN, KLEIWEG DE. Die Anthropologischen Ergebnisse der Sumatra-Reise des Herrn, A. Maas. *Ztschr. f. Anthrop. Berlin* (1909), 168–180.

ILLUSTRATIONS.[1]

[1] All photographs used in this study were made by Mr. Martin of the Bureau of Science or his assistants.

TEXT FIGURES.[2]

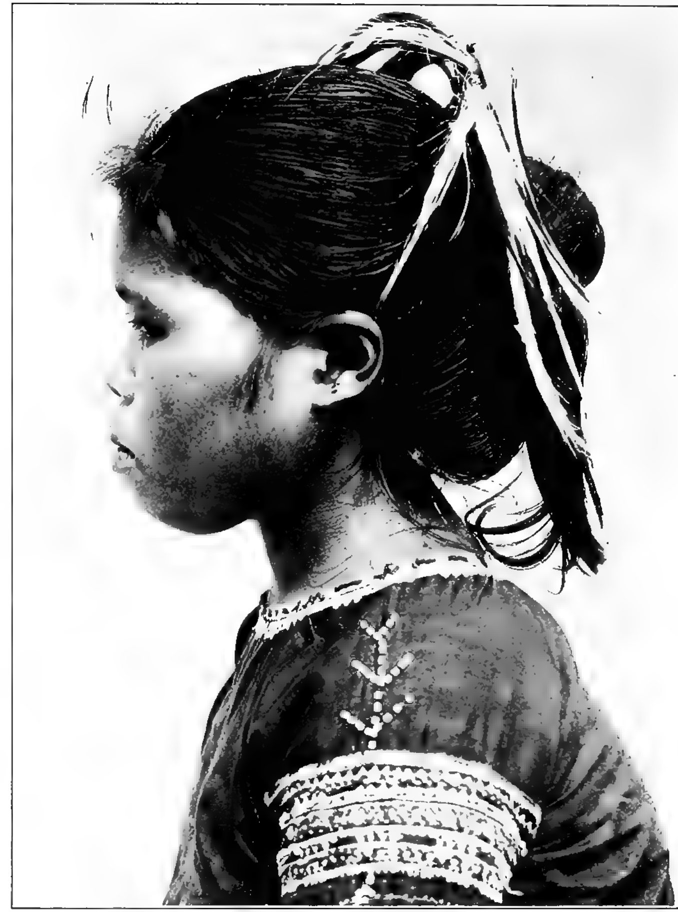
FIG. 1. Curve of stature of 183 adult male Taytayans. The number of individuals with a given stature is placed over each point on the line.
2. Stature and age.
3. Average Taytayan head outline. Serial number 99, clinical number 176.
4. The solid lines on the left represent the average European according to the canon of Fritsch. The broken lines on the right represent the average Taytayan according to the same canon. The European stature is equal to 8 total head heights. The Taytayan stature is equal to 7 total head heights. A and B point to the chin.
5. Composite head outlines of 74 brachycephalic individuals.
6. Composite head outlines of 69 mesocephalic individuals.
7. Composite head outlines of 22 dolichocephalic individuals.
8. Boy of Taytay aged 4. The small outline is from the left side of the head over the middle of the eye. The large outline is from the right side of the head a little nearer the median line.
9. Boy of Taytay aged 10. The short outline is 3 centimeters to the left of the midline. The long outline circumscribes the sagittal plane.
10. Head outlines of two Primitive Blends with flattened occipital region. Serial numbers 137 and 158.
11. Head outline illustrating the bony band about the occiput.
12. Primitive and Iberian head outlines. Iberian serial number 33, Primitive serial number 110.
13. Australoid head outline. Serial number 89, clinical number 564.
14. Iberian head outlines. Serial numbers 25 and 47.
15. Three Cro-Magnon head outlines. Blonde American number 2; Taytayan serial number 74; clinical number 535; serial number 103, clinical number 616.
16. Sagittal head outlines of Alpine and B. B. B. Alpine is serial number 88, clinical number 180; B. B. B. is serial number 8, clinical number 353.

[2] All head outlines were made with the cephalograph (7) unless otherwise stated, and they are all reproduced natural size.

IBERIAN D. AUSTRALOID. IBERIAN E. CRO-MAGNON B. B. B. MODIFIED B. B. B.

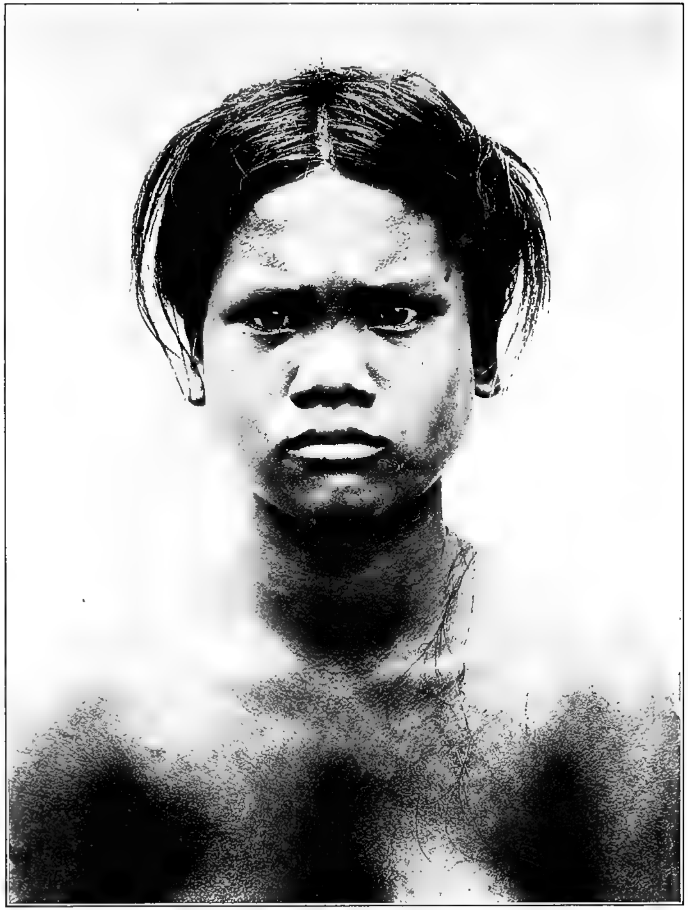
THE MEN OF TAYTAY.

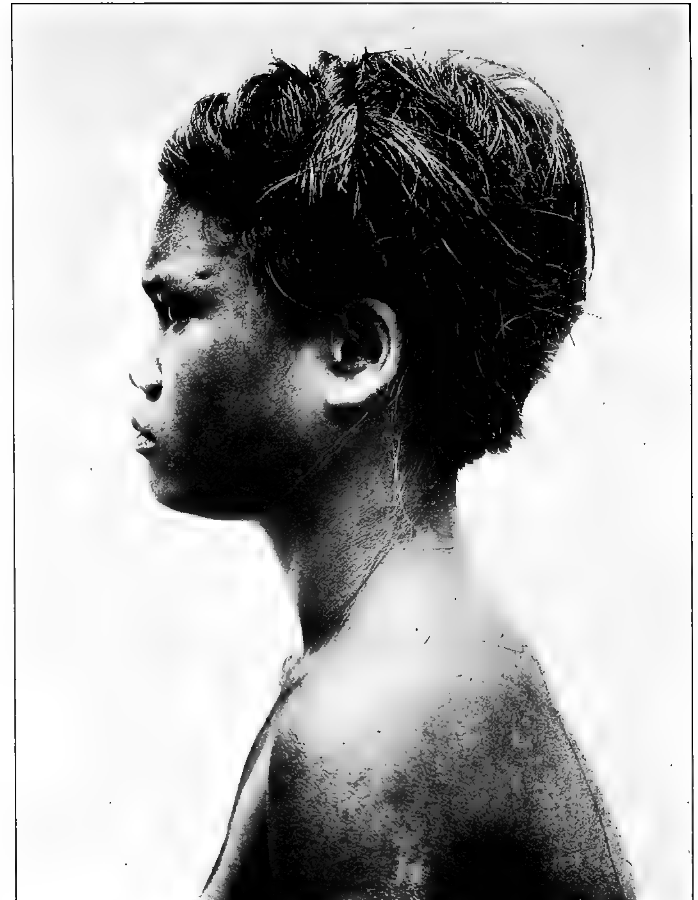
PLATE I.



BOGOBO, DAVAO, MINDANAO. PRIMITIVE EAR AND PRIMITIVE SPECIES.

PLATE II.



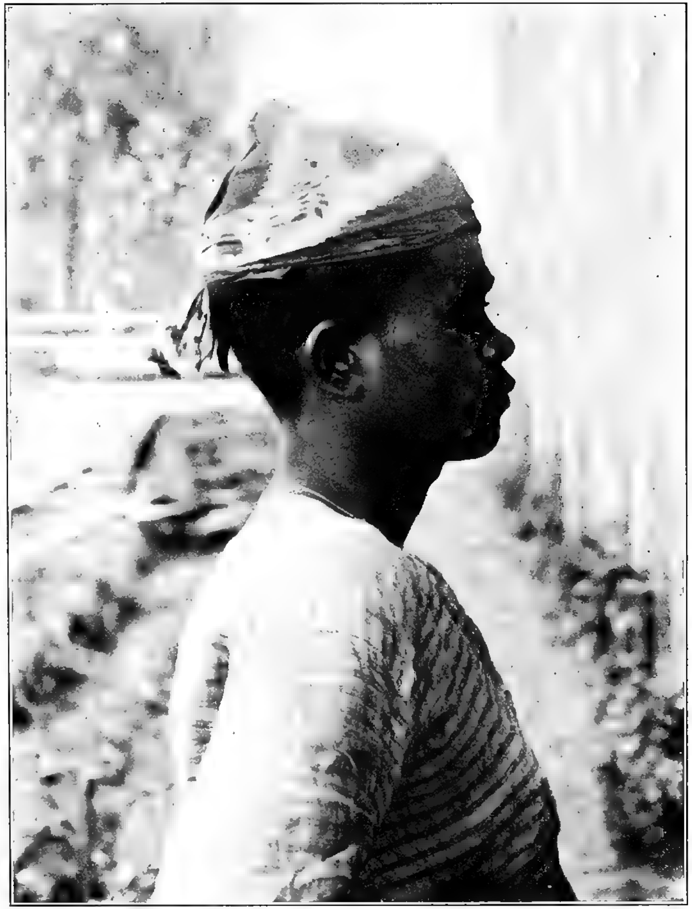


IFUGAO FROM QUIANGAN, NUEVA VIZCAYA, LUZON. PRIMITIVE EAR AND PRIMITIVE SPECIES.

PLATE III.

BONTOC IGOROT, MOUNTAIN PROVINCE OF LUZON. PRIMITIVE EAR AND MODIFIED PRIMITIVE SPECIES.

PLATE IV.



BUKIDNON FROM CAPIZ, ILOILO. PRIMITIVE EAR AND PRIMITIVE SPECIES.

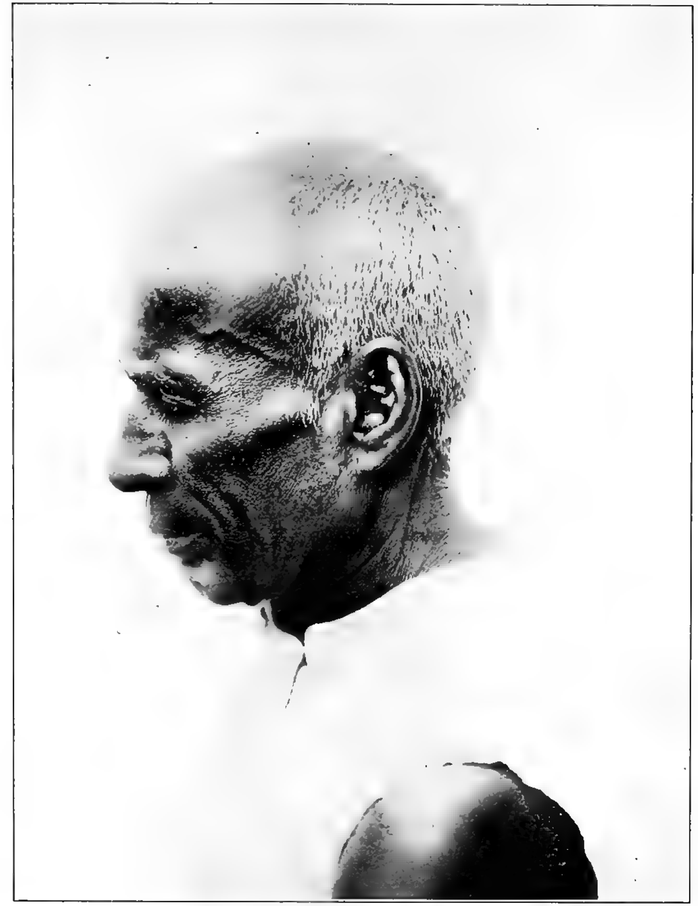
PLATE V.

KALINGA FROM ILAGAN, ISABELA PROVINCE, LUZON. MIXED PRIMITIVE EAR AND MIXED PRIMITIVE SPECIES.

PLATE VI.

YOUNG MAN FROM CAINTA, IBERIAN. MODIFIED EAST INDIAN TYPE.

PLATE VII.



OLD MAN OF CAINTA. IBERIAN B MODIFIED. EAST INDIAN TYPE.

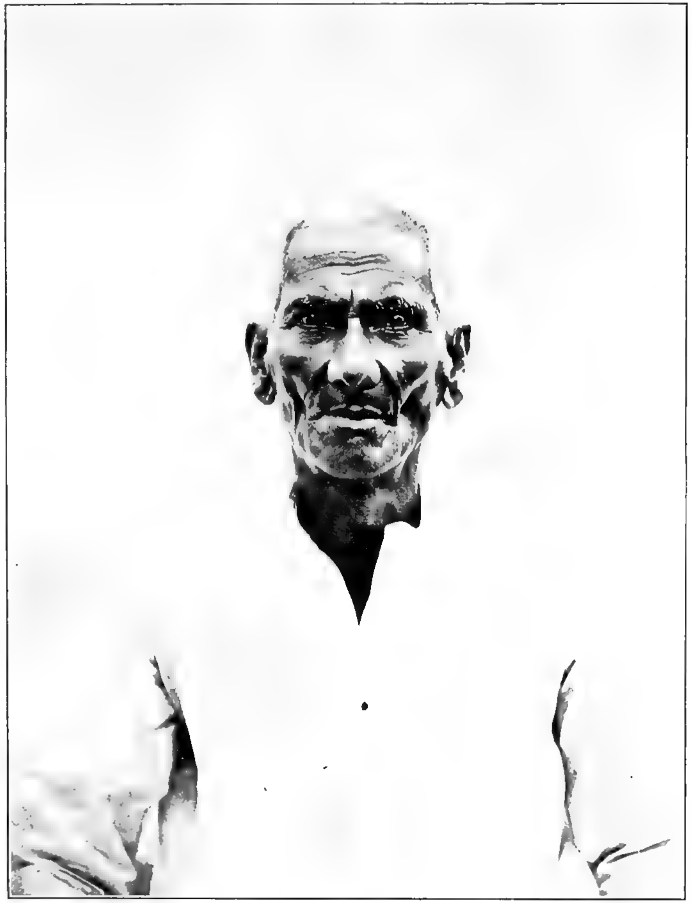
PLATE VIII.

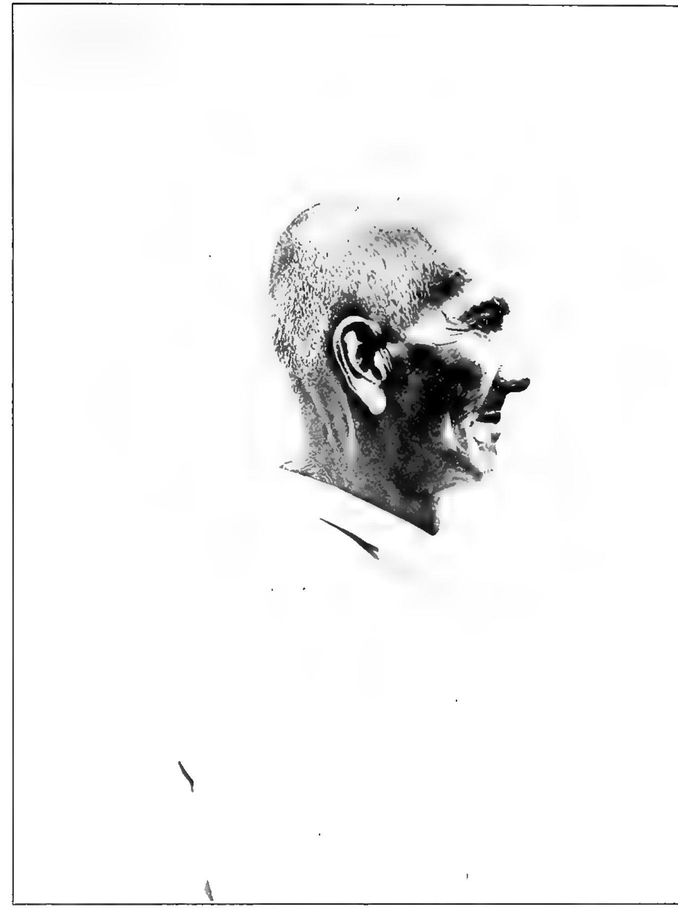
OLD MAN FROM CAINTA. IBERIAN D MODIFIED. CRO-MAGNON AFFINITIES. EAST INDIAN TYPE.

PLATE IX.

OLD MAN FROM NEAR TAYTAY. IBERIAN D. CRO-MAGNON AFFINITIES.

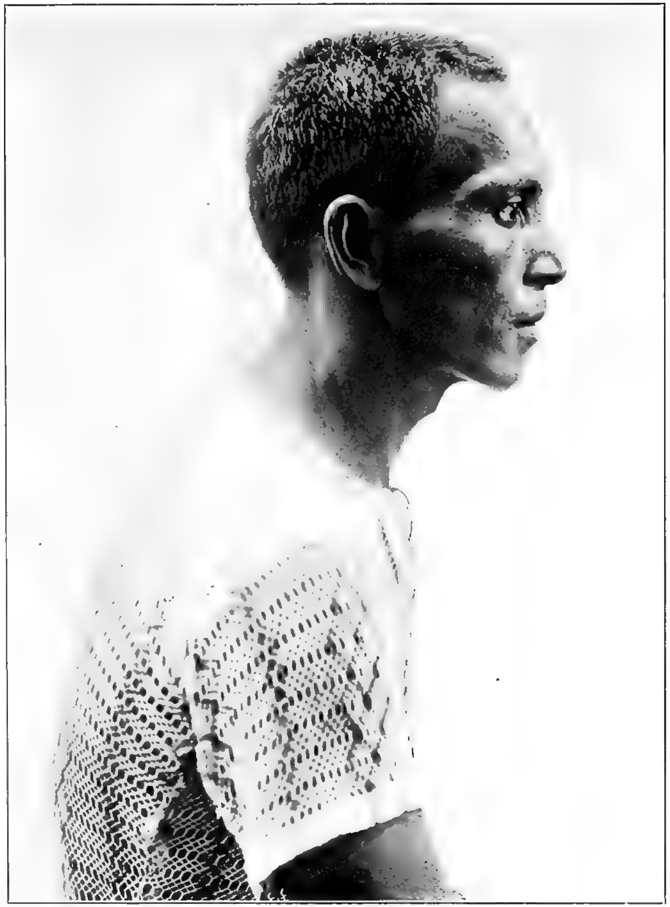
PLATE X.

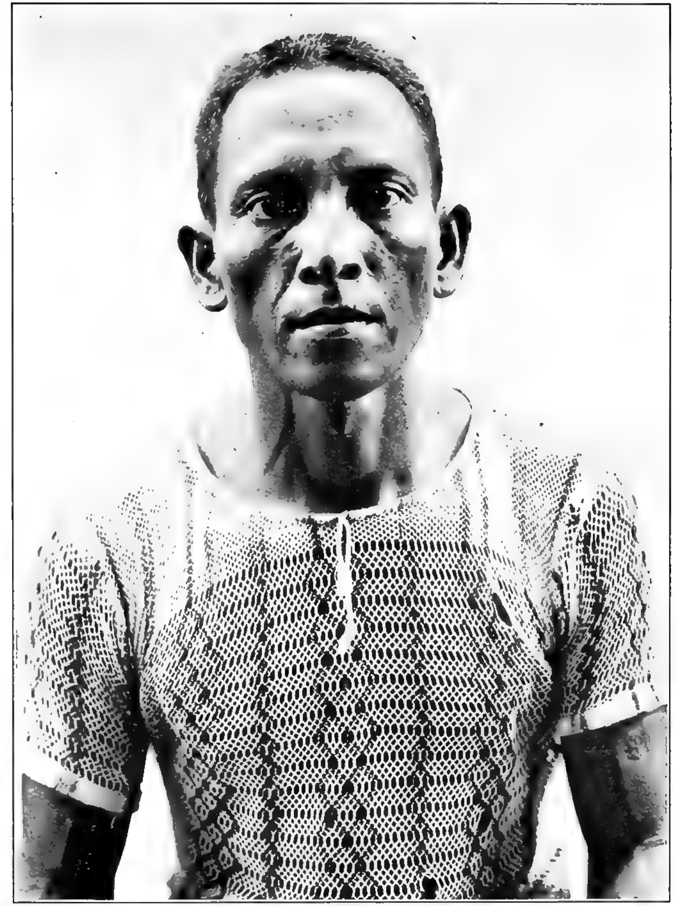




AN OFFICIAL OF TAYTAY. IBERIAN B AND D. CRO-MAGNON AFFINITIES.

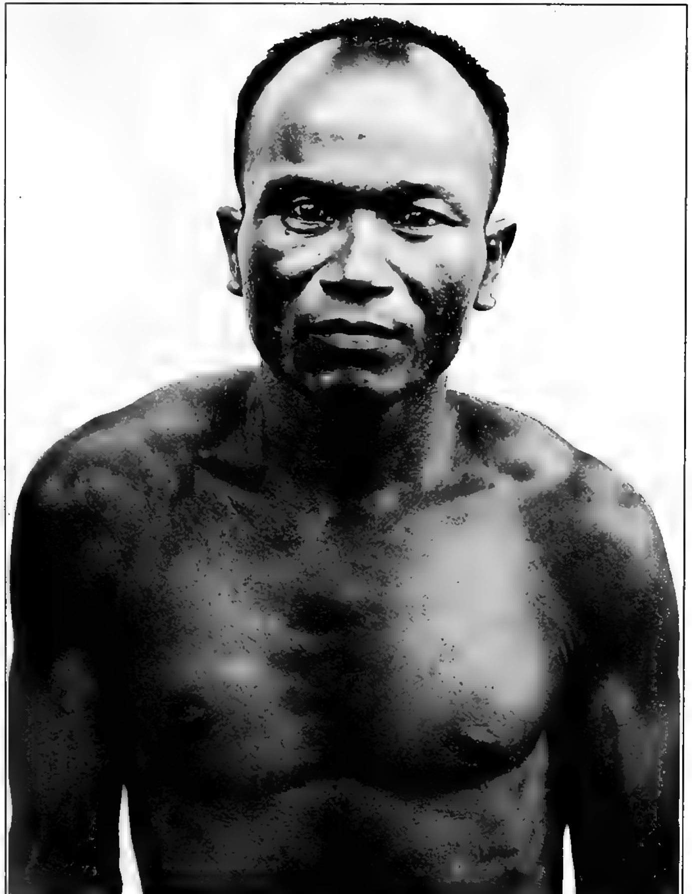
PLATE XI.





IBERIAN E. CRO-MAGNON AFFINITIES.

PLATE XII.



HAMMOCK CARRIER OF TAYTAY. ALPINE TYPE. ALPINE PRIMITIVE EAR.

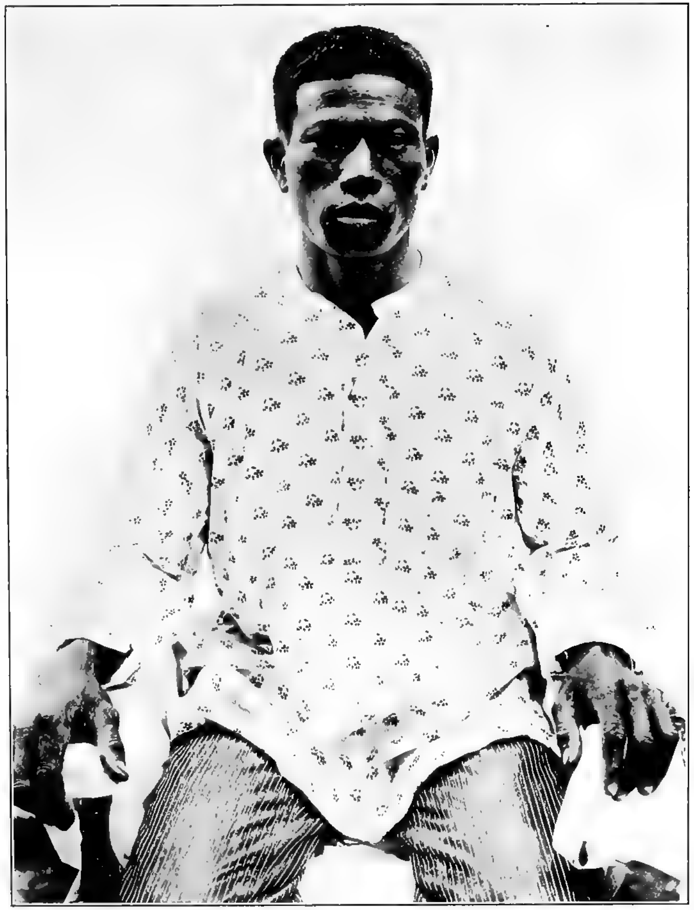
PLATE XIII.

MODIFIED B. B. B.

PLATE XIV.

MODIFIED B. B. B. CRO-MAGNON AFFINITIES.

PLATE XV.

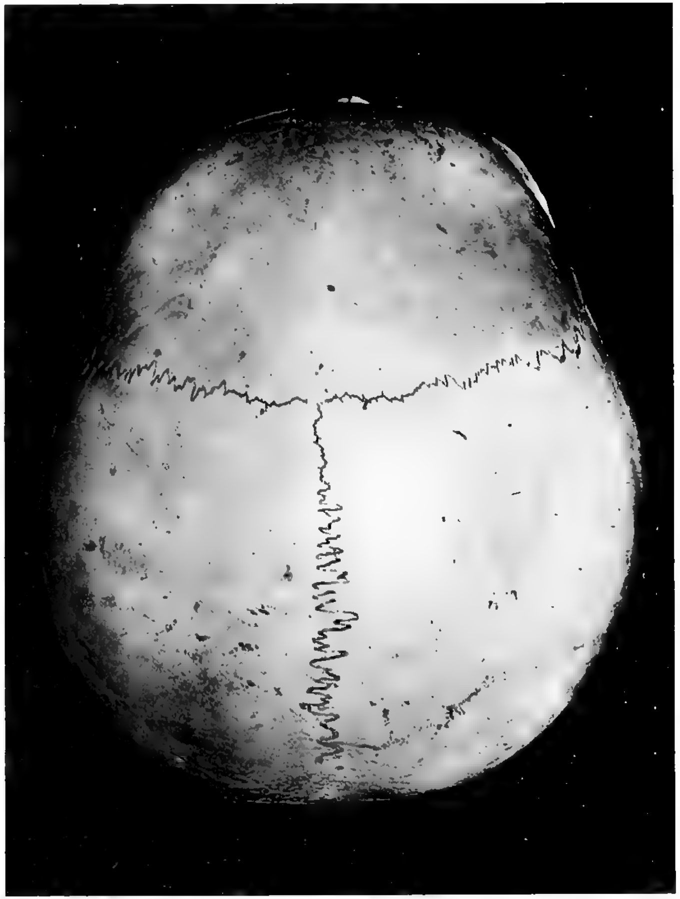


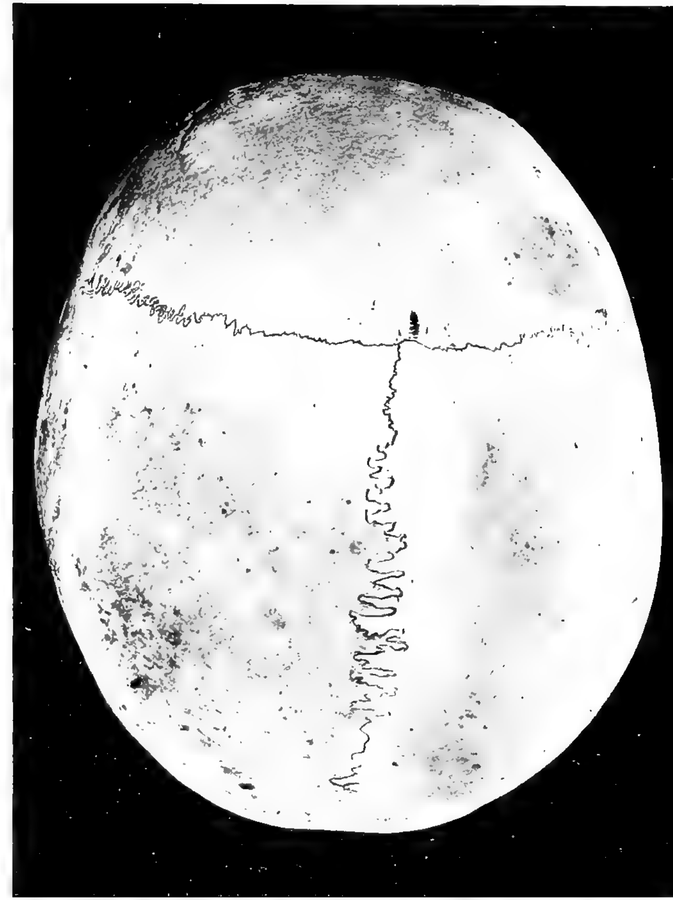
AUSTRALOID FILIPINO—SECONDARY VARIETY. IBERIAN AFFINITIES.

PLATE XVI.

AUSTRALOID FILIPINO—SECONDARY VARIETY. IBERIAN AFFINITIES.

PLATE XVII.





RIGHT DORSAL FLATTENING WITH LEFT CENTRAL BULGING IN TWO FILIPINO SKULLS.

PLATE XVIII.

A CEPHALOGRAPH: THE DESCRIPTION OF AN INSTRUMENT FOR REPRODUCING THE OUTLINES OF THE HEAD AND FACE.

By Robert Bennett Bean.

(From the Anatomical Laboratory of the Philippine Medical School, Manila, P. I.)

The value of an instrument that would accurately and easily produce the outlines of the head and face in any direction, through or over any plane, has long been recognized by anthropologists, and the instrument here described and pictured is presented with the hope that it will fulfill the requirements. The idea of the construction of a *cephalograph* occurred to me as early as 1905 when I used a machine for obtaining the outlines of the brain which would reproduce only the silhouette of the object but which could not be applied to the surface. At that time I spoke to Dr. Ales Hrdlicka who encouraged me to attempt the construction of such a machine, but the opportunity for its construction did not arise until I reached the Philippines in June, 1907.

In 1906 I consulted Prof. L. Manouvrier who was at that time working on a machine designed for the purpose of obtaining outlines of the head on the living, and I am grateful to him for any suggestions that may have been utilized in the construction of the *cephalograph*. The principles involved in the cranial instruments of Prof. Rudolph Martin [1] have been utilized, especially the pantograph to reproduce the exact outlines, the use of which occurred to me after my acquaintance with Professor Martin's instruments. The castings were made of aluminum through the kindness of my brother, Mr. Wyndham Randolph Bean, superintendent of the plants of the T. H. Symington Company at Rochester, New York, for whose interest in and personal supervision of the work I am greatly thankful. The measuring arm of the machine was made by Filipino students at the Philippine School of Arts and Trades in Manila, under the direction of Mr. Hewitt. To Mr. Hewitt I am also indebted for coöperation in constructing another *cephalograph* for the Bureau of Education of the Philippine Isalnds.

The *cephalograph* consists essentially of an aluminum frame supported by two vertical steel bars 1 meter long and 2 centimeters in diameter, fastened by brackets at each end to a board screwed to a frame or to any wall or post. The aluminum frame supports, by two parallel rods of the same diameter but only half as long, a horizontal aluminum bar,

[1] Ueber einige neure Instrumenten und Hilfsmittel fur den Anthropologischen Unterricht. *Correspondenz-Blatt der Deutscher anthropologischen Gesellschaft.* (1903), No. 11, pp. 127–132.

1 meter long and 12.8 centimeters wide, on which a sliding brass piece supports the pantograph with the measuring arm. A smooth board on which drawing paper is held by thumb tacks is clamped to the end of the horizontal bar. The aluminum frame has a horizontal aluminum rod inserted at its middle, through the end of which another rod passes vertically to carry the head rest. At the upper end the vertical rod works in a cylindrical joint which allows rotation through 360 degrees, and at the lower end is a ratchet attachment by which the head rest may maintain the head at any desired angle in the vertical plane. Four supports, only two of which are shown in Plate I, serve to fix the head so that it remains rigid while the outlines are being made.

A unique feature of the *cephalograph* is the measuring arm of the pantograph (Plate II), which has a semicircular brass bar with a radius of 25 centimeters interposed between its extremity and the adjacent joint in such a manner that the parts of the arm contiguous to the semicircular bar may glide from one end to the other of the bar, or may be fixed at any point, the end of the measuring arm remaining at the same point regardless of the position of the other parts of the arm.

On the end of the measuring arm is attached a small frame holding a wheel so that a rolling surface comes into contact at all times with the part being measured. The weight of the measuring arm and the rolling contact allow exactly the same pressure to be exerted continually without any appreciable effort on the part of the operator of the *cephalograph.*

Coronal, sagittal and horizontal outlines of the head and face may be made easily and rapidly, and outlines in almost any direction are possible with a little manoeuvering. With the position shown in Plate I, only vertical longitudinal outlines can be made, but by rotating the head rest through an angle of 45° horizontally, coronal outlines are possible; then, by depressing the head rest until the face is prone and the horizontal position of the head assumes the vertical direction, horizontal outlines can be made.

The weight of the machine packed in a portable case is about the average load for a native carrier, about 30 kilos (75 pounds.)

It is to be hoped that the *cephalograph* will be used in schools and universities, as well as among the wild tribes and native peoples of the earth that are little known, and wherever the living may be measured. The *cephalograph* can also be used for measuring any solid body to which the attachment at the head of the measuring arm can be applied. For this reason it may be of service in measuring skulls and other bones as well as any objects of which the contour in any given plane is wanted, although slight alterations may be necessary if a complete circuit of an object is desired. Criticisms and suggestions will be gladly received, for I realize the imperfections of the instrument, but I believe it represents a distinct advance in the application of mechanics to the reproduction of the outlines of the head and face.

ILLUSTRATIONS.

VENTRO-LATERAL VIEW OF THE CEPHALOGRAPH AT WORK AT TAYTAY, PROVINCE OF RIZAL, ISLAND OF LUZON, IN 1909.

PLATE I.

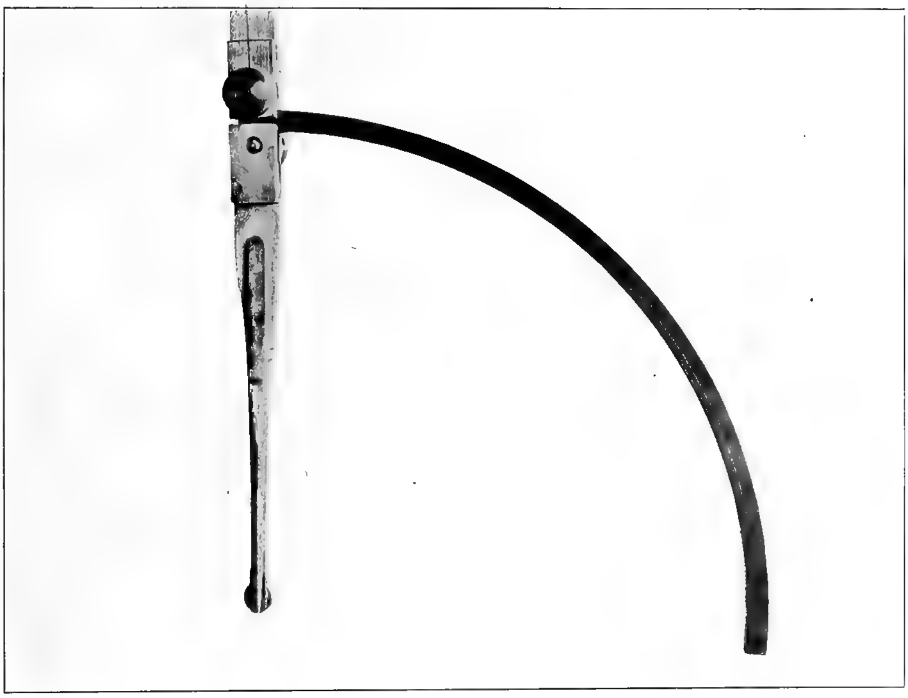


FIG. 1. THE MEASURING ARM OF THE PANTOGRAPH. THE SIDE FACING THE OPERATOR OF THE CEPHALOGRAPH.

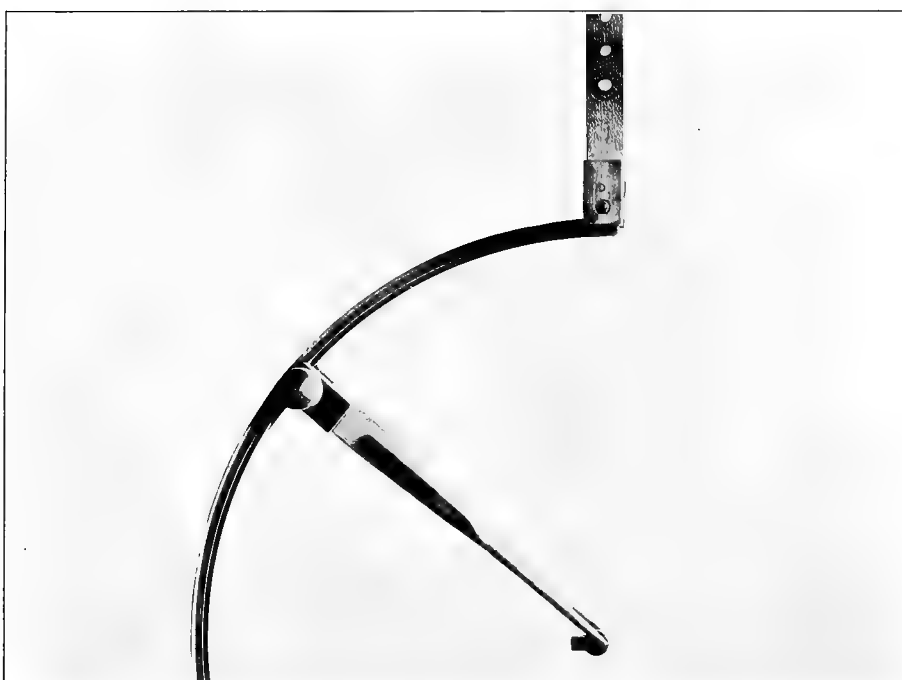


FIG. 2. THE REVERSE SIDE, SHOWING THE DISTAL END OF THE ARM IN A DIFFERENT POSITION.

PLATE II.

THE ACTION OF ORGANIC PEROXIDES ON THE PHOTOGRAPHIC PLATE.

By BENJAMIN T. BROOKS.
(From the Chemical Laboratory, Bureau of Science, Manila, P. I.)

With the recent development of our knowledge of radioactivity, the action of many substances on the photographic plate has been studied and in some cases this property has been taken as a test for radioactivity. This property alone is not sufficient to characterize a body as being radioactive, as is very generally recognized. Nevertheless papers still continue to find their way into the chemical literature ascribing radioactivity to certain substances which affect the photographic plate but which have little or no semblance to the heavy metals.

That the "pseudo-radioactive" substances are not radioactive in the same sense as the heavy metals has been shown by Russell, Saeland and Ebler.

Russell[1] has described recently the action on the photographic plate of colophony and a number of substances which contain resin. He has shown that the shadows thrown by resin are not bounded by straight lines, but curve round a screen; that the action is not capable of passing through glass, mica, or aluminium foil, even of extreme thinness, and does not affect an electrical field. The action can pass along a bent glass tube, and may be swept out of a tube by a slow current of gas. No action takes place in an atmosphere of carbon dioxide. Heat destroys the activity and previous exposure to sunlight accelerates it. Alkalies or sulphur dioxide destroy the activity. When the activity of a specimen is destroyed by any of the above means, exposure to oxygen and light restores it. Russell also prepared crystalline abietic acid and found it to be active. Turpentine and specimens of pure pinene and limonene after exposure to air showed the same behavior. A similar behavior of linseed oil is described by him[2] in a previous communication.

Russell states that the effect appears to be produced by a vapor rather than by any form of radioactivity. He had previously shown[3] that the vapors of hydrogen peroxide affect a photographic plate, even in dilutions of one part in a million. He suggests that this may be the active substance.

Saeland[4] has recently shown that the action on the photographic plate of the alkali metals, magnesium, zinc and other metals which have a high solution

---

[1] *Proc. Roy. Soc. Lond.* (1908), **B, 80,** 376.
[2] *Proc. Roy. Soc. Lond.* (1898), **63,** 102.
[3] *Proc. Roy. Soc. Lond.* (1899), **64,** 409.
[4] *Ann. d. Phys.* (1908), **26,** 899.

tension, is due to hydrogen peroxide formed by the oxidation of the metal in the presence of moisture.

Ebler[5] has recently confirmed this view by exposing certain metallic peroxides in moist air to photographic plates. The effect produced was the same as that described by Russell and Saeland.

Russell made no attempt to explain the formation of hydrogen peroxide by the organic substances studied by him or to call attention to the fact that they are capable of forming organic peroxides by autoxidation. The conditions under which the activity is destroyed or increased are strongly suggestive of an intimate connection with organic peroxides.

That organic peroxides are slowly hydrolyzed by water with the formation of hydrogen peroxide has been shown by Freer and Novy[6] and by Clover and Richmond.[7] This fact offers a plausible explanation of the formation of hydrogen peroxide and the consequent change in the photographic plate produced by the substances studied by Russell.

In order further to test this theory benzoperacid, acetyl peroxide and benzoylacetyl peroxide were tested and each substance was found to affect a photographic plate.

The experiment was carried out by placing about 0.1 gram of the substance on a moist piece of filter paper in a shallow crystallizing dish and covering the dish with a photographic plate. In the case of acetyl peroxide a distinct dark spot was obtained on developing the plate after an exposure lasting twenty minutes. Benzoylacetyl peroxide gave a distinct spot after about 45 minutes. If the plates were exposed too long a reversal, or positive, was obtained.

In a study of Manila copal it was found that the substance rapidly absorbed oxygen from the air and that the powdered resin affected a photographic plate in the same way as colophony. Russell stated that amber was very feebly active compared with colophony. In order to ascertain if the older fossil resins could be differentiated in this way from the more recent ones, several samples of Manila and other copal resins were exposed to photographic plates.

About 10 grams of each specimen of copal were pulverized and placed in a shallow crystallizing dish. A photographic plate was then placed with the film side down upon each dish. At the end of one week the plates were developed in the usual manner and in all cases a round dark spot sharply outlining the dish was obtained. Samples of recently collected, semi fossil and partially distilled Manila copal gave very dark spots. A specimen of kauri copal gave a much blacker spot than Manila copal, which probably has some connection with the fact noted by Worstall[8] that the oxidation of kauri is the faster of the two. Zanzibar copal gave a fainter spot than kauri or Manila and a specimen of hard brittle resin from Philippine coal showed the least activity of all.

[5] *Ztschr. f. angew. Chem.* (1909), **22**, 205.
[6] *Am. Chem. Jour.* (1902), **27**, 161.
[7] *Am. Chem. Jour.* (1903), **29**, 179.
[8] *Journ. Am. Chem. Soc.* (1903), **25**, 863.

In order to determine whether or not the resin acids in Manila copal would, like abietic acid, affect the photographic plate in the absence of terpenes, the following experiment was tried.

About 50 grams of powdered copal were dissolved in cold dilute alkali and the solution extracted four times with ether. The solution was then evaporated to one-half its volume on the steam bath to expel the ether. The solution was diluted and the resin acids precipitated by dilute hydrochloric acid. Ten grams of the dried acids were exposed to sunlight for one half day. A photographic plate was then placed over the substance and on developing the plate four days later a distinct black spot was obtained.

The above explanation of the action on the photographic plate of certain organic substances was suggested by a study of the autoxidation of Manila copal, but in view of the interest recently shown in this peculiar phenomenon it is published at the present time while the work on Manila copal will appear at a later date.

TESTS OF PHILIPPINE ROAD MATERIALS.

By George I. Adams.

(*From the Division of Mines, Bureau of Science.*)

Sometime ago the engineer of the city of Manila requested that the division of mines of the Bureau of Science find a quarry site which would supply a superior quality of stone for macadamizing the streets. The importance of this problem will be seen when it is realized that the city uses each year in surfacing streets about 50,000 cubic meters of crushed stone, which costs delivered in Manila about ₱2.50 per cubic meter. The quality is not satisfactory and any improvement in the quality of the material used would be evident in the better character of the streets and a saving in the cost of maintenance.

Abrasion machine.—It is obvious that in recommending a change of the quarry site one should not trust simply to his judgment, but should be able to base his recommendations on reliable tests. When geologic work was begun for the purpose of finding a better stone, there were no appliances in the Islands for testing stone for use as road material, and it seemed undesirable to resort to the only remaining method of making a practical test by macadamizing certain streets with different materials available, and waiting for the results of actual wear to show which material is the most desirable. A properly equipped laboratory should be supplied with apparatus for submitting stone to the abrasion test and determining its cementing value, toughness, absorption, hardness, specific gravity, and strength. Most of this apparatus is relatively expensive, and some of it, being of special design, can not be constructed easily. For the abrasion test, however, which is the one which most closely corresponds to the conditions of actual wear, a machine that can be constructed readily is required and accordingly one was designed. Castings were made in Manila, and the machine was completed and set up by the engineer of this Bureau. The Devall type of machine first constructed in France and accepted and used by the Road Material Laboratory of the United States Department of Agriculture at Washington, was selected, in order that tests might be carried on in conformity with accepted standards, and comparisons made with the results obtained in the Washington Laboratory, which has been in operation for a number of years.

The Devall abrasion machine consists essentially of two iron cylinders fastened to a shaft so that each cylinder is at an angle of 30° with an axis of rotation. Each cylinder is 20 centimeters in diameter and 34 centimeters in depth, closed at one end and having a tightly fitting iron cover for the other. In testing stone with this machine it is broken into pieces of as nearly uniform size as possible, each of which will pass in all positions through a 6 centimeter ring. Five kilograms approximating as closely as possible to 50 pieces of rock previously cleaned by washing and subsequently dried in an oven and then cooled in a desiccator, is used as a charge for each cylinder. The machine is rotated at the rate of 2,000 revolutions per hour for five hours, the inclination of the cylinders causing it to be thrown from one end to the other twice at each revolution. When the abrasion of the material is completed, the contents of each cylinder is placed on a sieve having openings of 0.16 centimeter, and the material which passes through this is caught on a sieve having openings of 0.025 centimeter. Both sieves with the rock held on them are placed under running water until all the dust is washed off. These fragments are then dried in a hot air bath and cooled in a desiccator and weighed.

Percentage of wear.—The percentage of wear indicates the amount of the original sample which was worn to fines less than 0.16 centimeter in size during the test. Theoretically, this percentage of wear may vary from 0 to 100, but materials which show 20 per cent or more of wear are considered unfit for use. Some materials will show less than 2 per cent of wear.

French coefficient.—The French coefficient, which is an arbitrary one, is determined by dividing 2,000 by the weight of the fragments under 0.16 centimeter in size, which are worn off during the test. According to this standard, the scale of excellence would vary from 0 to 20, with some material passing 20.

United States coefficient.—In reports of the road material laboratory at Washington, the United States coefficient is also given, which is found by dividing by 10 the weight of the material over 3 centimeters in size which remains after the test.

Report of a series of tests.—Inasmuch as the French coefficient is an arbitrary standard and the United States coefficient does not express so directly the wear in actual use on the roads, it is not considered necessary to record them, although they have been computed in all the tests made in this Bureau. The following table is a summary of the abrasion tests thus far made on road materials used in the Philippines. It is presented for the information of those who are in charge of the construction of roads with the hope that it may indicate the wide range in the character of the stone used and show that in many cases a considerable economy may be effected by carefully selecting the quarries.

Rock varieties.	Textures.	Localities.	Number of samples.	Percentage of wear.
Basalt	Dense	Talim Island, Manila city quarry	3	2.57
Do	Vesicular and scoriaceous.	do	1	8.66
Do	Dense	Road from Antipolo to Taytay, Rizal	3	2.61
Do	Vesicular	do	1	4.60
Andesite	Crystalline	Los Baños quarry, Laguna	2	2.66
Do	do	Sisiman quarry, Bataan	2	4.08
Do	do	Arayat quarry, Pangasinan	1	2.62
Do	Vesicular	do	1	3.54
Do	Crystalline, but weathered.	Sea beach below Batangas, used in road from Batangas to San Juan.	2	3.79
Gabbro	Dense, fine grained	New Manila city quarry, Angono, Rizal.	1	2.17
Do	Brecciated	Old Spanish quarry, Angono, Rizal	1	2.31
Diorite	Gravel, crystalline	Benguet road	1	1.98
Diorite and andesite	do	do	1	2.67
Diorite	Crystalline	Sara-Ajuy road, Iloilo	1	1.76
Limestone	Dense	Montalban, Rizal	2	3.97
Do	do	Sibul Springs, Bulacan	2	3.77
Do	Porous	San Esteban, Ilocos Sur	1	4.55
Do	Dense	Danar, Ilocos Sur	1	3.67
Do	Porous	San Fernando, La Union	2	5.73
Do	Dense	Benguet road	2	4.34
Do	Dense, argillaceous	do	2	6.09

Stone used for the streets of Manila.—During the Spanish régime very few streets of Manila were macadamized, and these only imperfectly. The streets which were well improved were, for the most part, paved with granite blocks imported from Hongkong as ballast. In addition, paving blocks were cut from an andesite near the present Sisiman quarry, which is situated near Mariveles at the entrance to Manila Bay. Also at several places near Angono, Binangonan and Talim Island, basaltic and gabbroic paving blocks were made in a desultory way. Samples of these classes of block pavements can be seen in Manila to-day, and the mode of wear of the paving blocks is a fair index to the quality of the stone for macadam. At the beginning of the improvement of the streets by the American authorities, some crushed stone was obtained from the Binangonan quarry. This quarry has a very limited face, the stone varies in texture, and, accordingly, is unsuitable for large operations and was soon abandoned. The next place where quarrying was carried on extensively was on Malagi Island just southeast of Talim Island. The establishing of quarries there came about through using the island as a prison and the effort to employ the convicts at manual labor. The stone was not of superior quality and when the island was abandoned as a prison colony, the quarries were discontinued. The present plant operated by the city is on the northwest part of Talim Island at Subay, where a crushing plant operated by steam and supplied with convenient tracks, bins, and facilities for dumping into scows, is still in operation, but shows the results of heavy usage. The stone at this quarry is of about the same character as at Binangonan and Malagi. The better qualities are a dense basalt, which has a conchoidal and splintery fracture and shows 2.57 per cent of wear. With it there is a variable vesicular and sometimes scoriaceous variety showing 8.66 per cent of wear, and the gradation into this quality is so irregular that in quarrying it is very difficult to separate the two. Moreover, the processes of weathering have attacked the poorer and softer stone and the quarry at Talim contains considerable dirt, so that it is impossible to obtain continuously a clean, uniform crushed stone.

A careful survey was made of the zone which embraces Talim Island and Binangonan Peninsula. No better material was found occurring in relations suitable for quarrying. The zone is characterized by flows of basaltic lava, varying from dense to vesicular and scoriaceous varieties, and a large part is covered with volcanic agglomerate and braccias, which grade into tuffs.

When the United States Army built the road between Los Baños and Calamba, they opened a quarry near Los Baños. The rock is a crystalline andesite, usually quite dense in texture. There is a high face of rock which rendered quarrying easy and a small crusher was installed which gave a very satisfactory output. It shows 2.66 per cent of wear. Besides using the stone on the road near Los Baños, a considerable quantity of it was transported to Fort McKinley and used in macadamizing the streets of that post. The city of Manila has been deterred from using this quarry because it was thought not to furnish the best quality of rock which could be obtained, and that the transportation which would include that by land to the shore of the lake and a long towage across to the mouth of the Pasig River would make the cost too high.

The quarry at Sisiman, near Mariveles, was opened for the purpose of supplying large stone for building the breakwater of Manila Harbor. The city was induced to try crushed stone from this quarry for macadam, and some streets were carefully prepared with it for the purpose of making a practical test, but it was found unsatisfactory since it is too soft and wears rapidly under the action of wheels, disintegrating into rock flour. Although the quality of the stone was soon determined, some additional attempts were made to use the screenings from it as a top dressing over the Talim rock, with a hope that it would serve as a binder. As it has a very low cementing value, this experiment was not successful, and the fact that the dressing consisted of fines containing a large amount of rock flour rendered the streets muddy and necessitated the removal of the dressing after the first heavy rains.

As soon as the abrasion machine was constructed, the Sisiman rock was tested and its percentage of water was found to be 4.08. This test demonstrated much more economically the unsuitability of the rock than did the practical test, and showed the value of using the abrasion machine.

In looking for a quarry site, the shores of the Bay Lake (Laguna de Bay) and Manila Bay were carefully explored as well as all points from which railway transportation appeared feasible. It was soon discovered that it would be impossible to ship stone by rail at the present freight rate, or even at such reduced rates as the company might be willing to concede, since the railway rates are high and seemingly excessive. No good quarry site was found on the immediate shore of the lake. The occurrence of hard rock on the shores of Manila Bay are all near the entrance, and most of them at places where the conditions for quarrying and loading are not favorable. Transportation across the bay could not be depended upon during rough weather, and this would be a serious handicap to the city since continuous operations are necessary in order to supply the amount of stone required, and if the launches and lighters and employees were unable to carry on continually this work they could not be employed readily in other duties.

The railroad to Antipolo passes an extensive outcrop of basalt in the vicinity of Antipolo Falls which is to the north of Binangonan Peninsula in the same zone of basaltic rocks. Samples of this stone were collected and tested for the sake of information. They showed 2.61 per cent of wear, or practically the same amount as the best grade of Talim rock; and although the fracture of this stone was somewhat better than that at the Talim quarry, it appeared that little could be gained by using it, and transportation, which would necessarily be by rail, would be too expensive. Between Antipolo and Taytay, in making a cut, a very hard stone was found and the railroad company called the attention of the division of mines to its occurrence. It was examined in the field and the exposures were found unsuitable for establishing a quarry. The rock was not tested, although a sample of it was obtained. Similarly, the limestone at the waterworks dam near Montalban was examined, since it was suggested that it might show better cementing values, and, being an unusually hard limestone, might prove suitable for macadam. The percentage of wear of this stone was found to be 3.97 per cent. Although it is superior limestone, it is not good enough to recommend for use on city streets; moreover, the color, which is nearly white, would be a serious disadvantage because of the strong reflection of light from it.

Up to this point in the field work, investigations had been carried on with the hope of satisfying the desire of the city officials to be informed of a location which would necessitate only water transportation. It was ascertained that a good quality of the rock could not be found situated under these conditions. It was believed that the hard stone found on the railway between Taytay and Antipolo was of superior quality, and it was judged from the geological formation that it would continue in a southerly direction to Angono, which is on the shore of the lake. At Angono, however, there is a belt of alluvial land lying between the hills and the lake shore, across which it would be necessary to use land transportation for a distance of approximately 2 kilometers. It was reported informally to the city engineer that this location would probably furnish the best rock available near Manila, and when it was seen that land transportation could not be avoided if a good quality of stone was to be secured, instructions were received to examine the vicinity of Angono. A hill situated to the northeast of the town contains a fine-grained, even-textured gabbroic rock, breaking with a good fracture. Samples of it were secured and tested in the abrasion machine. It showed 2.17 per cent of wear, and constituted at that time the best road material which had been received at the laboratory. Although the percentage of wear is not very much lower than that of the Talim rock, which is 2.57 per cent, the even quality of the stone and the possibility of obtaining it without admixture of quarry dirt and objectionable inferior material, such as is found in the quarry now operated, renders it far superior to the Talim product. It was learned during the investigation of the Angono locality that under the Spanish régime a quarry had been opened in the hills to the southeast of Angono, a tramway built to the border of the lake and a stone pier constructed from which the contents of cars could be dumped into scows. All of this installation was abandoned and sold before the American occupation and the quarry practically forgotten. Complete records, however, were discovered in the city archives. Before the location of the quarry had been visited, stone obtained from it was seen in the riprap on Pasig River in front of the municipal building at Pasig. This stone is suitable for many purposes and was used at various places in Manila by the Spanish, but it is brecciated, which uneven texture renders it much less desirable for road material than the stone in the hill northeast of Angono. Samples of the rock were selected and submitted to abrasion tests. It showed 2.31 per cent of wear on carefully selected pieces and it is probable that the run of the quarry would not be quite so good. It is unfortunate that the Spanish quarry is not suitable for supplying stone for macadamizing, since the utilization of what remains of the tram grade and the stone pier would save a considerable expense. Steps have been taken by the city to secure a title to the new quarry site northeast of Angono, and before long Manila may have better streets. The additional cost of the land transportation will probably be counterbalanced by the saving in maintenance.

Stone used on the roads of the provinces.—When the abrasion machine was installed, and a few samples of stone had been tested, a report of the results was made to the Director of Public Works, accompanied by an offer to test a series of samples of crushed stone from the quarries operated in the provinces. In accordance with this offer, a number of samples have been received and tested, and their percentage of wear will be found recorded in the table in the first part of this report. It has not been possible as yet to do any field work to determine whether the quarries which are operated are supplying the best rock which can be obtained, but it will be noticed that there is a wide divergence in the character of the stone used, and in some cases the percentage of wear is so excessive that if any better stone could be obtained, even at some additional cost, the roads might be improved and the expenses would perhaps be counterbalanced by the saving in maintenance. It is the desire of the Bureau of Science to aid as fully as possible in the economic problem of the use of road materials and it is hoped that further tests, and possibly some field work, may be carried on each year in coöperation with the Bureau of Public Works. It is planned to equip a laboratory with all the standand machines so that complete tests may be made. The necessary apparatus for this has already been ordered.

SAND, GRAVEL AND CRUSHED STONE AVAILABLE FOR CONCRETE CONSTRUCTION IN MANILA.

By George I. Adams.

(From the Division of Mines, Bureau of Science.)

While making a geological reconnaissance of southwestern Luzon, special attention was paid to the occurrence and availability of structural materials. In this area which produces no metallic minerals, the value of the stone, gravel, sand and clay products used during the last year surpassed that produced by any mining district in the Islands. Most of this output was used in and near Manila.

It is a surprising fact that sand and gravel taken from the Pasig and Mariquina Rivers have sold at the dredges for more per cubic meter than the average value of the gold per meter in good gold-dredging ground, and that the price of crushed stone at the quarries has in some cases been so high as to make the quarrying compare favorably, considering the expenses of production, with the mining of low-grade ores. The problem of the cost of structural materials in Manila should resolve itself without any special investigation. It is the purpose of this report to discuss the nature of the materials which are commonly used, to show where other and better ones may be obtained, and to indicate their relative efficiencies in concrete construction.

SAND.

Sources.—Most of the sand used in Manila is dredged from the Pasig River or dipped up in baskets and loaded into bancas by native divers. Some is also obtained from the Mariquina River which enters the Pasig just below the town of Pasig. The Pasig is the outlet of Laguna de Bay and does not bring coarse sediments from the lake. Accordingly, such sands and gravels as are found in its bed are received almost entirely from the Mariquina, which is its principal tributary, and the only large stream from the Eastern Cordillera which brings erosional products to the vicinity of Manila. (See fig. 1.)

North of Manila, the first large river which flows toward Manila Bay and contains an important amount of sand, is the Quingua, which flows from the Eastern Cordillera past Baliuag and Quingua and joins the delta system of waterways which enters Manila Bay. Near the station of Quingua, there is a switch of the Manila and Dagupan Railway which enters the river bed and there a large amount of sand, with which is mixed some gravel, has been taken out and used on the road as ballast. This material which will be referred to in this article as Quingua sand, can be transported to Manila by water, but the distance is great and the river near Quingua is often too shallow for navigation by launches. Transportation by rail at the present rates is prohibitive, and the cost as compared with usual railway rates seems excessive.

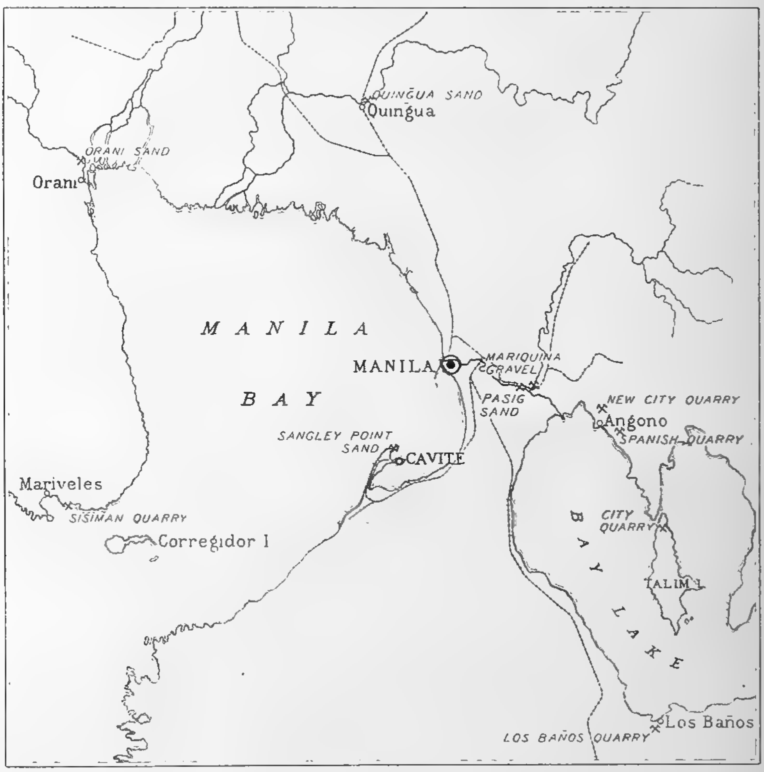


FIG. 1.—INDEX MAP OF LOCALITIES PRODUCING SAND, GRAVEL AND CRUSHED STONE.

South of Manila there are no streams entering the bay which contain deposits of gravel and sand, but all contribute small amounts to the beach. At Cavite, sand has been obtained in dredging the anchorage in front of the coal pockets on Sangley Point and considerable of it has been used in Manila; the beach also furnishes a similar material. This sand is referred to in this article under the name of Sangley Point sand.

Near the entrance to Manila Bay there are several places where beach sands composed largely of comminuted shells may be obtained. They have been used in building the fortifications at the entrance to the bay, but none have been brought to Manila, and it is probable that they will not be used here since better sands can be obtained more economically.

The sands used in Manila have been of only fair quality and it was the purpose of the investigation to find, if possible, one of superior quality. Sand from the Tarlac River at Tarlac, a railroad station situated halfway between Manila and Dagupan, was at one time recommended as a standard sand for use in testing cements, inasmuch as it was the best then known in the Philippines. An examination of the map showed that the sources of the Tarlac River are in the Western or Zambales Cordillera and it was accordingly concluded that rivers having their sources in these mountains and emptying into Manila Bay might carry the same kind of sand. It was decided that the Orani River was the most promising to investigate and upon visiting it there was found an abundance of sand similar to that of the Tarlac and of a slightly better quality. The river can be entered by launches and at low tide the sand can be loaded directly into barges. This sand is given the name of Orani sand in this report.

Nature of the sands.—The Pasig and Mariquina sand is a pebble sand which has resulted principally from the breaking down and wearing of andesite and basaltic rocks and gravels. The grains are in an advanced stage of decomposition and crush easily. The original rocks contain very little quartz and so there is not a noticeable amount of quartz in the sand. The few grains which may be seen in a small sample are probably mostly derived from quartz veins.

The Quingua sand is also a pebble sand, but it is derived from an area containing a great variety of rocks and many of its grains are hard and it contains a noticeable amount of quartz.

The Sangley Point sand is derived principally from basaltic rocks which occur fragmentally in the tuff formation which borders Manila Bay. The grains are in an advanced stage of decomposition and are readily crushed. In addition to the basaltic material many minute shells and fragments of larger ones are present.

The Orani sand is composed largely of clear sharp grains but little rounded. It is clean and sharp and produces a decided squeak when grasped in the hand. The clear grains are readily mistaken for quartz but in reality are plagioclase feldspars which have a similar hardness and specific gravity. The remaining minerals which it contains are pebbles and fragments of various igneous rocks. There are a few soft gravels of light specific gravity found with the sand but they are not more numerous than similar objectionable elements in the other sands.

Granularmetric analysis.—For finding the percentage of the different sized grains which constitute the sands, a series of sieves was obtained and the sizes of their meshes carefully calibrated. The analyses made by sieving the sands are illustrated graphically in the accompanying diagrams in which the curved lines represent the gradation of the sands and the broken line is an even grade line for the series of sieves used. This grade line runs from zero to 100 per cent on the 10 mesh sieve, which sieve corresponds approximately to the one having the smallest openings in the series used for stone and gravel. In order to ascertain the percentage held on any given sieve the amount indicated as passing the sieve should be subtracted from 100.

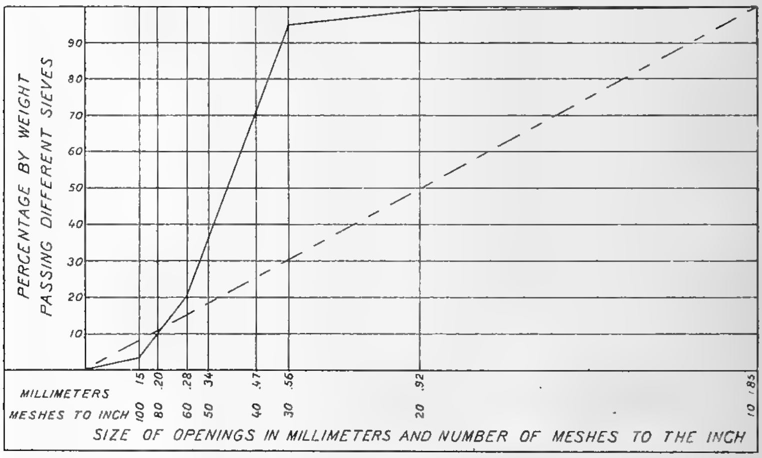


FIG. 2.—GRANULARMETRIC ANALYSIS OF PASIG SAND DIPPED UP IN BASKETS.

There is a large amount of fine-grained sand used in Manila on small jobs. It is dipped up in baskets and loaded into bancas by native divers. This sand is sometimes called banca sand. An analysis of some of it is shown in fig. 2. It will be seen that only 1 per cent is held on the 20-mesh sieve, but 5 per cent is held on the 30-mesh sieve, and the percentage passing the 100-mesh sieve is 2.6.

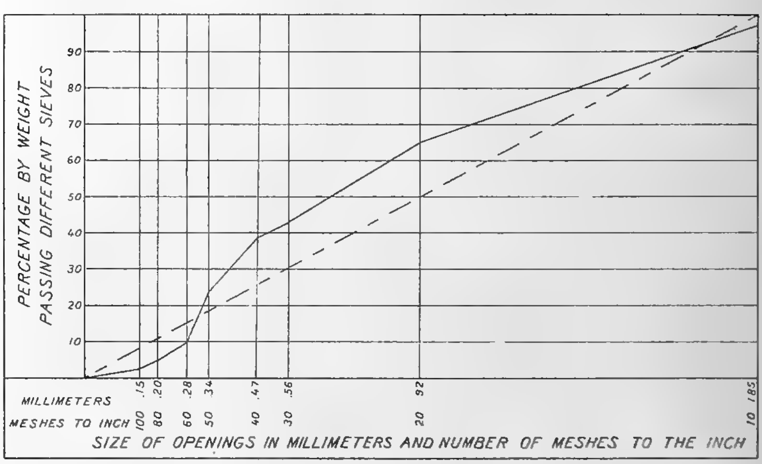


FIG. 3.—GRANULARMETRIC ANALYSIS OF PASIG SAND OBTAINED BY DREDGING.

The analysis of a good grade of Pasig sand is shown in fig. 3. This sand contains 2.3 per cent of fine gravel; 36 per cent is held on a 20-mesh sieve; 58 per cent is held on a 30-mesh and 2.6 per cent passes the 100-mesh.

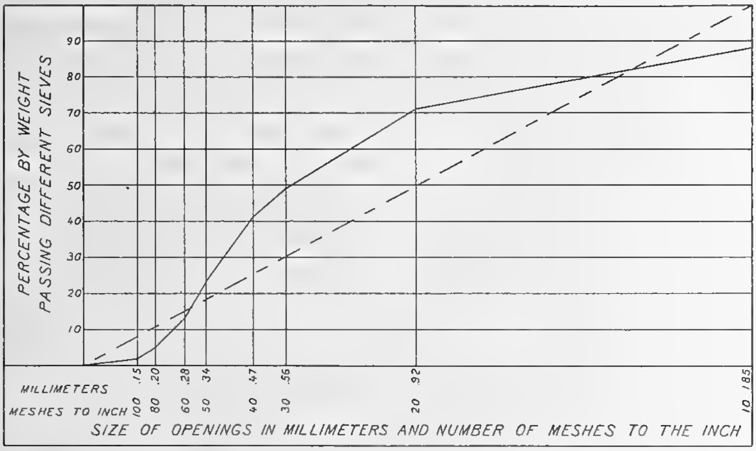


FIG. 4.—GRANULARMETRIC ANALYSIS OF PASIG SAND OBTAINED BY DREDGING.

The analysis in fig. 4 shows a sand containing 12 per cent of fine gravel. This sand runs a little coarser than the one shown in fig. 3. Twenty-nine per cent was held on a 20-mesh sieve, 51 per cent was held on a 30-mesh sieve and but 2 per cent passed the 100-mesh.

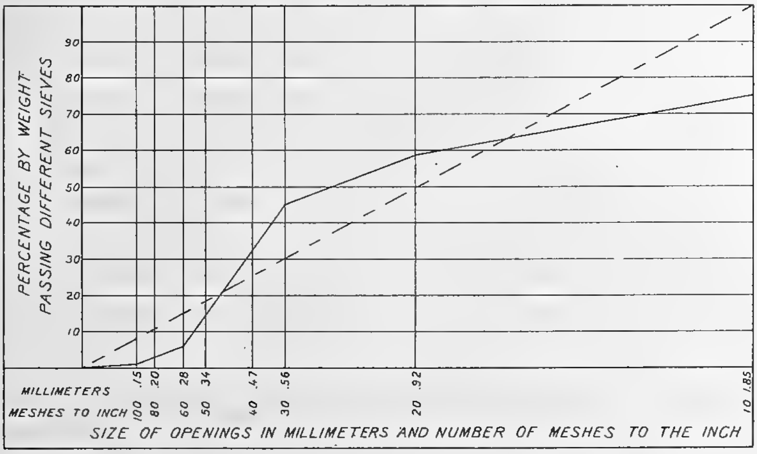


FIG. 5.—GRANULARMETRIC ANALYSIS OF QUINGUA RIVER SAND.

The sample of sand taken from the Quingua River shows 25 per cent of fine gravel mixed with it; 41.5 per cent was held on a 20-mesh sieve, 55 per cent was held on a 30-mesh sieve, and but 1 per cent passed a 100-mesh. This sand is clean and the most evenly graded of any of the samples examined.

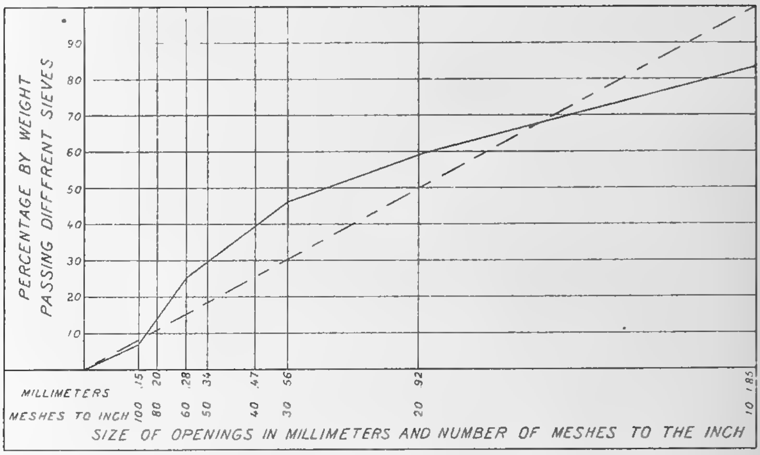


FIG. 6.—GRANULARMETRIC ANALYSIS OF SANGLEY POINT SAND.

There is a considerable percentage of coarse material in the Sangley Point sand which consists of decomposed pebbles and shells and shell fragments. In fig. 6 it is seen that there is 16 per cent of this coarse material, 41 per cent held on a 20-mesh sieve, 54 per cent on a 30-mesh, and 7 per cent passing a 100-mesh sieve. Accordingly the sand contains an objectionable amount of coarse material, consisting of broken shells and also considerable dirt.

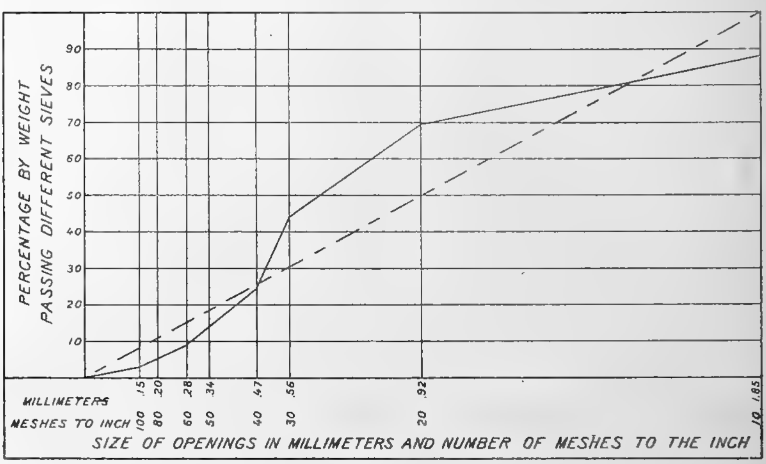


FIG. 7.—GRANULARMETRIC ANALYSIS OF ORANI SAND.

The analysis shown in fig. 7 indicates 12 per cent of fine gravel, 30.5 per cent held on a 20-mesh sieve, 56 per cent held on a 30-mesh and 3 per cent passing a 100-mesh. The Orani sand contains coarse sharp grains and very little fine material and practically no shell fragments.

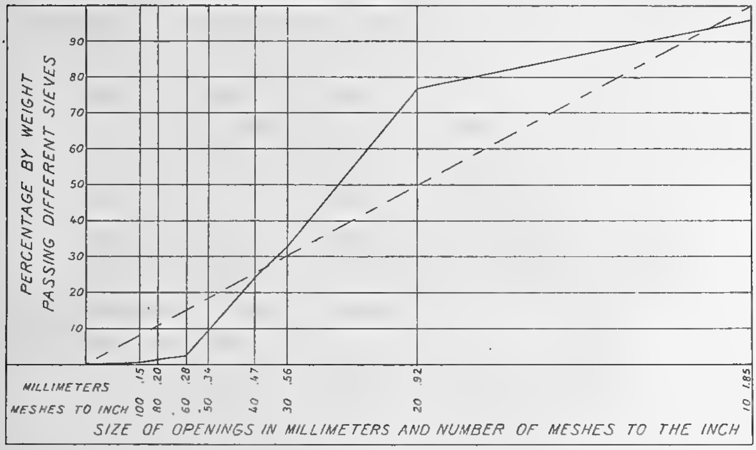


FIG. 8.—GRANULARMETRIC ANALYSIS OF ORANI SAND.

Another analysis of Orani sand is given in fig. 8 which shows 4.1 per cent of fine gravel; 23.4 per cent held on a 20-mesh sieve, 67.6 per cent held on a 30-mesh sieve, and 0.5 per cent passing a 100-mesh sieve. It will be noted that from the 60-mesh sieve to the 20-mesh the line indicating the analysis is nearly straight.

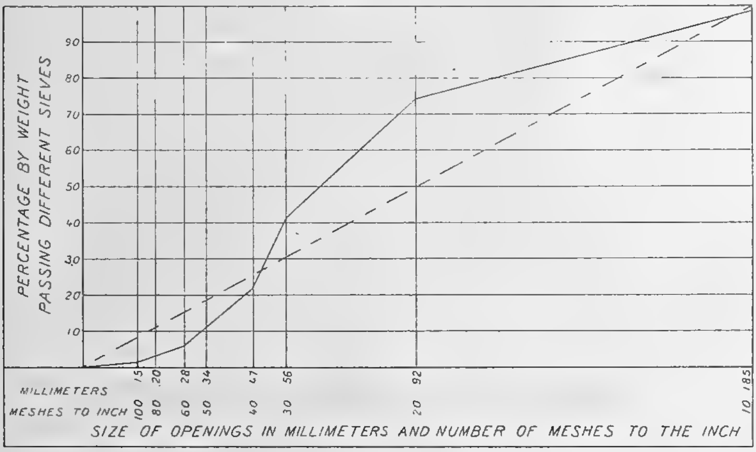


FIG. 9.—GRANULARMETRIC ANALYSIS OF TARLAC SAND.

The analysis of a sample of Tarlac sand is introduced for the sake of comparison, although the sand is not available for use in Manila. The percentage of fine gravel is shown to be 1.5; 26 per cent is held on a 20-mesh sieve, 59 per cent is held on a 30-mesh and 1.5 per cent passes a 100-mesh. This sample had been sieved to take out coarse pebbles.

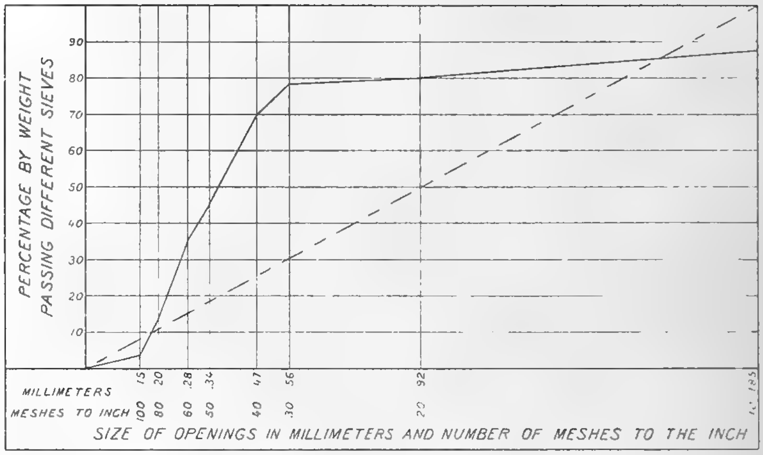


FIG. 10.—GRANULARMETRIC ANALYSIS OF BEACH SAND FROM NEAR CORREGIDOR.

In fig. 10 an analysis of a beach sand from near the entrance to Manila Bay is given. It shows 13 per cent fine gravel size, 20 per cent held on a 20-mesh sieve, 22 per cent held on a 30-mesh sieve and 3.3 per cent passing the 100-mesh. It is composed almost entirely of shell fragments.

All of the sands which have been analyzed granularmetrically show a certain amount of variation. The analyses presented above, however, may be regarded as fairly typical. Pasig sand, as it is used at present, is not screened according to any uniform specifications.

Efficiency.—Samples of sands from various localities above mentioned were sieved on a 20-mesh sieve and the portions passing were then sieved on a 30-mesh. The sands retained on the 30-mesh were used for making a series of tensile-strength briquettes in which a good quality of cement was employed in the proportion of one part of cement and three parts of sand. These briquettes were broken after seven days and their tensile strengths compared with similar briquettes made with crushed quartz used as a standard sand. The results of these tests, which, however, should be regarded as incomplete, are shown in the following table:

Comparative test of sands in tensile-strength briquettes.

Sand screened through 20-mesh and held on 30-mesh.	Percent of efficiency at 7 days.
Sangley	55
Pasig	66
Tarlac	91
Orani	97
Quingua	107
Crushed quartz	100

The variation of the efficiency in the Sangley, Pasig and Quingua sands, all of which are pebble sands, is probably largely due to the difference in the character of the rock fragments which compose them. Andesitic and basaltic materials are conspicuous in the Pasig sands and basaltic grains constitute nearly all of the rock material in the Sangley sands, while the Quingua contains harder materials which do not so readily decompose and become spongy or porous, but under the action of water are gradually worn down to smaller sizes by attrition and abrasion. The efficiency of the Sangley sand, which is the lowest, may be further accounted for by the presence of many minute shells which do not fill with cement.

The fact that the Quingua sand is more efficient than the Orani and Tarlac, is probably due to the shape of the grains, which being rounded decreases the voids. Moreover, the vitreous surfaces of the crystal fragments in the Orani and Tarlac sands may also cause them to wet less readily than the grains of the Quingua, which have minutely pitted surfaces and capillary openings.

A comparison of the efficiency of the Pasig and Orani sands was also made by crushing concrete blocks which were made in a uniform way, using the same cement and Pasig gravel in each, but different sands. In order to follow working conditions the sands were both screened through a 4-mesh sieve. The blocks were stored twenty-five days in moist air and afterwards exposed to the sun and rain. They were crushed at the end of three months and gave the following results: Pasig sand, 1:2:5: mixture, average of three breaks; first crack, 912 pounds per square inch; ultimate, 1,542 pounds per square inch. Orani sand, 1:2:5 mixture, average of three breaks; first crack, 1,568 pounds per square inch; ultimate, 1,951 pounds per square inch.

Specific gravity, percentage of voids and weights per cubic meter.—Samples of the various sands were screened through a 10-mesh sieve and their specific gravities, percentage of voids and weights per cubic meter determined as shown in the following table:

Sand.	Specific gravity.	Percentage of voids.	Weight per cubic meter in kilograms.
Pasig	2.67	37.5	1,671
Quingua	2.71	35.2	1,757
Sangley	2.58	42.0	1,500
Orani	2.62	42.9	1,500
Corregidor	2.77	41.7	1,615

Photographs of these samples are shown in Plates I and II.

GRAVELS.

Source of materials.—The only gravel readily available for use in Manila is that which is dredged from the Mariquina River. The gravel in the Pasig has already been largely dredged out in maintaining the channel of the river, and although it is partially renewed during the flood season when the Mariquina gravel is brought in, it does not furnish a satisfactory dredging ground.

The Quingua gravel at Quingua is too fine. Further up the river near Baliuag, the same river contains a good quality of gravel but it is not accessible.

Nature of the gravel.—The Mariquina gravel is derived principally from basaltic and andesitic rocks, as has already been explained in discussing the sands of the stream. Many of the pebbles are partially decomposed and show altered spots and "pin holes" when broken. The basaltic gravels frequently have a dense texture and are friable, being in many respects similar to the Talim basalt which is used in macadamizing the streets of Manila, and which has proved rather unsatisfactory on account of its friability.

Granularmetric analysis.—By sieving samples of the gravel on a series of stone and gravel sieves with round openings, the percentage of the different sizes in several samples has been determined. These analyses are shown graphically by the plotted curves in the following figures and they may be compared with the even grade line which is shown by the broken line drawn from zero to 100 per cent on the sieve through which the gravel should all pass according to the specifications.

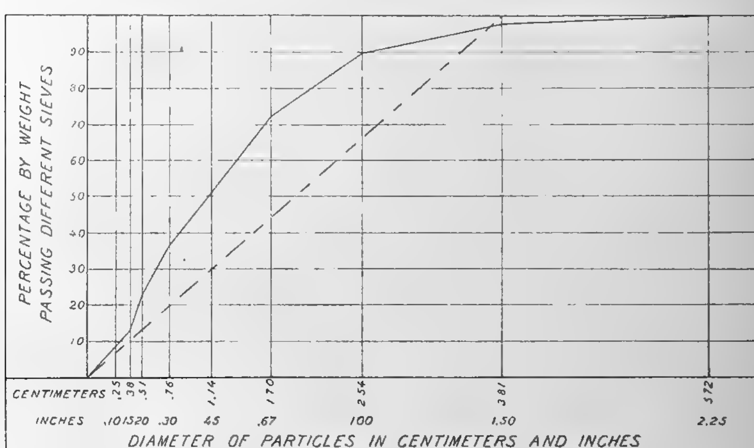


FIG. 11.—GRANULARMETRIC ANALYSIS OF MARIQUINA GRAVEL TO PASS A 1.5-INCH OPENING.

The analysis in fig. 11 shows 2.2 per cent of oversize and 8.7 which passes the smallest sieve. The percentage of voids is 31.2, and with material under 0.1 inch screened out, 33.5

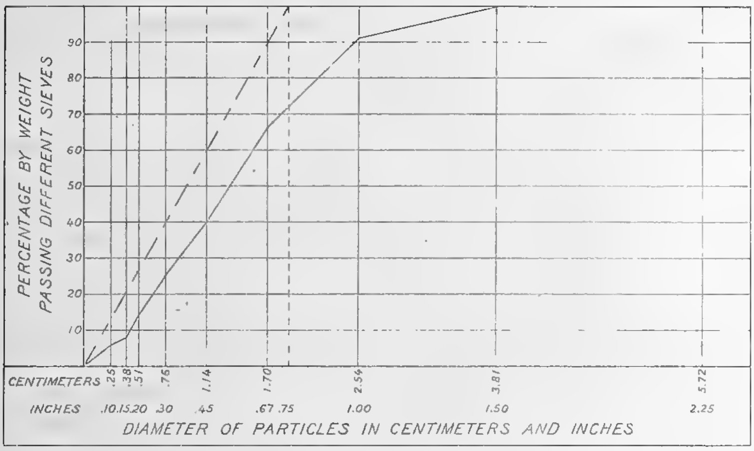


FIG. 12.—GRANULARMETRIC ANALYSIS OF MARIQUINA GRAVEL TO PASS A 0.75-INCH OPENING.

The analysis shown by fig. 12 indicates 27 per cent of oversize gravel and 6 per cent passing the smallest sieve. Voids 29.1, with material under 0.1 inch screened out, 32.9 per cent.

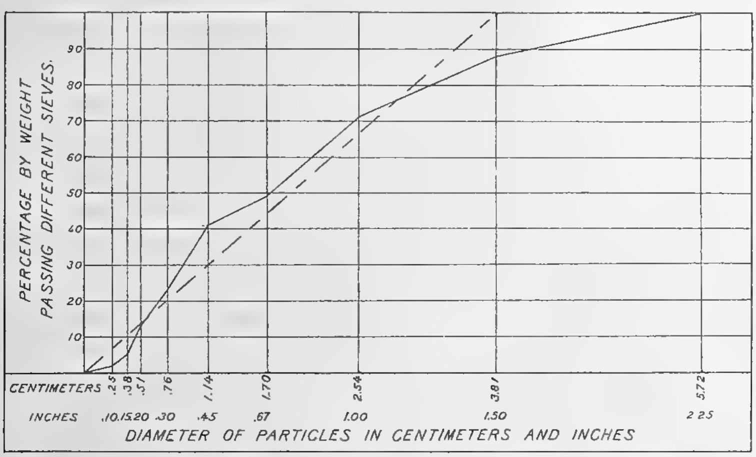


FIG. 13.—GRANULARMETRIC ANALYSIS OF MARIQUINA GRAVEL TO PASS A 1.5-INCH OPENING.

The analysis in fig. 13 shows 12 per cent of oversize gravel and 2 per cent passing the smallest sieve. Voids, 31.2 per cent.

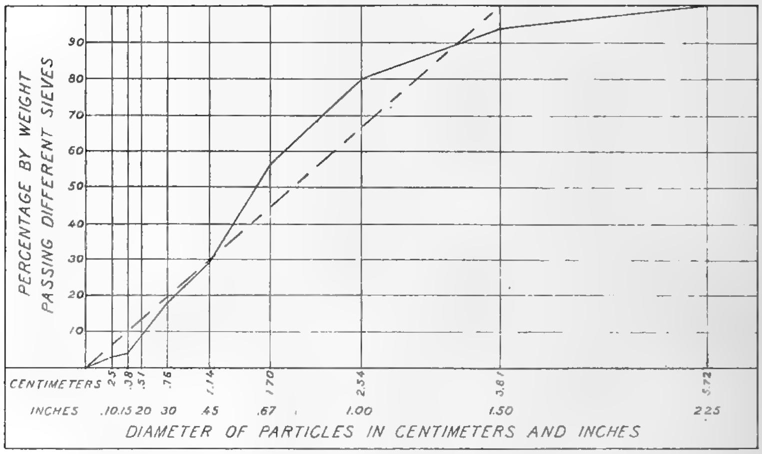


FIG. 14.—GRANULARMETRIC ANALYSIS OF MARIQUINA GRAVEL TO PASS A 1.5-INCH OPENING.

The analysis in fig. 14 shows 6 per cent of oversize and 3 per cent passing the smallest sieve. Voids, 31.5 per cent.

The Maraquina gravel varies greatly in character since it is not carefully screened as the analyses above will show.

Efficiency.—There is no standard gravel with which gravels may be compared after the manner that sands are compared with standard sands. It might be well to select a superior gravel to use as a standard in testing the efficiency of gravels in concrete. Cubes could be made with a good cement, a given sand or standard sand, and the standard gravel, and these could be used for comparing the crushing strength of cubes of concrete in which the gravel to be tested is combined with the same cements and sand in the same proportions. This would be especially helpful when a gravel is found to break under a pressure which is less than that required to crush the mortar of the concrete. In most gravels the smaller sizes have a lower crushing limit since they are in a more advanced stage of decomposition. It would, therefore, seem desirable that a standard gravel should be of small size. At Calapan, in Mindoro, a gravel was seen which had been obtained from a beach west of the port. It consists very largely of white quartz pebbles which will pass a 1.14-centimeter circular opening and be retained on a sieve with 0.51-centimeter circular openings. There are at present with the quartz pebbles some rounded fragments of shells and corals, and a few schist pebbles, but these can easily be picked out because of their texture and color. It is proposed to see what results can be obtained by using this material as a standard gravel and if it is satisfactory to recommend it for use. It is believed that quartz pebbles will be superior to crushed stone for the purpose of comparative tests of gravels because of the similarity of the shapes of and the absence of partially developed fractures which are found in the small sizes of crushed stone.

Thus far there has been accumulated only a small amount of data concerning the efficiency of Pasig gravel. In crushing concrete cubes, Mr. Reibling found that in several cases the gravel was weaker than the mortar. In one cube 40 per cent of the gravel broke.

CRUSHED STONE.

Sources.—The only large commercial quarry near Manila is situated at Sisiman, near Mariveles, at the entrance to Manila Bay. This point is so distant that considerable expense is required for transportation, nevertheless a large amount of the stone has been used in Manila for concrete construction. There are other quarry sites near Sisiman, some of which show a better stone and there are places which are better protected from storms.

Near Los Baños on Laguna de Bay a quarry was formerly operated for road material. To obtain stone from this situation a long tow across Laguna de Bay is necessary, and in addition land transportation to the border of the lake is required.

The city has for some time operated a quarry on Talim Island, but present indications are that the plant will be moved to a better site.

Under the Spanish régime a quarry was opened in the hills to the southeast of Angono, and a road bed was constructed to the border of the lake and a stone pier built out into the water to enable the dumping of stone from tram cars into scows. This quarry has not been operated recently. To the north of Angono the writer has found a superior grade of rock which the city is contemplating using for macadamizing Manila streets, and it is probable that a quarry will soon be opened there. Land transportation will be required for bringing the rock to the lake shore.

It appears that there are no good quarry sites of hard rock nearer Manila than the vicinity of Angono. Crushed rock obtained at this place can be brought in small barges which can enter the esteros in Manila and permit of the landing of the material at many places; this is an advantage since it saves land transportation in Manila. Rock from the Sisiman quarry, or others which might be opened near it, could best be transported on large scows and these, while they could land conveniently on the water front, could not ascend the Pasig River beyond the bridge of Spain nor enter the esteros.

Nature of the stone.—The Sisiman stone is a gray andesite which in the quarry shows columnar structure. This structure favors the quarrying of large stone. Near by the andesite has a somewhat better texture and is a little harder, and at a few points there is a dark andesitic rock which is superior to the gray andesite, but it is doubtful whether it can be obtained economically. The rock at Los Baños is andesitic with a crystalline structure and is of good quality.

The Talim quarry supplies a basaltic rock which is dense and shows practically no crystalline structure to the unaided eye. It is rather friable and breaks with a splintery fracture. Crushed stone from the quarry usually contains a considerable admixture of softer material and dirt, especially when operations are carried on during the rainy season. The old Spanish quarries near Angono show a dark green brecciated gabbroic rock. A clean crushed stone can be obtained from it, and, although the rock is brecciated and accordingly uneven in texture, it is believed that it is suitable for concrete work, but not so desirable for road material. When the city quarry is moved to the new location north of Angono, it will supply a clean, fine grained, crushed stone of very even texture. This is the best rock which can be obtained for use in Manila.

Granularmetric analysis.—Crushed stone as it comes from the crusher is usually very uniformly graded. In this respect it differs materially from gravels. Unless it contains a considerable amount of fines, it can be used just as it comes from the crusher. Usually the fines can be washed out by pouring water over the stone when it is measured up in baskets for obtaining the proper proportions in mixing concrete.

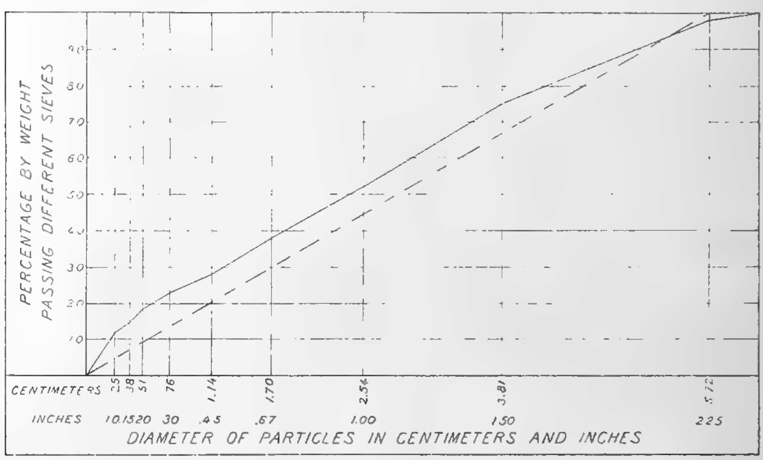


FIG. 15.—GRANULARMETRIC ANALYSIS OF SISIMAN CRUSHED STONE CONTAINING FINES.

In fig. 15 the granularmetric analysis of Sisiman rock is shown just as it was delivered from the crusher. Percentage of voids, 37.4; $11\frac{1}{2}$ per cent passed the smallest sieve and 98 per cent passed the $2\frac{1}{4}$-inch sieve. Between these two points as plotted the analysis runs in a nearly straight line. In fig. 16 the granularmetric analysis of the same sample of stone which was shown in fig. 15 is replotted excluding the fines which passed the smallest sieve. In this diagram the analysis follows very closely the even grade line. The percentage of voids in a sample of washed Sisiman rock was found to be 43.4.

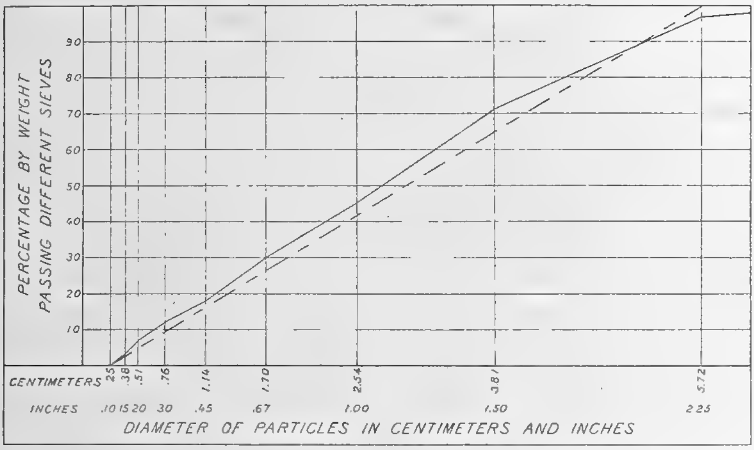


FIG. 16.—GRANULARMETRIC ANALYSIS OF SISIMAN CRUSHED STONE, FINES EXCLUDED.

Efficiency.—No tests have been made to show the strength which may be obtained in concrete using the Sisiman stone. It appears to be very satisfactory when used as crusher run. It may, however, prove to show a higher percentage of efficiency when selected sizes are used. The fines from the rock if replotted as sand, show 23 per cent passing a 100-mesh sieve. This is really a rock flour, and as has already been suggested above, should be excluded from concrete work by washing the stone.

The crushing strength of Sisiman stone was determined by dressing a block to true edges and crushing it in a compression strength machine. It broke under a pressure of 1,115 tons to the square foot (1088. kilograms per square centimeter).

At the writer's suggestion, the United States Army engineers opened a quarry on Corregidor. The stone is a white dacite, very much sheared and jointed so that it requires but little breaking up for feeding to a crusher. A block of this stone dressed to true edges crushed under a pressure of 1,009 tons to the square foot (985. kilograms per square centimeter).

A stone from the site of the new city quarry near Angono crushed under a pressure of 1,584. tons to the square foot (1547. kilograms per square centimeter).

It is proposed to make further tests of the crushed stone available for use in Manila and include in this work all the quarries which have been mentioned above.

AGGREGATES.

Pasig sand and Mariquina gravel.—In most of the concrete work in Manila, Pasig sand and Mariquina gravel are used. In the tests recorded above the sand in tensile strength briquettes showed in a seven-day test but 65 per cent efficiency when compared with crushed quartz, and it has been demonstrated by crushing concrete blocks that a large percentage of the gravel breaks under a lower compressive force than the mortar will sustain. Concrete blocks of Pasig sand and Mariquina gravel in the proportions 1 : 2 : 4–1 : 2 : 5–1 : 2 : 6 showed but little difference in compression tests. This is explained by the fact that the gravel is weak and that the concrete crushed below the ultimate strength of the mortar.

Sangley sand and Sisiman crushed stone.—This combination has been used extensively, as, for example, in the construction of the sewers. The stone is of good quality since a block of it crushed under a pressure of 1,115 tons per square foot. The Sangley Point sand has at seven days an efficiency of but 55 per cent. The crushing strength of concrete made with this aggregate has not been determined, but it is probably low, since the efficiency of the sand is low and the ultimate strength of the mortar will not approach that of the stone.

Sangley sand and Mariquina gravel.—This is the poorest aggregate which is used in Manila, and yet Mariquina gravel has been substituted for Sisiman stone in some cases where Sangley sand was used. The crushing strength of concrete made from these materials is yet to be determined.

Pasig sand and Sisiman stone.—This aggregate has not been much employed. It should prove superior to those above mentioned but concrete made from it will probably fall far below the limit of the stone, since the sand has an efficiency of only 66 per cent in seven-day tensile-strength tests.

Orani sand and Pasig gravel.—This aggregate has been used in the base of concrete paving blocks where but little strength is required. For constructions requiring great strength the combination is not desirable, since the gravel is not efficient. The mortar used in the surface of the paving blocks was found to be superior in quality to those of blocks made with Pasig sand.

Orani sand and crushed stone.—Orani sand and Sisiman stone have been used in reconstructing the shaft of the Magallanes Monument. This aggregate should develop greater strength than any combination above mentioned. Other crushed stone available for use in Manila may be substituted for Sisiman stone and some of it may even prove better, as for exaple, the Angono rock. The Orani sand showed 97 per cent efficiency in seven-day tensile-strength tests, and the strength of good crushed stone is higher than mortar made with this sand.

CONCLUSION.

The field work necessary to make known the sources and nature of the sand, gravel and crushed stone available for use in Manila has been completed. An extensive deposit of a superior sand has been discovered in the Orani River and some of this sand is now being used. A new quarry site has been selected for the city near Angono, the stone from which is considerably better than what is now being used from the Talim quarries and is the best obtainable for macadamizing the streets of Manila and is in every way suited for concrete work.

The testing of the materials, while incomplete, is sufficient to show their relative efficiencies and to check the conclusions arrived at from the geologic examinations. Further tests extending over longer periods of time and embracing all the conditions which will be met with in practice will be made in the testing laboratory of the Bureau of Science as soon as the facilities will permit.

The economic problems of the cost of quarrying, dredging and transporting, and the more vital one of obtaining the best results in the use of the materials is beyond the scope of this paper, but some data have been supplied to assist in their solution.

For the tests of materials which are reported in this article the writer is indebted to Mr. W. C. Reibling, in charge of the cement-testing laboratory of this Bureau, and to F. D. Reyes, assistant in the cement laboratory.

LIST OF ILLUSTRATIONS.

TEXT FIGURES.

PLATES.

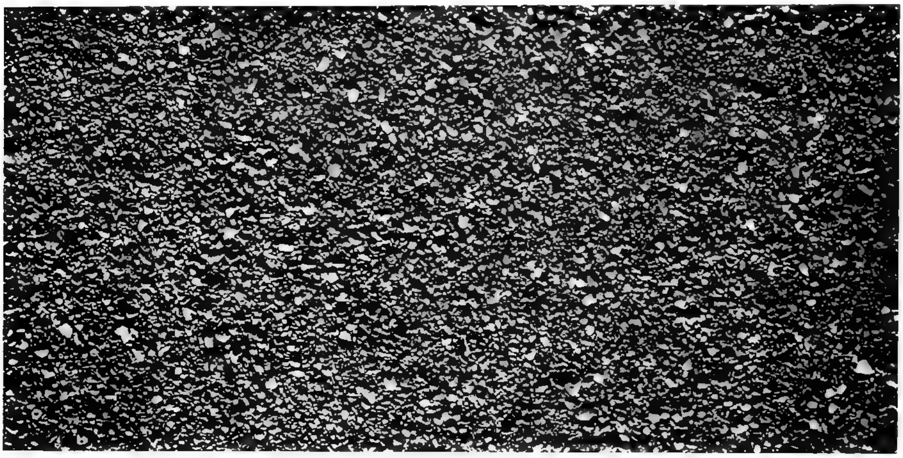


FIG. 1. PASIG SAND.

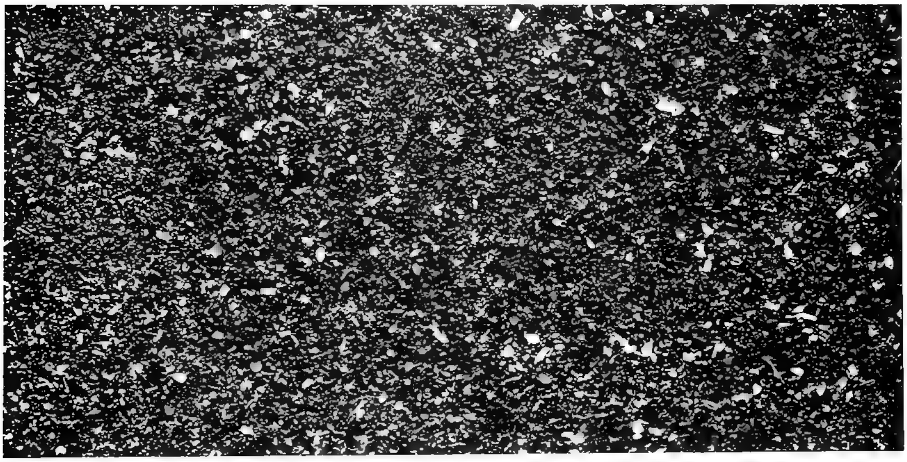


FIG. 2. SANGLEY SAND.

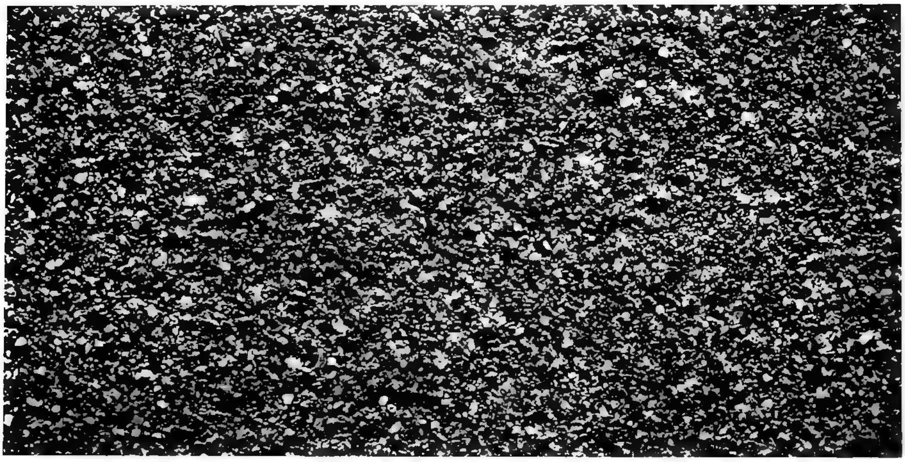


FIG. 3. ORANI SAND.

PLATE I.

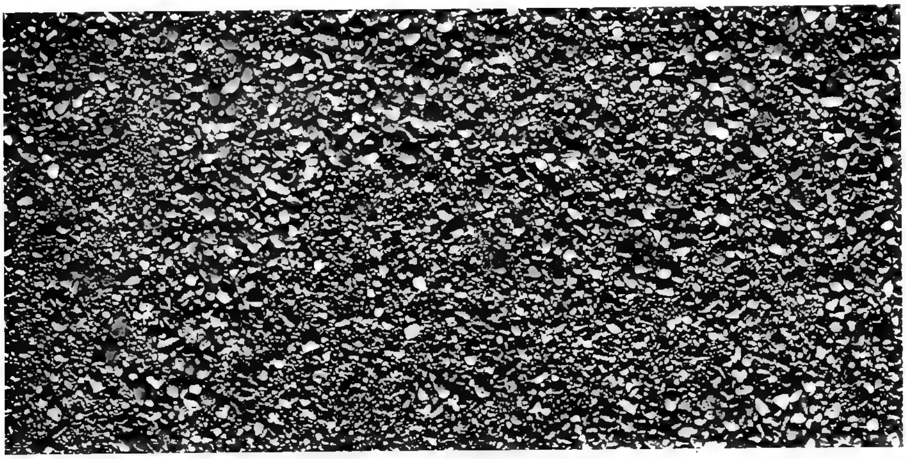


FIG. 1. QUINGUA SAND.

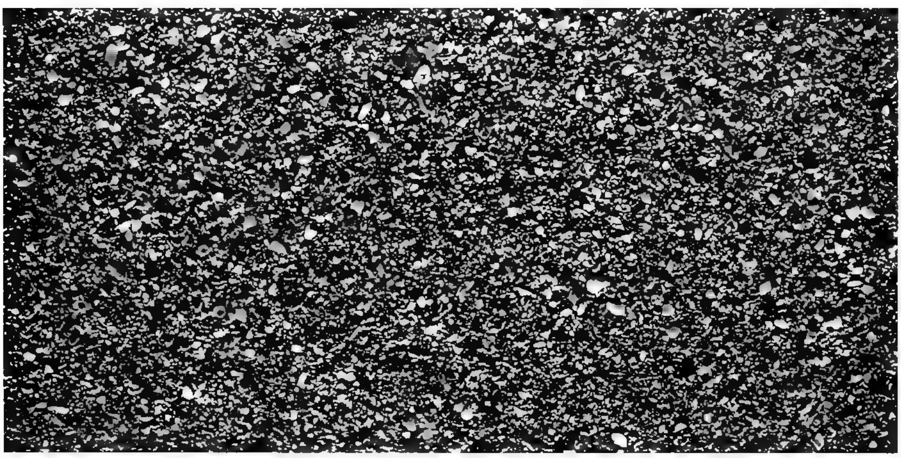


FIG. 2. CORREGIDOR SAND.

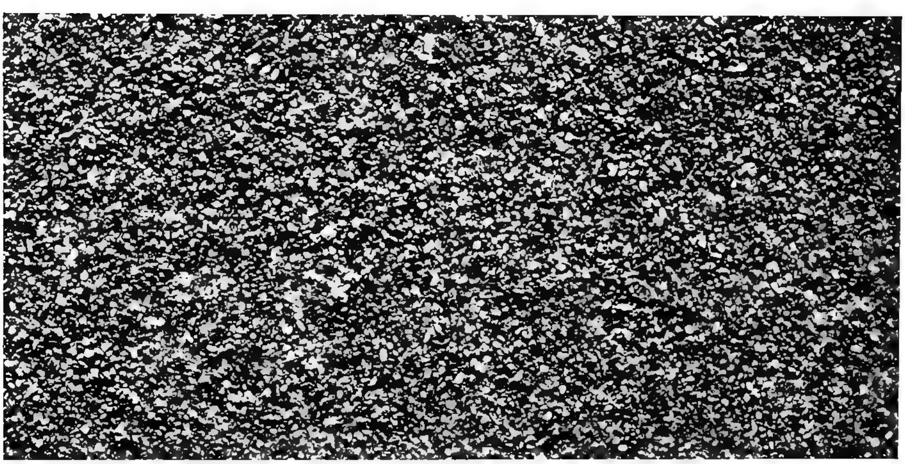


FIG. 3. TARLAC SAND.

PLATE II.

A GEOLOGICAL RECONNAISSANCE FROM INFANTA, TAYABAS, TO TANAY, RIZAL.

By H. M. Ickis.[1]
(*From the Division of Mines, Bureau of Science, Manila, P. I.*)

During the hot season of 1907, the writer made a reconnaissance in the Camarines and examined the coal beds on the Islands of Polillo. Returning to Manila from Polillo, he arrived in May at Infanta on the Pacific coast of Luzon. The nearest well-known route of travel overland from this coast to Manila is from Mauban, a port 60 kilometers south of Infanta, by the way of Lucban and Majayjay to Pagsanjan on Laguna de Bay; at Pagsanjan a boat may be taken to Manila. There is, however, an unfrequented trail from Infanta to Sinaloan on the lake, and Lieut. George W. Wray, commanding the Thirty-second Company Philippine Scouts, informed me that the Negritos who inhabit the mountain country near Infanta sometimes travel up the Agos River and thence across a low range of hills to Tanay on Laguna de Bay. It was decided to attempt to travel by the latter route, and, with the aid of Lieut. Wray and Dr. B. B. Warriner, P. S., the services of the Negrito *presidente,* David, the *teniente* of one of the barrios, two Negrito guides, four expert Negrito *banqueros,* and one Tagalog *cargador* were secured.

Two light *bancas* were procured which were used to transport a small amount of baggage and food, and to ferry the party across the river when it was necessary to cross where the water was too deep for the men to wade. Only expert *banqueros* can manage a banca in this river; the two men stand up in the unsteady craft poling it against the current and do not attempt to use paddles. Coming downstream, however, the Negritos shoot the rapids like Indians, steering dexterously with a paddle to avoid the many dangerous rocks.

The *bancas* were left hidden a short distance above the junction of the Canaan with the Agos, since it was slow work moving them up the numerous rapids and as it was thought that the river above could be waded whenever it might be necessary to cross.

The equipment carried by the party was very light: no tents were taken and the soldiers and *cargadores* carried no blankets or extra clothing; the mess outfit consisted of an iron pot to be used in cooking rice,

[1] Posthumous publication.

and a skillet for frying bacon. At night the men constructed a shelter with palm leaves; the leaves of the *anahao* palm also served for buckets, cups and plates. The food consisted of rice, canned corned beef, a little bacon, and fish caught in the river.

A rapid survey of the route was made with a pocket compass and an aneroid barometer, the distances being paced or estimated. Only two and one-half days were occupied in making the trip, so that the survey and the geologic notes were taken necessarily very hastily and there was little time available for collecting specimens. However, as the bed of the Agos affords an excellent cross-sectional view of the rock formations over a little-known portion of Luzon, and since published maps of the interior were found to be incorrect, it is thought that these notes may be of both geologic and geographic interest. (See Plate I.) Petrographic sections of many of the rocks collected have been made since in this Bureau and have been examined microscopically by Warren D. Smith, chief of this division.

The last habitation observed on the banks of the Agos River was estimated to be about 5 miles from its mouth, and the only people encountered until we were within a few miles of Tanay were some Negrito fishermen and one family of Filipinos fishing along the headwaters of Alasasin Creek. The Negritos fished in the large stream with spear and bow and arrow, while the Filipinos killed their fish by throwing into the small creeks a poison obtained from certain trees. Fish of excellent quality abound in the waters of the Agos, some that were speared by the guides being 20 inches in length. One crocodile, some 5 feet in length, was observed and crocodile trails were seen frequently in the sand.

A short distance above the Macadata River Corporal Bromio shot a large eagle which was identified subsequently by Mr. R. C. McGregor, of this Bureau, as the rare Philippine eagle *Pithecophaga jefferyi,* which has heretofore been suspected but not positively known to inhabit Luzon.

Published maps of this area show the Agos River as little more than a creek a few miles in length, while most of them indicate a much larger stream called the Tiauan or sometimes the Rio Grande de Lampon, draining the interior between Infanta and Montalon. As will be seen by a reference to the route map, the Agos was found to be one of the largest rivers on the east coast of Luzon, having an extensive watershed in the Eastern Cordillera. The Tiauan, therefore, does not extend as far north as the town of Infanta.

In the office of the United States Coast and Geodetic Survey in Manila, there is a tracing of a map which represents the Agos River as an important stream, but this map is far from correct. The tracing is from an unpublished map in Madrid, presumably by d'Almonte, and was obtained by Mr. Putnam, formerly in charge of the Manila office of the United States Coast and Geodetic Survey. Sheet No. 32 of the Progressive Military Map of the Philippines, issued from the office of the chief engineer officer, Philippines Division, United States Army, also accurately represents the position and size of the Agos but does not indicate the Canaan branch nor show the Alasasin correctly.

My trip was made late in the dry season, but even at that time the Agos River below the entrance of the Canaan was found to be about 100 meters wide and from one-half to 1 meter deep at the rapids. The Canaan enters the Agos from the north at a point approximately 12 kilometers in a direct line from the mouth of the Agos. Although the southern branch retains the name Agos above this point, the Canaan is the larger stream and is entirely unexplored. This conjunction point is called Pagsanjan by the Negritos, and the Agos River above this point is sometimes called the Calua, but usually simply the Agos.

The main river was left at a point about half-way between Infanta and Tanay and a tributary called the Alasasin followed to within 7 or 8 miles of the latter place. The Macadata, flowing in from the north, is the only tributary of any considerable size between the Canaan and the Alasasin.

From a low alluvial coastal plain at Infanta, not more than 3 miles broad, a range of heavily wooded mountains rises rapidly to a height of from 1,000 to 1,300 meters. This coast range is composed of andesitic rock ranging from pure augite andesite to andesite porphyry, diorite porphyry, and andesite tuff. The rock shows considerable variation in structure but is apparently all andesitic as far west as the Macadata River. In the river bed a large variety of rocks is exhibited, including limestone and hard siliceous shale as well as andesite and diorite bowlders. Some of the andesite bowlders contain a large amount of secondary white chalcedonic silica. The principal jointing planes in this igneous mass appear to strike about N. 75° E. and dip 75° to the southeast. There are also joints that strike nearly at right angles to these and dip steeply to the northeast.

A representative specimen from the eastern part of the coast range consists of firm, tough, dark colored rock which, when unaltered, resembles in outward appearance a basalt more than an andesite, the phenocrysts not being prominent; but when slightly weathered, the plagioclase phenocrysts are conspicuous. Under the microscope it is readily determined to be an augite andesite.

A few hundred yards below the Macadata River a fine-grained, dark gray rock is present, the nature of which could not be determined megascopically. Under the microscope the specimen is seen to be badly altered as shown by magnetite in the midst of patches of red oxide of iron and the uralitized pyroxene. The feldspars are all quite obscure and clouded, belonging probably to an andesite porphyry. One specimen of this rock contains white and green chalcedony.

At the mouth of the Macadata River a dark rock was observed, with a slight greenish tinge containing light colored phenocrysts and amygdules of white stilbite. Under the microscope the ground mass is seen to be typically andesitic but the feldspar phenocrysts can not be identified.

Near the mouth of the Calua a tough, hard, dark colored rock was found in places, which has the appearance of a basalt and shows many red spots, probably oxidized iron of the ferromagnesium minerals. A few crystals of striated feldspar are visible in this rock. By microscopic examination it was determined to be of a tuff consisting of consolidated fragments of andesite as well as of some large individual crystals of hornblende. Feldspars in some of the rock fragments show almost complete alteration.

The river valley below the Macadata is 200 to 600 meters wide. On both sides, the hills are marked by high sharp ridges and deep narrow gullies, and are covered with a heavy forest growth. There are some sharp bends, but there would be no unusual difficulties to overcome in constructing either a wagon road or railway along the river banks.

Sedimentaries, consisting of limestone and shale in various stages of metamorphism, appear a short distance above the Macadata and continue as far as the ridge north of Tanay which forms part of the main divide of Luzon. A hot spring bubbles up in the river near the contact between the igneous and sedimentaries above the Macadata, from which the locality has received the name *Mainit* (hot spring). The first sedimentaries are shale beds striking N. 30° W. and having a dip of 80° W.; these are followed by vertical beds striking N. 10° E. The guides here left the river, taking the party over a heavily wooded ridge and down to the river again where the rock is bedded limestone having a strike of N. 10° W. and a dip of 60° toward the east; a kilometer up the stream the dip of the beds is reversed to 45° to the west, the strike remaining the same. This rock was determined microscopically by Doctor Smith to be foraminiferal limestone containing Orbitoides, *Lepidocyclina insulae-natalis,* Jones and Chapman. The rock is from light gray to cream color, hard and compact. Fossils are most numerous in the gray rock but are not distinguished in either without careful examination. A pebble picked up near the mouth of the Agos was found to be foraminiferal limestone containing *Cycloclypeus,* a common miocene fossil.

The river bed is narrow and the walls precipitous through this limestone belt which is about half a mile in width. To the westward, shale beds and graywacke appear again, and an open and comparatively level country, the source of the Agos River, is seen to the northwest. One sample collected and classed as a graywacke is seen under the microscope to be composed of grains of silicates, some of which are rounded, others not, but all are clastic and consist mostly of fragments of plagioclase feldspar; megascopic examination showed a greenish gray rock somewhat gritty to the touch. Some fractures have a greasy luster.

Following the Alasasin branch to the southwest a narrow limestone belt is first encountered, and this is followed by very hard shale or schist beds that strike northwest and dip 30° to the southwest. Hard shales and graywacke continue for some two miles where another limestone bed, having a strike of N. 30° W. and a dip of 80° to the northeast, crossed. Under the microscope this limestone was found to contain many imperfect fragments of foraminifera, among which were recognized species of *Textularia, Pulvinulina* and *Globigerina.*

At Sungay Creek the trail leaves the valley, ascending a ridge the crest of which has an elevation of approximately 500 meters. As one ascends from the valley, the sedimentary rocks gradually disappear. The extension of this ridge forms Jalajala Peninsula and the rock which is found here very much resembles that found near Jalajala. It is a light colored igneous rock, composed largely of plagioclase and hornblende and classed as an andesite, but no well-preserved specimens were obtained for microscopic determination. This ridge is covered with an excellent forest growth as far as the *sitio* of Balabasa. Between Balabasa and Laguna de Bay the country is open and overgrown with cogon grass in which great numbers of wild deer and hogs exist.

At the Creek of Elog-na-batjala a tough, hard rock which looks like a typical basalt was observed; microscopically it is seen to be closely related to the andesite. On the crest of the ridge west of Comall Creek a coarse-grained olivine basalt was observed, which was distinguished by large phenocrysts of almost colorless plagioclase. These were the only good rock exposures to be seen on the Laguna de Bay slope, but there is little doubt that this entire section consists of andesitic and basaltic igneous rocks and volcanic tuff. A general geologic section of the route is shown in fig. 1.

A few lumps of coal which had been collected and left by Lieutenant Wray a few days before were observed at the Macadata River. Lieutenant Wray, acting under orders from department headquarters, examined some coal beds that were known to occur near the headwaters of the Macadata. They were found to be of doubtful economic value, although very little prospecting work was attempted.

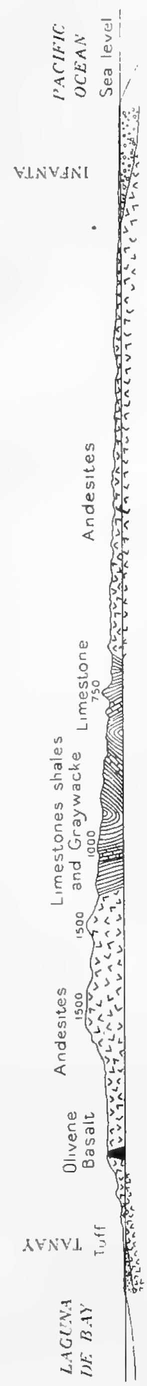
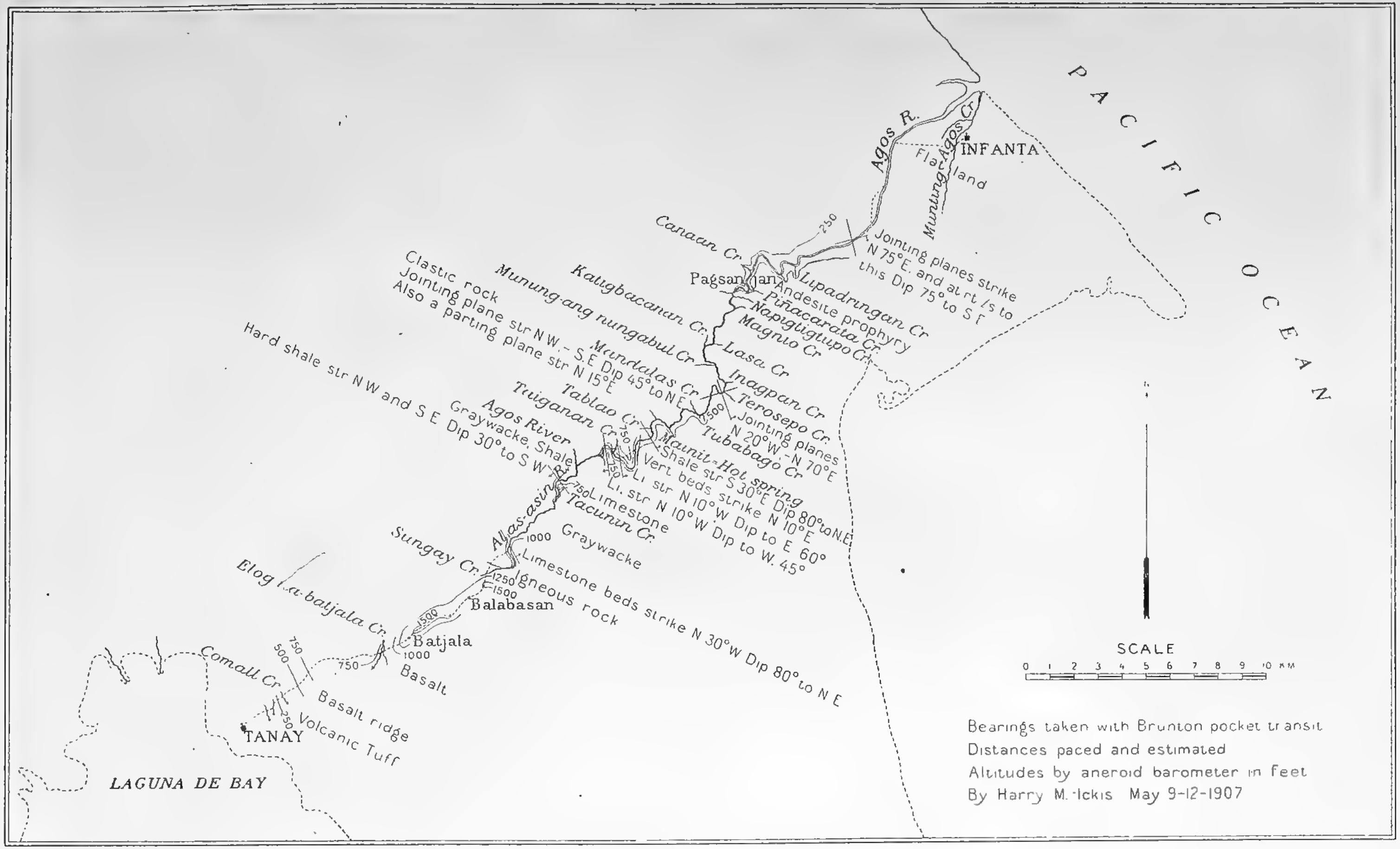


FIG. 1.—GENERAL GEOLOGICAL SECTION, INFANTA TO TANAY.

No coal outcrops, quartz ledges, or bowlders of mineralized quartz were observed on this journey.

ILLUSTRATIONS.



ROUTE MAP OF GEOLOGIC RECONNAISSANCE, INFANTA TO TANAY.

PLATE I.

Order No. 405.

STUDIES IN MORO HISTORY, LAW, AND RELIGION.

By NAJEEB M. SALEEBY.

107 pages. 16 illustrations. 5 diagrams.

A Treatise on the history and customs of the Moro People.

Price $0.25, United States currency.

Order No. 408.

A VOCABULARY OF THE IGOROT LANGUAGE AS SPOKEN BY THE BONTOC IGOROTS.

By the Rev. WALTER CLAYTON CLAPP.

Igorot-English and English-Igorot.

Price $0.75, United States currency.

Order No. 103.

A MANUAL OF PHILIPPINE BIRDS.

By RICHARD C. MCGREGOR.

Part I.—412 pages.
Part II.—(In press.) } In two volumes.

Descriptions of all known species of Philippine birds, together with complete keys to species and genera.

Price (for the two volumes) $4, United States currency.

Any of the above-announced publications may be ordered from the Business Manager, Philippine Journal of Science, Manila, P. I., or from any of the agents listed on the cover of this Journal. Please give order number.

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.

Authors receive 100 copies of their papers free.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

A limited number of unbound copies of previous volumes are available which may be secured from the Business Manager, Philippine Journal of Science, Manila, P. I., at the following rates: Volume I, 1906 (not divided into sections), $5, United States currency; Supplement to Volume I, $2.50, United States currency; Volume I (without supplement), $3, United States currency; all later volumes at current subscription prices.

Vol. IV NOVEMBER, 1909 No. 6

THE PHILIPPINE JOURNAL OF SCIENCE

EDITED BY

PAUL C. FREER, M. D., Ph. D.

CO-EDITOR,

RICHARD P. STRONG, Ph. B., M. D.

WITH THE COÖPERATION OF

MERTON L. MILLER, Ph. D.; GEORGE F. RICHMOND, M. S.
W. D. SMITH, Ph. D.; ALVIN J. COX, Ph. D.
RAYMOND F. BACON, Ph. D.; CHARLES S. BANKS, M. S.
H. D. GIBBS. B. S.; R. C. McGREGOR, A. B.

PUBLISHED BY

THE BUREAU OF SCIENCE

OF THE

GOVERNMENT OF THE PHILIPPINE ISLANDS

A. General Science

MANILA
BUREAU OF PRINTING
1909

THE PHILIPPINE

JOURNAL OF SCIENCE

A. GENERAL SCIENCE

VOL. IV NOVEMBER, 1909 No. 6

NEW SPECIES OF PHILIPPINE FISHES.

By ALVIN SEALE.

(From the Section of Fisheries, Biological Laboratory, Bureau of Science, Manila, P. I.)

The present paper is based on the study of about ten thousand specimens of fishes collected in the Philippine Islands by the author and his native assistants, C. Canonizado and Datto Alli, during 1907 and 1908. The collections were made in almost all the important islands of the Archipelago. All of the specimens were taken to Stanford University and compared with the material in the collection of that institution which included a number of types. All types mentioned in this paper are in the ichthyological collection, Bureau of Science, Manila, P. I.

I take this opportunity to thank President David Starr Jordan for valuable suggestions in regard to the work.

Family MURÆNIDÆ. The Morays.

Gymnothorax indong[1] Seale, sp. nov. [Indong-indong.]

[2] Head 3.50 in body to anal pore; tail is longer than the body by a distance equal to about two-thirds of head; eye 2 in snout; snout 5 in head; interorbital space equal to eye. Mouth large, the jaws not closing completely, mandible 1.70 in head; gape 2. Teeth strong and saber-like,

[1] Indong is a Moro name for Morays.

[2] All comparative measurements in this paper are taken in the length from tip of snout to end of last caudal vertebra, and the head is measured to posterior edge of hard operculum and excluding the membraneous opercular flap. Scale count is to end of caudal vertebra, the vertical series being counted at origin of anal, unless otherwise stated.

in a single series in each jaw. Three large median canines anteriorly, no teeth on shafts of vomer except a few small ones at its extreme posterior end. Posterior nostrils consisting of a large round pore situated just above the anterior half of iris, anterior nostrils consisting of two tubes at extremity of snout, their length about two-thirds of eye. Between the nostrils, the skin on sides of snout has a loose fold capable of dilatation. Dorsal fin is low, beginning slightly anterior to gill opening, which is of moderate size, being about equal to eye. Origin of anal fin at anal pore, fins are low, the dorsal the highest, its longest rays being almost equal to snout. The fins are continuous around caudal.

Color in life, brown with irregular-shaped black blotches, which assume the form of irregular, broken vertical bands slightly less than interspaces. Head has a distinct elongate white mark between eye and gape of mouth, this white stripe penetrates the lower portion of a large blackish blotch bordering the posterior portion of eye; another short white stripe from anterior border of eye to middle of maxillary. A black blotch in angle of jaws which is bordered anteriorly by an elongate white stripe on the mandible. A dusky area crossing near the posterior portion of lower jaws, this area with a white median line. Throat crossed with narrow white lines, pores of jaws white, the fins are barred with black.

Color in alcohol similar but slightly faded.

Type is No. 4445, a specimen from Zamboanga, Mindanao, P. I., 16 June, 1908. Length, 385 millimeters.

Gymnothorax samalensis Seale, sp. nov.

Head 3.80 in body; body is shorter than tail by a distance equal to under jaw; gape of mouth 2.70 in head; snout 6.75 in head; eye 1.25 in snout; interorbital space, measured to include soft portion, is equal to eye; posterior nostrils round, pore-like; openings of nostril just above eye; anterior nostrils consisting of two rather long tubes at end of snout, their length about two-thirds of eye. Teeth of upper jaw in a single series except in front where there are several enlarged canines, four enlarged depressible ones in the median line; vomerine series single, about 10 in number, short and rounded. Teeth on lower jaw in a single series except in front, where there are about five or six enlarged depressible canines on each side. Origin of dorsal, a distance equal to length of snout in front of gill openings. Origin of anal directly back of anal pore, the fins of moderate length.

Color in alcohol brownish with indistinct darker cross-bands, more numerous and distinct on posterior of tail, almost obliterated anteriorly; belly and throat yellowish. A distinct white blotch on lower jaw just in front of angle. A white spot on upper jaw below eye and another halfway between eye and tip of snout; these form rings around the mucous pores. Three similar white spots on lower jaw. Top of head and snout brown, the color fusing gradually with the yellowish of the under jaw and throat.

Type is No. 3781 from Samal Island, Gulf of Davao, Mindanao, P. I., 1 May, 1908. Length, 220 millimeters.

Family OPHICHTHYIDÆ.

Jenkinsella oliveri Seale, sp. nov.

Head 5.10 in body; body 1.80 in tail; gape 1.75 in head; snout 5.75 in head; eye 1.75 in snout; interorbital space about equal to eye; upper jaw projecting beyond lower by a distance equal to eye; upper lip well fringed; mouth large; mandible 2.50 in head. Teeth in lower jaw in two rows, short sharp teeth, no canines. Teeth of upper jaw in two rows on sides, the inner row being larger and depressible; vomerine teeth in two series, uniting posteriorly into one; a patch of 8 or 10 sharp teeth at tip of upper jaw; no canines; posterior nostrils with an inflated membraneous opening more or less fringed. Their location midway between eye and anterior nostril; the anterior nostril is tube-shaped, near end of snout, length about two-thirds length of eye. Several distinct pores on head, one just above and in front of eye, another on middle posterior portion of interorbital space. Origin of dorsal fin about the length of pectorals in front of the gill openings and extending to tip of caudal, its longest rays slightly more than half depth of body, pectorals 3.30 in head. Origin of anal directly behind anal pore, it extends to tip of caudal, no caudal fin.

Color, light yellowish brown above, yellow below median line, belly whitish, sides finely punctulate with minute black specks, throat white, top of head brown, these two colors uniting in a sharp line on the middle of side of head, extending from angle of fins to gill openings; tip of snout and anterior portion of dorsal darker.

Type is No. 4299 from Zamboanga, Mindanao, P. I., 2 June, 1908: Length, 360 millimeters.

Moringua cagayana Seale, sp. nov.

Head 8.75 in body to anal opening, the caudal being just one-third of total length from tip of snout to tip of caudal; angle of mouth 4.50 in head; snout 8; eye 2.25 in snout; interorbital 1.10 in snout; pectorals equal to distance from tip of snout to posterior of eye. Origin of dorsal fin posterior to vent by a distance equal to the length from tip of snout to tip of pectorals, its origin being over the anterior third of anal, the fin is then high and distinct for about this same distance when it becomes atrophied, reappearing again near tip of tail to form part of the paddle-shaped end of caudal. The anal fin is similar to dorsal but its origin is nearer the anal pore. Both the anal and dorsal widen at the end of tail and unite with caudal forming a wide paddle or fin-like end to the fish, the caudal is lunate, its length equal to upper jaw. A single row of rather short strong canine teeth in each jaw and irregular double row of the same kind down shaft of the vomer. Posterior nostril consisting of a large round open pore with a membrane on its anterior margin. Anterior nostril consisting of a small round pore with a membraneous cover formed something like lips to the small central opening, each nostril on a line in front of eye. Buccal cavity large and baggy.

Color yellow brown, the posterior of tail and the head brown, a black line along the entire dorsal surface, angle of jaws white, fins brown except pectorals which are yellowish.

Type is No. 1621 caught in the sea near Cagayan, Mindanao, 13 September, 1907.

Probably the form most nearly related to this species is *M. bicolor.*

Family CYPRINIDÆ. The Minnows.

Barbus ivis Seale, sp. nov. Plate I. [Ivis.]

Head without opercular flap 3.75; depth 2.55; dorsal 10; anal II, 6 (not counting branch on last ray) scales 4–23–3, the lateral line curves down to a little below median line of sides, then up again to middle of caudal peduncle; eye 4.70 in head; snout 3.50; interorbital space 2.35; maxillary 3.10 in head, its end under anterior margin of eye. Two maxillary barbules on each side, the lower one the longest, its tip reaching to angle of preopercle; mandible 2.55; pectorals 1.15; ventrals 1.45.

Body is oblong compressed, the upper outline between the spinous dorsal and head is distinctly gibbous; the lower outline from anal to tip of snout is a low even curve, the profile of head from nape to tip of snout is practically straight. The greatest depth of the body is at origin of ventrals. Length of caudal peduncle 1.50 in head, its least depth 1.75; its median width 6.50. The upper portion of head is somewhat rounded, the interorbital space is very slightly convex. Snout is rounded at tip, its median width is slightly greater than its length; anterior nostril with a funnel-like membrane. Greatest depth of head 1.35 in its length, the greatest width 1.55. Eyes small, less than snout. Mouth small, the upper lip closing over the lower. No teeth except pharyngeals, which are 5–3–2, larger ones slightly hooked with a small shoulder. Gill openings restricted, ending on a line with angle of preopercle.

Gill rakers rather short, shaped something like the pharyngeal teeth with the points exaggerated, 7 on lower limb, the longest 3 in pupil.

Body entirely covered with large smooth scales which have five or six striate lines in the centers. Dorsal and anal with high scaly sheaths, base of caudal scaled, ventrals with a long axillary scale, pectorals without axillary scale. Head entirely naked.

Origin of spinous dorsal midway between end of last caudal vertebra and nostril, the third ray of which is large and modified, the longest being 1.14 in head, its hard portion is distinctly serrated except on its lower third; posterior ray 1.50 in modified ray; base of anal 1.55 in head. Origin of anal is slightly nearer origin of ventrals than to end of caudal vertebra; its longest ray 1.55 in head, its base 2.75, its last ray 3; ventral fins are midway between anal and origin of pectorals, their tip not reaching to anal pore; pectorals low on body. Caudal deeply emarginate, its length a fifth greater than head.

Color in life is grayish above, the margins of the scales darker, shaded with greenish, yellowish on sides, shading into pinkish below. From 3 to 5 black spots along the median area of sides, all specimens have at least an indication of a dusky stripe connecting these spots, some show the stripe very distinctly; a slight dusky blotch just below origin of dorsal, none at origin of anal. The head has some bronzy markings on opercles and in front of eye. Dorsal grayish with dusky tip, caudal pinkish with dusky tip, the lower lobe bright red, anal and ventrals bright red with slightly dusky tips. Pectorals bright red.

Color in alcohol is similar except the dark markings show more distinctly. The lower half of fish is yellowish white, the fins are yellowish, dorsal, caudal, and anal with dusky tips.

Ninety specimens from a small stream near the town of Balabac, Balabac Island. Type is No. 5233, Balabac Island, P. I., taken by the author 11 August, 1908. Length, 130 millimeters.

Family BELONIDÆ. The Gars.

Oxyporhamphus brevis Seale, sp. nov. Plate II. (Bamban).

Head 4.40; depth 8.50; dorsal 15; anal 15; scales are very deciduous, about 50 from axil of pectoral to end of caudal vertebra; eye 3.75 in head; snout 3.20, the width of the free triangular portion of upper jaw considerably greater than its length; maxillary equal to eye; mandible 1.75 in head, the beak on under jaw scarcely developed, its length beyond the end of upper jaw equal to pupil of eye; interorbital space equal to eye; pectorals 1.75 in head; ventrals 2.45.

Body elongate, compressed, length of caudal peduncle 3 in head, its least depth 1.50 in its length, its width 3.

Upper profile of head and snout a low even curve; interorbital space like nuchal region very slightly convex, a wide distinct ridge down the middle of interorbital space; greatest width of head 2.50 in its length, its greatest depth 2.10. The most characteristic thing about the head is the extremely short beak of under jaw which while it varies slightly, in most specimens and in type is nearly equal to width of pupil of eye or 2.50 in snout. Eyes of moderate size, impinging slightly on upper profile; mouth large, teeth in villiform bands in jaws, none on vomer, palatine, or tongue. Gill openings carried forward to below anterior margin of eye. Gill rakers short, wide at base, sharp, pointed, and denticulate on their inner surface, about 20 on lower limb, the longest less than pupil.

Entire body covered with large, smooth, thin deciduous scales; head naked; vertical fins scaled. Origin of dorsal is just one-third distance between end of caudal vertebra and lower axil of pectorals, its longest ray 1.90 in head. Origin of anal is under third ray of dorsal, its longest ray 3.50 in head. Origin of anal is slightly nearer the origin of ventrals than to end of last caudal vertebra. Origin of the ventrals is midway between end of last caudal vertebra and angle of preopercle. Caudal forked, upper lobe scarcely equal to head, lower lobe considerably longer.

Color in life greenish above, silvery and white below, a distinct silvery band on side, bordered above by a narrow greenish band, fins white, the dorsal, anal, and caudal distinctly tipped with jet black.

Color in alcohol dull yellowish, green above, margins of scales darker. Sides with silvery bands which have a bluish green upper margin, yellowish white below. Cheeks silvery; tip of under jaw, snout and top of head more or less dusky; eyes golden, with dusky blotch above; dorsal, caudal, and anal yellowish, broadly tipped with jet black; pectorals and ventrals yellowish, a black spot on upper base and axil of pectorals.

Fourteen specimens, type is No. 5301 from Paawacan, Palawan Island, P. I., 14 August, 1908. Length, 145 millimeters.

Family ATHERINIDÆ. Silversides.

Atherina regina Seale, sp. nov. Plate III, fig. 1. (Gunoc.)

Head 3.50; depth 4.95; dorsal VI–I, 10; anal I, 10; scales 36, counting from the enlarged scale directly above axil of pectoral, 7 in vertical series; eye 2.25 in head; snout 4; interorbital space 2.75, being less than eye; maxillary 2.50; mandible 2; pectoral 1.25; ventrals 1.60; depth of caudal peduncle 3.45.

Body elongate, moderately compressed, greatest depth at origin of ventral fins. Caudal peduncle compressed, its least depth equal to twice its length.

Head heavy and rather blunt, its greatest width equal to its greatest depth, the lower portion of head strongly compressed. Interorbital space is slightly concave, caused by the prominence of the superocular ridges, these bones form distinct ridges on upper lateral part of snout. Top of snout flat except the small hump anteriorly caused by the processes of the maxillary, the anterior margin of the snout is an even concave curve, with a point on each side of processes; width of snout considerably greater than its length. Eye large; mouth large, oblique, the lower jaw slightly protruding. Maxillary narrow, ending on a line with the front margin of iris. Mandible ending under anterior third of pupil.

Preorbital with two or more distinct pores. Teeth in villiform bands in jaws, a small patch of villiform teeth on vomer, back of tongue, and pterygoids; the type specimen has the vomer broken but the two cotypes show teeth on the vomer; no teeth on palatine. Gill openings wide. Gill rakers long and slender, twenty-five or more on lower arch. Pseudobranchia large.

Scales large and smooth, their margins rounded and scarcely broken, the scaling not extending on the head except on the occiput, no scales on the fins except on base of caudal, but there is a distinct sheath of scales for the soft dorsal and anal. Top and sides of head well furnished with pores. A very large one just above opercles. There are sixteen scales in front of dorsal fin, ten scales between the origin of the two dorsals, and six scales along the base of the soft dorsal.

The origin of the spinous dorsal is midway between end of caudal vertebra and the anterior margin of eye, its longest spine is equal to orbit, the spines are slender and pungent. Soft dorsal on a line with origin of anal, and much nearer tip of ventrals, or to spinous dorsal, than to caudal; the second ray is longest being 1.85 in head; anal rays similar to soft dorsal, the longest being 2 in head. Origin of ventrals midway between end of maxillary and origin of anal. The anal pore is located between the posterior third of the ventral fins. Caudal rather large and deeply emarginate, the lower lobe being at least 1.40 in head. Pectorals are above the median line of body.

Color in alcohol is straw-yellow all the scales on upper half of body more or less punctulate with fine black or bluish dots. These black dots very thick on the middle of the three rows of scales on the back forming a median dark line on its either side. A distinct silvery band occupies the entire median row of scales on the side, the upper margin of this band is of a dull lead color, a double row of small black dots separating the two colors; there is an additional row of very minute black dots on the row of scales below the silvery stripe. The lower third of body is unmarked. Snout and rim of lower jaw washed with dusky, a distinct dusky spot at upper anterior margin of opercle directly behind eye, a dusky spot at upper axil of pectorals and a dusky bar across its inner base; a dusky area just over and impinging on eye. Dorsal, anal, and ventral fins uniform yellowish white. Pectoral with a distinct dusky blotch occupying an area slightly greater than eye at the beginning of the posterior third of fin; the tip of pectorals and the basal third of most of the rays white. Caudal slightly washed with dusky, two more or less distinct dusky blotches on its base.

The type is No. 2082, in the collection of the section of fisheries, Bureau of Science, Manila. It was secured by the writer at Culion Island, P. I., 7 October, 1907. Length of type, 80 millimeters. Two additional specimens No. 2083 were secured the following day at the neighboring island of Busuanga.

This species is related to *A. pinguis* Lacépède, which is no doubt the *A. lacunosa* Forster from which it differs in the fewer scales, location of fins, size of eye and absence of teeth on the palatines.

It somewhat resembles *A. morrisi* Jordan & Starks but their fish has 14 anal rays and scales 45 and the origin of the anal is in advance of the soft dorsal.

A. tsuruga Jordan & Snyder is a long panetela-shaped fish whose chief resemblance to the present species consists in its dusky spot on the pectorals; in other respects it is quite different. *A. lacunosa* Bleeker has no black spot on pectorals. *A. insila* Jordan & Seale has a large number of scales and is a quite differently shaped fish. I have compared this type with all of the above species now in the Stanford University museum and find it quite distinct.

Atherina balabacensis Seale, sp. nov. Plate III, fig. 2. (Gunoc.)

Head 3.75; depth 4.10; dorsal VI–I, 10; anal I, 12; scales 36; six in vertical series; eye 2.10 in head; snout 5; interorbital space 2.50, being less than eye; maxillary 2.50; mandible 2; pectorals 1.10; ventrals 1.80; depth of caudal peduncle 3.

Body elongate, moderately compressed, rather heavy and deep, its greatest depth at origin of spinous dorsal; the back is slightly but evenly curved; caudal peduncle compressed, its least depth 1.50 in its length, measured from end of caudal vertebra to posterior axil of anal.

Head rather heavy and deep, its depth being considerably greater than its greatest width, the lower profile of head is an even rounded curve while the upper profile from the occiput is almost straight. The lower jaw is the longest, forming the anterior point of head. The interorbital space is almost flat and has three short low ridges. Width of snout equal to its depth at its median point. Top of snout flat except for the small hump caused by the processes of the maxillary. Mouth large, oblique, the lower jaw protruding. Maxillary narrow, ending on a line with anterior margin of orbit. Mandible ending under the anterior margin of pupil. Preorbital with about four large pores or mucous cavities which give this bone a sculptured appearance. Villiform teeth in jaws, vomer, pterygoids, and back of tongue; no teeth on palatine. Gill openings large and carried forward to below anterior margin of iris. Gill rakers long, slender, and numerous. Pseudobranchia large, longer than the longest gill filaments. Isthmus long and narrow, a distinct groove on its lower surface.

Scales large and smooth, their margins not rough nor denticulate. Head without scales, fins unscaled, but with a scaly sheath to the soft dorsal and anal. Head is well furnished with numerous pores and canals. Fifteen scales in front of dorsal fin; nine scales between the margin of the two dorsals, and six scales along the base of the soft dorsal.

The origin of the spinous dorsal is midway between end of caudal vertebra and the posterior margin of pupil, its longest spine is equal to orbit, the spines are slender and pungent. Origin of soft dorsal on a line with the origin of the fourth ray of anal, and much nearer spinous dorsal and tip of ventrals than to base of caudal, the second ray is longest being 1.80 in head. Anal similar to soft dorsal, its longest ray 1.50 in head. Origin of ventrals midway between origin of anal and a line with anterior margin of pupil. Anal pore between and at beginning of posterior half of ventrals. Caudal deeply emarginate, its lower lobe at least 1.20 in head. Pectorals are above the median line of body.

Color in alcohol straw-yellow, a slight greenish wash above. The scales above lateral line with fine dark punctulations. A dusky line along the middle of back from head to caudal, some darker shadings at the origin of the two dorsal fins, a dusky line from origin of anal fin to caudal. A bright silvery stripe occupies the middle third of the median line of scales, a narrow lead-colored margin along the upper margin of this silvery stripe, the row of scales below this silvery stripe has a row of very small black dots along its middle, there is also an indistinct incomplete row of dots on the next row of scales below. Base of pectorals with a dusky band and dusky spot in axil. A dusky blotch on upper part of eye. Lower jaw, top of head, and snout, shaded with dusky. No dusky spot on pectoral rays. Fins all grayish white, the caudal with a slight dusky wash, but without dusky spots at base.

The type is No. 4983 from Balabac Island, P. I. Taken by the writer 1 August, 1908, near the mouth of a small stream. Length of type, 10 millimeters. Eight cotypes were secured from the same locality, Nos. 4983, 5308 and 5229. Additional specimens of this species were secured from the following places: 1241 Samar Island, 1295 Cebu, Cebu Island, 1370 Siquijor Island, 1447, 1457, 1495, 1658 and 1659 Cagayan, Mindanao Island, 1981 and 5475 Puerto Princesa, Palawan Island, 2079 Culion Island, 4866 Samal Island, Mindanao. Thirty-two specimens in all including types.

This species but slightly resembles *A. forskalii* (Rupp.) being a deeper, heavier fish with a caudal peduncle not nearly so deep and has fewer scales and anal rays. Evermann and Seale [3] refer specimens from Bacon and Bulan to *A. forskalii* which probably belong to this species. This species somewhat resembles *A. duodecimalis* Bleek., but the shape and color markings are different, the rows of black dots on the sides being always present in our specimens. This species somewhat resembles *A. lineata* Gunther but the latter species has teeth on the palatines, a smaller eye, and different location of fins. *A. lineata* also has the pectoral slightly washed with dusky over its entire surface and the rows of dots are larger and more distinct.

[3] *Bull. Bur. Fish.* (1906).

Family MUGILIDÆ. The Mullets.

Mugil joloensis Seale, sp. nov. Plate IV.[4] (Banak.)

Head 4.30; depth 3.60; dorsal IV, I, 7; anal I, 9; scales 33, 10 in vertical series; eye 3.30 in head; snout 4.10; interorbital space 1.95; maxillary exposed at tip; mandible 2.75; pectorals equal to head; ventrals 1.30; least depth of caudal peduncle 2.

Body moderately elongate, compressed, the greatest depth being in middle of body, the depth of the caudal peduncle is scarcely less than its length (measured to axil of dorsal). The profile from origin of spinous dorsal to snout is almost a straight line.

Interorbital space is moderately convex. Top of snout almost flat. Greatest width of head 1.45 in its depth. Depth of head at middle of eye 1.75 in length. Snout short and blunt. The preorbital has a very deep notch, its depth being greater than width of pupil. The upper lip is very thick, with a fold, and fringed with a row of papillæ, an additional row of pipillæ on the lip just above the fold, an additional fringed fold at each corner of the mouth; under lip with moderately broad membrane. The nostrils are situated directly above the posterior margin of preorbital notch. Teeth on tongue, vomer, and palatine, none in jaws. Eye with but the slightest indication of adipose eyelid, which is present as a narrow rim to orbit. Snout is much broader than long, it is fully tipped by the broad maxillary. There are four soft differentiated areas between the scales on preopercle. Gill openings large being carried forward to under pupil. Gill rakers numerous slender, longest about equal to pupil. Pseudobranchia present.

Body and head covered with large smooth scales which are slightly ctenoid at margin. A single small ridge in center of each scale. About nineteen scales in front of dorsal fin; soft dorsal and anal scaled. Pectorals without axillary scale. An axillary scale at ventrals. Eleven rows of scales between the origin of the dorsals.

The spinous dorsal is midway between end of caudal vertebra and middle of pupil, the longest spine 1.70 in head. Origin of soft dorsal midway between end of last caudal vertebra and origin of first dorsal being over the middle of anal, its longest ray equal to longest anal ray, 1.50 in head. Origin of anal is slightly nearer end of caudal vertebra than to origin of ventrals. The ventrals are midway between anal and anterior margin of orbit. The upper portion of pectoral base is on a line with upper margin of eye. Caudal fin is rather deeply emarginate its length greater than head.

Color in alcohol silvery with wash of yellowish, grayish above. Upper third of pectorals washed with dusky; soft dorsal, anterior rays of anal, and tip of caudal also slightly washed with dusky. No stripes on body,

[4] In our figure the spinous dorsal and the ventrals are drawn too far forward.

except those caused by the small ridge along center of scales. A distinct black dot at axil of pectorals.

Type is No. 2379. Secured by the writer at Jolo, Jolo Island, P. I., February, 1908. Length, 125 millimeters.

This species is related to *M. labiosus* C. & V., but *M. labiosus* has "upper lip without fringe." Our species has fewer scales, and the upper third of dorsals dusky, our species has teeth on vomer and palatine.

Mugil banksi Seale, sp. nov. Plate V. (Banak.)

Head 4.50; depth 3.50; dorsal IV, 9; anal III, 9; scales 37, 10 in vertical series; eye 3.10 in head, the exposed portion 4; snout 5; interorbital space 2; maxillary is entirely hidden; mandible 9 in head; preorbital with shallow notch, its end but slightly denticulate, its width at end 1.30 in pupil; pectorals equal to head; ventrals 1.30.

Body moderately elongate and compressed, the upper and lower outlines being about evenly curved to the short blunt snout. Tip of head formed by the deep upper lip. Caudal peduncle is thick and strong, its depth 1.25 in its length measured to vertical dorsal axil.

The head from the blunt snout is rounded conical; interorbital space convex. Eye is large with the adipose lid developed as a narrow fringe to orbit and not covering more than a third of the iris before and behind. Greatest width of head 1.45 in its length being almost equal to its greatest depth, width of snout is equal to twice its length and is much more than its depth. An elongate shallow depression on upper sides of snout containing the two nostrils, the posterior one much the larger. Upper lip thick, with two distinct rows of papillæ, these becoming united into little folds near the corners of the mouth. Lower lip thin, without papillæ. No teeth in jaws or mouth. Gill openings extend forward to below posterior margin of pupil. Gill rakers are short slender and numerous. The two margins of the subopercles fitting closely below, the space between them being confined to a short narrow line anteriorly. The mandibles cover the entire chin.

Head and body including soft fins scaled. The scales of body large, smooth, thin, margined with a thin soft membrane. A short narrow groove in the center of each scale, about 20 scales in front of dorsal fin and 13 series between the origins of the two dorsals. A distinct axillary scale at pectoral and ventral. Anal with scaly sheath. Five soft differentiated areas on the margin of the preopercle between the marginal scales.

Origin of spinous dorsal midway between tip of snout and end of last caudal vertebra, length of first spine 1.50 in head; origin of soft dorsal very little nearer origin of spinous dorsal than to end of caudal vertebra, being on a line with the third anal ray, its longest ray 1.30 in head. Origin of anal slightly nearer end of caudal vertebra than to axil of ventrals. The longest ray equal to longest ray of soft dorsal, base of fin 1.70 in head. Origin of ventrals midway between origin of anal and notch of preorbital, caudal deeply emarginate, its length considerably greater than head.

Color in life silvery with a grayish wash above. The head with bronzy reflections. A distinct black spot at upper axil of pectorals and a rather broad and distinct white bar across the base of the fin below the dark spot. A white margin to anal pore. Fins whitish, soft dorsal and caudal slightly washed with dusky on posterior third.

Color in alcohol similar to above, but the groove on middle of scale showing more distinctly above and giving the appearance of narrow stripes on center of rows of scales.

Type is No. 1412. Secured at Siquijor Island, P. I., 7 September, 1908. Length, 190 millimeters.

This species is related to *M. longimanus* but is distinguished by the fringed lip, 9 anal rays, and smaller adipose eyelid, markings, and position of fins.

Named for C. S. Banks, entomologist Biological Laboratory, Bureau of Science, Manila.

Family SPHYRÆNIDÆ. The Barracudas.

Sphyræna aureoflammea Seale, sp. nov. (Babayo.)

Head 3.10; depth 6.35; dorsal V, 10; anal 11; scales 7–83–9 (counting to end of caudal vertebra); eye 5 in head (measured to tip of upper jaw); snout 2.25; interorbital space 1.75 in eye; maxillary 2.75 in head; mandible 1.75; ventrals 3.10; pectorals 2.75.

Body elongate, cylindrical, the upper and lower outline about evenly curved, length of caudal peduncle 1.50 in head, its least depth 3 in its length.

The head is elongate, conical, its greatest depth 2.75 in its length, greatest width 3. Upper profile of head is almost straight; the interorbital space is flat, with 4 distinct ridges. The opercle ends in a single obtuse flat point. The lower angle of preopercle extends back as a large membraneous flap. The eyes are of moderate size. Snout is conical, its median width being somewhat greater than its median depth. Preorbital with a distinct oblique ridge in front of the eye. Maxillary falls short of the eye by a distance equal to pupil, the maxillary ends in a small but distinct spine. The lower jaw considerably the longer. Teeth of upper jaw consist of a single row of small teeth on sides of palatines with three enlarged canines a short distance from tip of jaw, and two enlarged canines on each side at tip of jaw, the maxillary also has a single row of small teeth. Teeth of lower jaw a single series of rather strong canines. A single large canine at symphysis. No teeth on vomer. Gill openings large, ending on a line with anterior margin of eye. Two gill rakers on lower limb, one being at the angle, these are distinct, sharp, pointed, their length 2 in pupil.

Body entirely covered with large smooth scales, about 23 in front of dorsal, and 31 between the origins of the two dorsals. The fins, except spinous dorsal, are more or less scaled. Head is naked except on nape, cheeks, and opercles; lower limb of preopercle naked, no scales on head in front of anterior margin of pupil.

Origin of spinous dorsal midway between origin of second dorsal and posterior margin of pupil, being above the middle of the ventral rays, the anterior spines longest, being equal to postocular portion of head. Origin of second dorsal considerably nearer the first dorsal than to end of caudal vertebra. Origin of anal is under the second dorsal ray and is slightly nearer end of caudal vertebra than to orgin of ventrals. Base of soft dorsal slightly greater than base of anal which is 3.75 in head. The longest dorsal ray and longest anal ray about equal, 3.10 in head. Origins of ventrals midway between middle of maxillary and anal fin. Caudal deeply emarginate, the lobes 2 in head.

Color in life, above lateral line lemon-yellow, a purplish stripe from snout over interorbital space and nuchal region to near base of second dorsal, a short stripe with some yellow edgings in front of eye. A brown stripe from origin of lateral line to middle of base of caudal, another line from posterior margin of eye over base of pectorals to caudal, the area between these two lines rather a bright blue, ventral surface a pale blue. Some greenish scales with yellow margins on nuchal region, lips brown, soft dorsal with slight wash of brown, caudal yellowish brown, anal with a slight trace of pink, other fins white.

Color in alcohol dull brownish above, silvery below; two brown lines on sides; top of head and snout darker; soft dorsal and caudal grayish, pectoral more or less grayish at axil.

Five specimens. Type is No. 4138, from Zamboanga, Mindanao, 22 May, 1908. Length, 280 millimeters.

Family SYNGNATHIDÆ.

Trachyrhamphus caba[5] Seale, sp. nov.

Head 4 in body (measured from tip of snout to anal opening); greatest depth equal to postocular portion of head; dorsal 22, its base occupying 4 rings which are swollen, thus the base of the fin is considerably elevated above the level of the dorsal surface; body with 18 rings, tail with 33 rings. The dorsal is located on two of the tail rings and two of the body rings; anal 4; snout equal to distance from pupil of eye to posterior margin of opercle; eye 4 in head; interorbital equal to eye; pectorals 1.75 in snout; caudal 1.50 in snout, its tip rounded; length of body and head equal to 21 rings of caudal; lateral line passes to lower caudal edge which is strongly scalloped; nuchal region has a decided crest; snout strongly depressed, being in line with lower margin of body,

[5] *Caba* is the native name for this fish.

the forehead has an abrupt curve, formed by the pronounced ocular ridges; interorbital space deeply concave; opercles with numerous fin-shaped striæ, which radiate from a single larger longitudinal ridge; ten distinct ridges in the interorbital space which unite and form one on the snout, this ridge has a few small spines; the orbital ridge is also spinate; rings of body and tail without spines; length of dorsal rays less than width of opercle.

Color brown, the three anterior caudal rings lighter, the ventral surface of body rings and opercles brown, with the yellow cross lines on their under surface, these cross lines not extending on body rings; snout brown above and white below. A brown ring near the tip, fins grayish without markings.

Type is No. 2324 from Balayan Bay, Luzon, 20 January, 1908. Length, 140 millimeters.

Family HOLOCENTRIDÆ. The Squirrel Fishes.

Myripristis schultzei Seale, sp. nov. (Baga baga.)

Head 3.10; depth 2.50; dorsal X, I, 15; anal III, 13; scales 28 to end of vertebra, 10 in vertical series; eye large, 2 in head; snout 7.50; interorbital space 3.30; maxillary 1.80, its posterior tip ending on a line with posterior margin of pupil, width of distal end 2 in eye; mandible 1.60 in head; pectorals 1.25; ventrals 1.45.

Body oblong, compressed, greatest width at origin of dorsal. Upper and lower outlines of body about equal. Length of caudal peduncle 2.50 in head, its depth 3.10. Depth of head about equal to its length, its greatest width 1.50 in its length; interorbital space flat with 4 longitudinal ridges. The anterior outline of head is bent rather abruptly down in front of eyes making a short blunt snout, the length of which is 2 in its width. The groove to receive the maxillary process ends on a line with anterior of eye. Preorbital is narrow and denticulate, its greatest width 3 in interorbital space; opercular bones are denticulate, the opercle has a single flat spine on its posterior margin, maxillary with small teeth on its lower posterior border. Mouth large, oblique, lower jaw slightly the longest. Four distinct pores on tip of lower jaw; bands of villiform teeth in jaws, vomer, palatin, and on hyoid portion of tongue. A few large exterior teeth on the outside of each jaw, more abundant and larger on lower jaw. Gill openings very large being carried forward to below anterior margin of pupil. Gill rakers rather long, about 30 on lower arch, the longest 2 in eye. Pseudobranchia present.

Scales are large and toothed; body fully scaled; head naked except about 3 rows of scales on cheeks; ventral with distinct axillary scale.

Origin of dorsal fin midway between tip of snout and third anal ray. Fourth spine the longest, 1.85 in head. Anal and soft dorsal similar, the anal rays are slightly the longest, being 1.30 in head. Third dorsal spine is slightly the longest being 2.30 in head, both the soft dorsal and anal are sharp pointed.

Origin of ventrals midway between anal and anterior margin of eye, caudal forked, 1.10 in head.

Color in life pinkish, washed with violet above, the margins of scales on sides with brighter red, tip of lower jaw and snout red. Margin of spinous dorsal deep red, the body of fin pale red, anterior of soft dorsal and anal broadly margined with deep red. Tip of caudal deep red shading into lighter red at base. No opercular blotch, some deeper red on base of pectorals, inner axil of pectorals deep black.

Color in alcohol yellowish white with some bronzy reflections, darker above; fins uniform yellowish white; no opercular blotch; inner axil of pectorals deep black.

Type is No. 3899 taken at Samal Island, Gulf of Davao, P. I., 4 May, 1908. Length, 160 millimeters.

This species is related to *M. violescens*.

Family CARANGIDÆ. The Pampanos.

Caranx auriga Seale, sp. nov. Plate VI. (Talakitok.)

Head 3.30 in length; depth 2.75; dorsal VII, I, 17; anal II, I 16; 35 armed scutes constituting the straight portion of the lateral line, about 70 scales in curved portion of line, curved portion 1.35 in straight, greatest depth of curve 4.25 in head, the line becomes straight under the third dorsal ray; eye 3.50, the adipose eyelid covering the posterior third of eye and a narrow margin anteriorly; snout 4.20; interorbital space equal to eye; maxillary 2 in head, its end under posterior margin of iris; width of its distal end 1.50 in eye; ventral 2.10 in head; least depth of caudal peduncle 2.40 in eye, its width scarcely less than eye.

Body oblong, moderately compressed, the depth at the origin of spinous dorsal and at soft dorsal equal; the lower outline from the origin of anal rays to mandible is a straight line, the mandibles being placed at a very low angle. The upper outline from origin of soft dorsal to tip of snout is curved, the snout being at an angle much greater than 75°. The length of caudal peduncle (measured from upper origin of caudal rays to axil of dorsal) is but little more than its width, its depth is 2 in its length. Upper profile of head strongly rounded, a distinct ridge from occiput to nostrils, the snout is placed at a steep angle. Width of preorbital 1.60 in eye; greatest width of head 1.85 in its length; eye of moderate size, the adipose lid covering the posterior portion up to pupil, a very narrow anterior adipose lid. Lower jaw is slightly projecting, each jaw has rather wide membraneous lips; maxillary with strong supplemental bone. Each jaw with moderately strong curved canines, the upper jaw with an inner row of villiform teeth. Villiform teeth on vomer, palatines, and tongue. Gill opening wide, being carried forward to a line with the anterior margin of eye; gill rakers rather strong and saber-like, 14 on lower limb, the longest about 1.50 in eye. Pseudobranchia present.

Scales small, rather smooth, breast fully scaled, head naked except on cheeks and nape. The scutes are graduated in size from middle of caudal peduncle, their greatest depth being slightly less than pupil, their size at beginning of straight portion of lateral line very minute.

Origin of spinous dorsal slightly posterior to axil of pectoral, the spines weak, the second spine the longest being 2.40 in head, the last dorsal spine is free. The soft dorsal and anal are quite similar the rays being of about equal length, the longest being 2 in head, base of anal slightly less than base of soft dorsal, the origin of the anal rays being under the fifth dorsal ray; the last anal ray is slightly prolonged. Anal spines are under origin of soft dorsal; ventrals are about midway between tip of snout and origin of anal rays; their tip reaching to anal pore. Pectorals long and falcate, their tip reaching to fifth anal ray. Caudal strongly forked, two narrow ridges on its base, one on each side of the scutes, length of fin slightly less than head.

Color in life silvery with bronze wash and golden reflections, soft dorsal, anal and caudal yellow, a rather large, not very dark and somewhat diffused opercular spot at origin of lateral line, a black spot on inner axil of pectoral not showing on outer surface.

Color in alcohol similar to above but dull silvery on upper half, yellowish white below. Head with bronze reflections, fins yellowish white, without dark markings except a slight trace of brownish on tip of spinous dorsal and on tip of upper half of caudal.

Type is No. 30. Secured at Manila, P. I., 21 May, 1907. Length, 230 millimeters.

Caranx butuanensis Seale, sp. nov. Plate VII.

Head 3.75; depth 2.50; dorsal VIII, I, 21; anal II, I, 17; scales small; 43 scutes in straight portion of lateral line, and about 70 scales in curved portion, the curved portion contained 1.50 in straight, the greatest depth of the curve about equal to eye. The lateral line becomes straight under the sixth dorsal ray; eye 3 in head; snout 4; interorbital space 3 in head; maxillary 2.1, ending slightly posterior to pupil, width of its distal end 1.50 in eye; mandible 1.85 in head; pectorals 3.30 in body; ventrals 1.85 in head; least depth of caudal peduncle 2 in eye. Body oblong compressed, its greatest depth at origin of soft dorsal, the lower outline from origin of anal rays to tip of lower jaw is a low even curve. The upper outline from origin of soft dorsal to tip of snout is an irregular curve being deeply concave at the occiput, causing the head to be of considerable less depth than in most species of the genus. Length of the caudal peduncle is about a fourth greater than its width. Upper profile of head with a ridge from origin of dorsal to nostril. The snout is at an angle of a little more than 45°. Greatest depth of head slightly less than its length, its width 2 in length. Mouth is of moderate size, the lower jaw slightly the longest, distinct membranous lips on each jaw, a large supplemental bone on maxillary. Width of preorbital about 2 in eye. Teeth of lower jaw small, in two or more rows, with some large canines anteriorly. Teeth of lower jaw consisting of a single row of rather small canines, teeth on vomer, palatines, and tongue. Gill openings large, being carried forward to below anterior margin of eye. Gill rakers saber-like, 16 on lower limb, the longest about 1.50 in eye. Pseudobranchia present.

Scales are small, smooth, and fully cover the body, including breast. Head is naked except on cheeks and occiput. The scutes are graduated from the caudal peduncle, the deepest being 1.75 in eye, those at the beginning of straight portion of lateral line minute.

Origin of spinous dorsal slightly posterior to axil of pectoral, the third spine longest, 2.45 in head; the last dorsal spine free. Soft dorsal and anal similar, their longest rays being about equal, 1.85 in head, the last ray of each fin slightly prolonged.

Base of soft dorsal slightly the longest, the origin of anal being under the sixth dorsal ray. Anal spines are below origin of soft dorsal. Origin of ventrals midway between tip of snout and origin of first anal ray. Pectorals falcate, their tip scarcely reaching to anal rays. Caudal forked with the two ridges on base almost obsolete, length of fin slightly less than head.

Color in life silvery below, with about 7 wide dusky bands over the back and down on sides, these bands of much greater width than the interspaces, bands of equal width. Fins yellowish white, except spinous dorsal which has a slight wash of grayish. A dusky opercular spot.

Color in alcohol silvery with slight bronzy reflections, 7 dusky bands on back, the first being on nuchal region and the last on caudal peduncle. A dusky opercular spot. Top of head with some grayish, fins yellowish white except spinous dorsal, which has a slight wash of gray, there is also a very slight trace of grayish on tip of soft dorsal. Inner axil of pectorals dusky, no dusky on their base. Iris golden with dusky blotch on upper margin.

Type is No. 1896, taken at Butuan Bay, Mindanao Island, P. I., 25 September, 1907. Length, 120 millimeters.

Family APOGONICHTHYIDÆ.

Amia magnifica Seale, sp. nov. (Daugat.)

Head 2.75; depth 3; dorsal VI, I, 8; anal II, 7; scales 24, lateral line complete; 7 scales in vertical series; eye 2.75 in head; snout 3.50; interorbital 1.50 in eye; preopercle distinctly denticulate; bands of villiform teeth in jaws, vomer, and palatines.

Body oblong, compressed, the greatest depth at origin of dorsal; caudal peduncle rather long and slender, its depth 2.50 in head, its length 1.45. Upper outline of body more strongly curved than lower. Head pointed, mouth large, lower jaw projecting; eye large, interorbital space slightly convex with two ridges, which unite into one midway between eyes. Tip of maxillary extends to a line with pupil, its distal margin concave, its length 2.10 in head.

Gill openings large, extending forward to below pupil. Gill rakers rather slender not very pointed, about 19 on lower limb.

Body covered with large smooth scales, cheeks and opercles scaled.

Origin of dorsal midway between middle of caudal peduncle and tip of of snout, its second spine the longest, 1.80 in head, last dorsal spine almost as long as first ray, the longest ray 2.70 in head; caudal slightly lunate. Origin of ventrals midway between base of caudal and pupil, its second spine about two-thirds length of rays, its longest ray 1.75. Origin of ventrals midway between anal and a line with nostril, their tip reaching almost to anal, their length 1.50 in head. Pectorals 1.75 in head.

Color in life. A bright cardinal red with five silvery longitudinal lines, the middle one being composed of round silvery spots. These lines are arranged as follows: the first is from tip of snout through upper part of eye back to below anterior third of dorsal where it unites with the second line, the portion of this line on the snout is orange, the remainder is silvery; the second line is from posterior of eye to caudal, the portion on the opercle is margined above and below with dusky; the third line is from the lower posterior portion of eye to caudal, this line on the opercle is also margined with dusky, and posterior to opercle it is composed of round silvery dots: the fourth line is from maxillary below eye to lower margin of opercle, this line is margined with dusky; the fourth line extends from the lower posterior portion of opercle to the caudal; the fifth line is below this and forms the general white coloring of the belly, to anal fin. The fins are all uniformly red. Top of head with orange stripe from interorbital space along base of dorsals: chin orange, tip of jaws brownish.

Color in spirits. The bright cardinal fades into dull brownish, the silver becomes pale yellow, the orange fades into dull yellow, the opercles show a beautiful, opalescent bluish reflection, the black on tip of jaw and a black line on snout fade into white; the dusky margins to the stripes on head show more distinctly, the lines on interorbital being bluish white ending on nuchal region. A slight black area on middle of caudal base, fins yellowish white.

Numerous specimens. Type is No. 5192, from Balabac Island, 10 August, 1908. Length, 40 millimeters.

Amia cardinalis Seale, sp. nov.

Head 3; depth 2.75; dorsal VI, I, 9; anal II, 8; scales 24, the lateral line complete, 7½ scales in vertical series; eye 2.75 in head; snout 4; interorbital 1.50 in eye; maxillary 2 in head, its distal end on a line with posterior margin of iris; mandible 1.55; posterior margin of preopercle strongly denticulate.

Teeth in villiform bands in jaws, vomer and palatines.

Body oblong, compressed, the greatest depth at origin of dorsal, caudal peduncle rather long and thin, its depth equal to orbit, its length 1.20 in head. Upper outline of body more strongly curved than lower. Head rather bluntly pointed, mouth large, cheeks and opercles each with two rows of scales, opercle with a sharp flat spine. Gill openings wide, being carried forward to a line with the pupil. Gill rakers short and sharp pointed, about 13 on lower limb. Body fully covered with large smooth scales which have very finely toothed borders, head without scales except on cheeks and opercles.

Origin of dorsal fin is midway between tip of snout and middle of caudal peduncle, its second spine is the longest and strongest, its length 1.50 in head. The last dorsal spine scarcely more than half the length of the first ray which is 1.75 in head. Caudal slightly bilobed, 1.25 in head; origin of anal midway between end of last caudal vertebra and distal end of maxillary, its longest spine about equal to orbit, its longest ray 1.75 in head. Origin of ventrals midway between anal and a line with middle of pupil, their length 1.50 in head; pectorals 1.40 in head.

Color in life uniform bright cardinal, without stripes or bands; a slight tint of yellow on side of belly, and a brownish blotch on opercles just posterior to eye, fins all uniform red.

Color in alcohol uniform yellowish white, some dusky marks at base of dorsals. A slight opalescent tint on opercle. A brown spot on nuchal region, fins uniform yellowish white.

Type is No. 5463 from Puerto Princesa, Palawan Island, P. I., 21 August, 1908. Length, 40 millimeters.

This species seems to differ in several respect from *A. erythermus* to which it is most nearly related.

Family SERRANIDÆ.

Epinephelus albimuculatus Seale, sp. nov. Plate VIII. (Lapo lapo.)

Head 2.65 (measured from tip of jaw to tip of opercular flap); depth 3.35; dorsal XI, 16; anal III, 8; scales about 120 in lateral series, 50 in vertical series, about 50 pores in lateral line; eye 5.80 in head; snout 4.45; interorbital 7.10; maxillary 2.14, extending posterior to eye; mandible 1.80.

Body oblong, compressed, rather slender and elongate for this genus, the upper outline considerably more curved than lower. Least depth of caudal peduncle 3.30 in head, caudal truncate.

Anterior profile from origin of dorsal to tip of snout has a gradual even curve. Lower jaw rather strongly projecting. Mouth large. Each lip with a fold. Upper jaw without teeth directly in center of jaw, but with a patch of small sharp teeth on each side of symphysis. A single, small projecting canine on each side; extending back on the jaws from each anterior patch are several rows of villiform teeth with an outer row of enlarged canines. Under jaw with bands of cardiform teeth anteriorly with a projecting canine on each side (broken in type) the side of lower jaw with two rows of enlarged teeth, the anterior row of larger depressible teeth. Bands of villiform teeth on vomer and palatine. Tongue spatulate, without teeth; preopercle rounded and finely toothed, a slight notch near its angle below which the teeth are slightly enlarged. Soft portion of opercle ending in a single sharp point, the hard portion of opercle with three spines the middle one being much the largest in fact the only conspicuous one, the upper one being obtuse and hidden, and the lower one very small, the middle spine is the most posterior and its tip is nearer tip of lower than to upper spine. Gill openings large, being carried forward to below anterior portion of eye. Gill rakers large and strong, 16 on lower limb, the longest equal to two-thirds diameter of eye. Scales are minute and ctenoid; body, head, and fins, except jaws and posterior portion of maxillary, finely scaled; the scales on under surface and on nuchal region smallest.

Origin of dorsal midway between tip of snout and third ray of dorsal, the third to fourth spine longest, 2.40 in head, the first spine 1.90 in second, the longest ray 2.75. Origin of anal slightly nearer to last caudal vertebra than to angle of preopercle, its third spine the longest, 3.75 in head, its longest ray 2.10 in head. Ventrals 2 in head, their origin midway between anal and a vertical line with posterior nostril. Pectorals 1.75 in head.

Color in life brownish with tint of green, about 30 rather large scattered round yellow spots on head, fins slightly darker, otherwise color uniform.

Color in alcohol. Uniform brown with scattered round whitish spots on head, about 30 on each side and 4 or 5 showing indistinctly on shoulders, above lateral line, fins dark brown, uniform, the pectorals a shade less dusky.

Type is No. 1908 from Butuan Bay, Mindanao, P. I., 26 September, 1908. Length, 280 millimeters.

This species is related to *E. coromandelicus* Day but differs in several respects, being more elongate and having a longer maxillary, a slightly different arrangement of opercular spines, and a different color pattern.

Family HÆMULIDÆ.

Plectorhynchus doanei Seale, sp. nov.

Head 3; depth 2.40; dorsal XI, 20; anal III, 8; scales about 75; 64 pores in lateral line; about 30 scales in vertical series; eye 3; snout 3; interorbital space 4; maxillary 3.75, scarcely reaching to anterior margin of eye; mandible 2.75.

Body is oblong, compressed, the upper outline with much stronger curve than lower, the greatest depth is at origin of ventrals. Depth of caudal peduncle 2.75 in head, its length 1.80.

The anterior profile from origin of dorsal to end of snout is a strong curve, the snout however is almost straight and at an angle of more than 45°. Mouth small, lips thick, with fold. Teeth of upper jaw mostly anterior in several rows, small, sharp pointed. Teeth of lower jaw similar, except that those on sides of jaws are in single series. No teeth on vomer or palatine. Posterior margin of preopercle rather strongly denticulate. A rather deep notch on posterior margin of opercle. Gill openings wide, being carried forward to below anterior margin of eye. Gill rakers short, fine, almost hair-like, 26 on lower limb. Pseudobranchia present. Entire body and head, including also bases of all the soft fins covered with fine ctenoid scales. Origin of dorsal midway between tip of snout and base of sixth dorsal ray. The third or fourth spine longest, 1.75 in head, the eighth, ninth and tenth spines are shorter than the first spine, being less than length of snout. Longest dorsal ray 1.35 in head. Origin of anal midway between end of last caudal vertebra and the middle of base of pectorals, its base 2.50 in head, its second spine is much the longest and strongest, its length 1.75 in head, the longest ray 1.40 in head. Caudal forked, 1.1 in head, its lobes rounded; ventrals nearer to angle of mouth than to anal, their length 1.10 in head; pectorals equal to head.

Color in life orange red with about 7 large white areas margined with black, the anterior one occupies the snout, the second the nuchal region, extending down to opercles on each side but not to base of dorsal, the third occupies a region from origin of gill openings to, and including base of ventrals and obliquely up to eye, there is a square red band in the middle of this area across the thorax. There is a dark ocular band about width of eye down from eye around base of lower jaw, the fourth white area is a round spot back of, and above, base of pectorals, the fifth is below seventh to ninth dorsal spines and includes these spines, the sixth just above and includes the origin of anal, the seventh is an oblique white ring occupying the outer two-thirds of caudal peduncle. The posterior two-thirds of caudal is white with an oblong dusky patch on each lobe, the sixth and seventh white areas have an indistinct round dusky spot in the center. The soft dorsal is dusky with margins of rays white and a white spot near middle of fin. Anal is dusky at base, broadly margined with white, with some dusky blotches at tip. Ventrals black, with a white spot on anterior ray. Pectorals black with white tips.

Color in alcohol similar to above, except that the orange fades into a light brown, the black margins to the white areas remain very distinct.

Type is No. 4760 from Sitanki Island, Jolo Archipelago, 15 July, 1908; length, 40 millimeters; also a specimen No. 1695 from Cagayan, Mindanao.

Family THERAPONIDÆ. The Grunts.

Dentex filiformis Seale, sp. nov. Plate IX.

Head 3.75; depth 4.15; dorsal X, 9; anal III, 7; scales 3–47–16; eye 3 in head; snout 3.10; interorbital space equal to eye; maxillary 3; mandible 2.35; pectorals 1.25 in head; ventrals 1.30; depth of caudal peduncle 3.

Body moderately elongate, oblong, compressed, of about equal depth at origin of pectorals and at anal pore; least depth of caudal peduncle 3 in head.

Head somewhat conical, the profile from nape to snout evenly curved, the interorbital space is moderately convex. Greatest width of head 1.85 in its length. Snout rounded, its width at anterior nostril equal to its length; jaws equal, the upper moderately protractile, each jaw with a rather wide fold or lip. Maxillary fully hidden except at its tip, premaxillary scarcely reaching to eye, preorbital notched at angle of jaw, its width at this point equal to pupil, no spine on its posterior margin. Lower jaw with two distinct pores on each side, mouth wide, slightly oblique. Curved canines in each jaw, with patches of inner villiform teeth anteriorly, the fourth anterior canine of upper jaw largest. No teeth on vomer, palatine, or tongue. Preopercle fully serrated, opercle with a single rather distinct spine; five rows of large scales on cheeks. Head, except snout, preorbital, and under jaw, fully scaled. Gill opening wide, being carried forward to a line with middle of eye. Gill rakers consisting of short, thick asperites, about 4 on lower limb. Pseudobranchia present. Eyes quite large.

Scales small and ctenoid, the rows running horizontally on upper third of fish and obliquely below, body fully scaled; five distinct rows of scales on cheeks with the addition of a few scattered scales at margin of orbit.

Dorsal fin continuous, the spines weak, the fourth and fifth spines the longest, 2.50 in head, the longest ray 1.95 in head, the fin is provided with a distinct groove into which it fits, its origin is directly above the axil of pectoral. Origin of anal on a line with base of second dorsal ray and is midway between end of caudal vertebra and origin of ventrals, the anal spines are graduated, the third being 3.75 in head, longest ray 2.75, base of fin 1.90 in head. Origin of ventrals slightly nearer tip of snout than origin of anal, its length 1.30 in head. Pectorals 1.30 in head, caudal forked with the outer rays of upper lobe filliform, its length 2.35 of body, the lower lobe 1.30 in head.

Color in alcohol yellowish, a wide brown band slightly less than width of eye, occupies the middle of sides from eye to caudal. A yellowish area above this band, the entire upper portion brown, a round dusky dot at posterior end of lateral line, snout dark brown. There is a slight indication of an additional but very indistinct dusky band on upper sides of belly fading out posteriorly. Fins all uniform, yellowish white without markings.

Type is No. 1755 from Surigao, Mindanao, P. I. taken 17 September, 1907. Length, 130 millimeters.

Family LUTIANIDÆ. The Snappers.

Lutianus orientalis Seale, sp. nov. (Mayamaya.)

Head 2.75; depth 2.80; dorsal X, 14; anal III, 8; scales 8–51–14; eye 3.75; snout 3.10; interorbital 5.25; maxillary 2.30, ending under anterior third of pupil; mandible 1.75 ending on a line with posterior margin of pupil; pectorals 1.30; ventrals 1.55.

Body oblong, compressed, the greatest depth at origin of spinous dorsal. The upper outline from axil of dorsal to eye is an even curve; outline of head at eyes slightly concave. The lower profile from anal to chin is almost straight, the lower jaw being at a low angle. The length of the caudal peduncle is 1.80 in head, its greatest depth 1.25 in its length. Interorbital space slightly convex, a median ridge along its center; snout conical; width of preorbital but slightly greater than pupil. Jaws equal. Teeth consisting of villiform bands with outer row of curved canines, and a very long and strong anterior canine on each side of upper jaw. Teeth on vomer and palatine, none on tongue. A very shallow preopercular notch, no opercular knob, opercle ending in a flat spine. Gill openings wide, ending under anterior margin of eye. Gill rakers of moderate length, sharp-pointed, ten on lower limb, the longest about equal to pupil. Pseudobranchia present. Body fully scaled, cheeks, nape and opercles scaled, soft dorsal, caudal, anal and pectoral scaled at base.

Origin of dorsal above axil of pectoral, the fourth spine the longest, 2.50 in length; longest dorsal ray 2.30 in head; second anal spine slightly the longest, 2.75 in head; longest anal ray 2.10 in head. Origin of anal under second dorsal ray; origin of ventrals, midway between tip of snout and fourth anal ray, their spine only about half length of rays. Pectorals not reaching to anal. Ventrals extend to anal pore. Caudal scarcely emarginate, its length 1.35 in head.

Color in life yellow, darker above, four wide black longitudinal stripes of almost the width of pupil at their median point, the first from snout through interorbital space to posterior base of spinous dorsal. Second from posterior margin of eye to base of soft dorsal. Third from tip of snout through eye to upper base of caudal, a large black ovate spot in this line and extending above it, below the anterior portion of soft dorsal. Fourth from suborbital to lower base of caudal through the upper axil of pectoral, there is a slight dusky wash on tips of spinous dorsal and caudal, otherwise fins yellowish white.

Color in alcohol similar to above except the lines on top of head do not show, and the general color is dull yellowish white, brownish above with the black lines and black blotch showing very distinctly.

Four specimens; type is No. 2201 from Limbones Cove, Island of Luzon, P. I. Length, 95 millimeters, 14 January, 1908. The three additional specimens are from Balabac Island, P. I.

This fish was called *L. russeli* by Jordan & Seale and *L. quinquilineatus* by Jordan & Richardson. Day gives it as the young of *L. chrysotænia,* but we have specimens of *chrysotænia* and there is no doubt of it being a different fish. I have examined specimens of the two former species in the Stanford University Collection and find it can not be classed with either.

Family SPARIDÆ. The Porgies.

Lethrinus cutambi[a] Seale sp. nov. Plate X. (Cutambak.)

Head 3; depth, 2.75; dorsal X, 9; anal III, 8; scales 6–45–13; eye 4; snout 2, width of maxillary at symphysis almost equal to pupil; its length 2.75 in head; mandible 2.45; width of preorbital 2.95; pectorals 1.20; ventrals 1.50; interorbital space 1.10 in eye.

Body oblong compressed, the greatest depth being at origin of ventrals. The upper outline of body from occiput to axil of dorsal is an even curve, the forehead in front of eye is slightly convex while the snout is decidedly concave, the lower outline of body much less curved than upper; the lower jaw being very slightly oblique. The length of the caudal peduncle is 2 in head, its median width is 3.50 in its length, while its depth is 1.50 in its length.

Greatest depth of head slightly less than its length, its greatest width 2.20 in its length; interorbital space convex. Snout is elongate, its median width being about 2 in its length, nostrils some distance apart, the anterior one with membranous flap. Mouth large, the lips with thick membranous folds. The upper jaw strongly protractile. Teeth of upper jaw consisting of a single row of about six conical molars without cusps on each side, with small conical canine-like teeth anteriorly and with four enlarged outer canines in front. Lower jaw with about eight conical molars without cusps, and small canines, anteriorly, two enlarged outer canines on each side in front. No teeth on vomer,

[a] From the native name of this fish.

palatine or tongue. The jaws are equal, the maxillary ends on a line with anterior nostril, its end is fully hidden by preorbital. The mandible ends on a line with posterior nostril. Gill openings are of moderate size being carried forward to a line with middle of eye. Gill rakers are thick and short 5 on lower limb, the longest about one-fourth of pupil. Pseudobranchia present.

Body fully covered with rather large smooth scales which are very slightly denticulate on margins. Fins are unscaled, except pectorals which are slightly scaled at base. Head is naked except on opercles, with a small patch of scales behind and posterior to the eye, another small patch posterior to, and slightly above eye.

Origin of dorsal is one spine anterior to a line with axil of pectorals; fourth dorsal spine the longest, 3 in head, the spines received into a sheath, longest dorsal ray 2.50 in head.

The second anal spine is strongest, the third is the longest being 3.10 in head, longest anal ray 2.75, origin of anal is on a line with the second dorsal ray. Origin of ventrals midway between tip of snout and fifth anal ray. Tip of ventrals reaching to anal pore. Pectorals extend to a line with origin of anal. Caudal deeply emarginate, its length 1.25 in head, its shortest ray 2.10 in head.

Color in life rather a dark greenish with 7 or 8 irregular darker vertical bars over back and down on sides. Vertical fins marked with bars of dark green.

Color in alcohol yellowish, with slight shades of greenish, about 8 irregular darker greenish bars extending over back and down on sides to ventral surface, these bars much less than the interspaces, the bands are more or less broken at the lateral line but are continuous below it, there is on the second of these bands above middle of pectorals and below the lateral line an intensified dusky area or blotch, scarcely distinct from coloring of bands. Head is brownish with tint of green, there is a darker band easily overlooked, from lower half of eye down to posterior end of mandible; posterior margin of opercle darker. A darker green line at base of pectorals. A mottling of darker green on the membrane at base of each dorsal spine, each ray of soft dorsal and anal is crossed by one or two darker green blotches. Caudal has three or four darker green vertical bars. Ventrals are crossed by three bars of darker green, pectorals white.

Type is No. 4678, taken at Sitanki Island, Jolo Archipelago, P. I., 11 July, 1908. Length, 210 millimeters. Cotype No. 4680.

Lethrinus atkinsoni Seale, sp. nov. Plate XI. (Cutambak.)

Head 2.90; depth 2.50; dorsal X, 9; anal III, 8; scales 5–48–13; eye 3; snout 2; interorbital space 1.45 in eye (bony part only measured); maxillary 2.50 in head; mandible 2.10; pectorals equal to head; ventrals 1.45.

Body is oblong, compressed, rather deep, greatest depth at origin of ventrals. The upper outline is an even curve to the anterior margin of eye, it is slightly more convex from this point, the practically straight snout extends down to the protractile upper lip, at an angle slightly greater than 45°. Lower outline from anal to tip of snout forming a low even curve, the lower jaw being but slightly oblique. The depth of caudal peduncle is 1.50 in its length, its median width is 3 in its length, while its length is 2 in head. Greatest depth of head equals its length, its greatest width 2 in length; interorbital space slightly convex. Outline of snout almost straight, excluding the protractile upper jaw; width of upper lip at symphysis 2.50 in pupil; maxillary ends slightly posterior to anterior nostril; the mandible ends on a line with anterior margin of eye. Eye is large, 1.50 in snout. Preorbital 2.50 in head, jaws equal. Teeth of upper jaw consisting on each side of three large molars, two of which have cusps, five conical teeth, and two large curved anterior canines, also a patch of minute teeth in anterior of jaw, behind the canines. Lower jaw on each side with four large molars, three of which are biscuspid, five conical teeth, two canines, and a patch of minute teeth just inside the curved anterior canines. No teeth on vomer or palatines, opercle ends in a flat spine and has a rather broad yellow membranous margin.

Gill openings end on a line with middle of eye, the gill rakers are short, thick and blunt, four on lower limb, the longest less than one-fourth of pupil. Pseudobranchia present.

Body entirely covered with large smooth scales which are slightly denticulate on margins; head naked except on opercles and a small patch of scales behind and above eye. The spinous dorsal when collapsed is fully hidden in scaly sheath. Fins not scaled except base of pectorals and caudal. Origin of dorsal is directly above axil of pectoral, its fourth to fifth spines are longest, 2.75 in head. Longest dorsal ray 2.25 in head. Origin of anal is over second dorsal ray, its third spine is the longest, 3.25 in head, the second spine is strongest. Longest anal ray 2.75 in head. Origin of ventrals midway between tip of snout and posterior axil of anal. Tips of ventrals reach to anal pore. Tips of pectorals extend to base of anal. Caudals deeply emarginate, its longest lobe 1.20 in head, its shortest ray 2.30.

Color in life yellow, with slight wash of grayish, fins immaculate, except ventrals which have dusky tips and caudal which is washed with yellow.

Color in alcohol whitish, slightly grayish drab above; the middle of each row of scales darker, making 4 or 5 narrow longitudinal lines above the lateral line, these rows follow the curvature of the back. A large rather indistinct oblong dusky blotch between the pectoral and lateral line, base and upper axil of pectoral grayish. The fins are white, unmarked except the upper surface of the first ray of pectorals which is gray, and the ventrals, which have some dusky on their posterior third.

Type is No. 5080 taken at Balabac Island, P. I., 6 August, 1908. Length, 220 millimeters.

Family POMACENTRIDÆ. The Damsel-fishes.

Pomacentrus tropicus Seale. sp. nov. Plate XII, fig. 1. (Danigsahasa.)

Head 3; depth 1.95; dorsal XIII, 14; anal II, 14; scales 24, eighteen pores in lateral line, 12 in vertical series; eye 3 in head; snout 3.75; interorbital space 2.75; maxillary 3.50; mandible 3.10; pectorals equal to head posterior to nostril; ventrals slightly longer than pectorals; depth of caudal peduncle 2.10.

Body oblong, compressed, its greatest depth at origin of ventrals, this depth being considerably greater than at origin of anal. Depth of caudal peduncle greater than its length.

Anterior profile from origin of dorsal to tip of snout, is strongly rounded with a very slight constriction on nuchal region. Lower profile not quite so strongly rounded as upper, jaws when closed are equal. Interorbital space evenly convex. Greatest width of head 1.50 in its greatest depth. Snout rounded, its median width being a third less than its depth, its width considerable greater than its length, numerous small pores on top of snout and on orbital ring. Preopercle strongly denticulate, narrow but becoming abruptly wide under anterior margin of orbit, this wide portion ending posteriorly below in one or more strong spines, its anterior margin with a shallow notch; width of preorbital, at angle of mouth, 2 in eye, width below middle of eye, 1.50 in pupil. Maxillary scarcely extending to the anterior margin of orbit; mandible ending under anterior margin of orbit. Teeth in a single row in jaws. They are rather strong and incisor-like, 18 on each side of upper jaw; no teeth on vomer or palatine. Gill openings wide, carried forward to below anterior margin of eye. Gill rakers moderately strong, toothed on their inner side, about 12 on lower limb.

Body and head scaled, no scales on orbital ring. All fins except ventrals more or less scaled; strong scaly sheaths at base of dorsal and anal. The scales are smooth with finely ctenoid margins, those on median portion of sides largest. Three rows of scales on opercle with a few additional small scales on lower margin. Eight scales between dorsal and head, about 14 series on top of head.

Origin of dorsal fin midway between tip of snout and base of twelfth dorsal spine, the median spines of the fin are longest, the first spine is 1.25 in eye, the eighth is 2 in head, the thirteenth is 2.10 in head. The soft dorsal is pointed, its longest ray 1.50 in head. Anal similar to soft dorsal, the second spine is 2 in head, the longest ray equal to length of head posterior of the nostril. Origin of first anal spine is under the origin of the ninth spine of dorsal, origin of anal is much nearer origin of ventrals than to base of caudal, in fact, the distance between origin of ventrals and anal is considerably less than base of anal. Origin of ventral is midway between anal pore and a vertical line with posterior margin of iris, the ventral rays are more or less prolonged and filamentous, reaching to the origin of anal. Origin of pectorals is slightly anterior to origin of ventrals. Caudal rather long and sharp-pointed, scarcely emarginate, the upper lobe the longer, being longer than head.

Color in alcohol similar to life color except less bright being orange yellow with a slight brownish wash on top of head, fading on shoulders into the yellow body color. A blue line below eye on preopercle, some blue spots on opercle, a blue line on side of snout, a blue line from each side of belly out onto the anal fin where it forms a submarginal blue band, the tips of the anterior anal rays being black, a narrow black tip to spinous dorsal, otherwise fins all bright yellow. A black dot at origin of lateral line, another in upper axil of pectoral fin, lips dusky.

Type is No. 4737 from Sitanki Island, Jolo Archipelago. Taken by C. Canonizado and the writer 15 July, 1908. Length, 750 millimeters Five cotypes No. 4736 were taken at the same time and place.

This species is related to *Pomacentrus popei* Evermann and Seale but the coloring is different and the relative location of the anal and ventral fins is quite different. It is also related to *P. moluccensis* Bleeker, but has larger scales and a sharp-pointed caudal, with the additional differences in color markings.

Pomacentrus elongatus Seale, sp. nov. Plate XII, fig. 2.

Head 3.50; depth 2.15; dorsal XIII, 14; anal II, 15; scales 28, 18 pores in lateral line, 14 scales in vertical series; eye 3.10 in head; snout 3.40; interorbital space 3; maxillary 3.40; mandible 3; pectoral equal to head; ventrals longer than head; depth of caudal peduncle 2.

Body oblong, compressed, rather elongate for this family. Greatest depth in middle of body. Depth of caudal peduncle a fourth greater than its length.

Anterior profile from dorsal fin to snout evenly curved and about equal to curve of thorax and chin. Interorbital space convex. Snout rounded, its median width being slightly less than its length. Orbital ring strongly toothed, unscaled, very narrow below pupil, becoming wider under anterior of eye, its width at angle of mouth 2 in eye. A rather strong spine at posterior margin of this wide portion. Preopercle denticulate. Mouth small. Maxillary ending under anterior margin of orbit. Mandible ending under anterior margin of pupil. Teeth in two series the second being smaller and less securely fixed and alternating with those of the anterior series. Gill openings large, being carried forward to below anterior margin of orbit. Gill rakers slender, about 14 on lower limb.

Scales covering entire body and head, except orbital ring and chin.

Four rows of scales on preopercle, the lower row consisting of three or four small scales. All fines, except ventrals, more or less scaled, dorsal and anal with high scaly sheath.

Origin of dorsal midway between tip of snout and base of 11th dorsal spine, the spines increasing in length posteriorly, anterior spine equal to orbit, posterior spine 1.35 in head. Soft dorsal, caudal, and anal sharp pointed, the caudal scarcely emarginate, the upper lobe the longest. Second anal spine 1.55 in head. Longest rays of anal equal to rays of soft dorsal, 1.10 in head. Origin of anal is on a line with base of 13th dorsal spine, and is but slightly nearer origin of ventrals than to end of caudal vertebra. Origin of ventrals midway between anal and angle of jaw.

Color in life brown, becoming lighter on caudal peduncle, some blue lines on cheeks and top of head.

Color in alcohol is a reddish brown, shading into yellow on caudal peduncle, the caudal yellow, with a very slight wash of dusky. Distinct blue lines of less width than pupil uniting on top of snout extend back to about origin of lateral line at top of eye. Another from anterior of eye to middle of maxillary. A few blue dots on cheeks. A black dot at origin of lateral line. Inner axil of pectorals whitish, giving a more or less distinct white dot in upper axil of fin, pectorals grayish, ventrals black, other fins similar to color of body except the yellow caudal.

Type is No. 2214, collected by the writer and C. Canonizado at Limbones Cove at the entrance to Manila Bay, Luzon, P. I., 14 January, 1908. Length, 765 millimeters. Two cotypes were taken at same time and place, Nos. 2212 and 2213.

This species is *P. trilineatus* of Bleeker, Altas, fig. 3, which we believe to be distinct from the original *P. trilineatus* Ehrenberg.

Pomacentrus suluensis Seale, sp. nov.

Head 3; depth 2.10; dorsal XIII, 13; anal II, 14; scales 25, nineteen pores in lateral line, 12 scales in vertical series; eye 3 in head; snout 3.55; interorbital space 3.20; maxillary 3; mandible 2; pectorals 1.10 in head; ventrals about equal to head; depth of caudal peduncle 1.75 in head.

Body is oblong, compressed, the greatest depth being in the middle of body; upper and lower anterior profiles from base of dorsal and base of ventrals to snout are equal low curves, making the head rather sharp pointed. Depth of caudal peduncle slightly greater than its length. The top of head is almost a straight line from dorsal to snout, the curve being very low. Interorbital space slightly convex, median width of snout slightly greater than its length; two low ridges on upper side of snout; preopercle denticulate. Orbital ring entirely smooth and unscaled, its width at angle of mouth about equal to pupil; suborbital very narrow, less than one-half of pupil. Maxillary scarcely extends to anterior margin of eye; mandible ending under anterior margin of eye, the lower jaw slightly the longest. Teeth rather strong, in two series, the second alternating with those of first series.

Gill openings wide, carried forward to below anterior margin of orbit, gill rakers sharp-pointed, rather long, about 18 on lower limb.

Body entirely covered with ctenoid scales. All the fins except ventrals more or less scaled. Large scaly sheaths at dorsal and anal, three rows of scales on preopercle.

Origin of dorsal fin midway between tip of snout and base of last dorsal spine, the median dorsal spines are longest, being 2 in head. Longest dorsal ray about equal to longest anal ray, being 1.50 in head; dorsal, anal, and caudal sharp-pointed, caudal scarcely emarginate. Origin of anal under base of eleventh dorsal spine, being nearer origin of ventrals than to base of caudal. Origin of ventrals midway between anal and a vertical line with anterior margin of pupil. Caudal equal to length of head.

Color in life yellowish white, with two reddish brown vertical areas, one occuping the entire head, its posterior border from origin of dorsal to origin of ventrals, the second is from sixth dorsal spine to base of sixth soft dorsal ray down on sides to anterior half of anal fin. A large black yellow-edged ocellus on the last four spines, remainder of soft dorsal and caudal are yellowish white, the anal is bright yellow, some purplish on its anterior part. Ventrals white with some purplish anteriorly; no spot in axil of pectoral or at origin of lateral line.

Color in alcohol similar to above, but the purplish on anal more distinct, forming a dusky anterior border to fin.

Type is No. 4689. Secured by the writer and C. Canonizado at the Island of Sitanki, Jolo Archipelago, 12 July, 1908. Length 355 millimeters.

This species is related to *P. notaphthalmus* Bleeker but differs considerably in the color markings and in having preorbital strongly serrated, the anal fin sharp-pointed and the black spot above operculum absent.

Abudefduf coracinus Seale, sp. nov. Plate XIII.

Head 3.60; depth 2; dorsal XIII, 14; anal II, 13; scales 27; 18 pores in lateral line which ends under middle of soft dorsal, 14 scales in vertical series; eye 3.50; snout 3.10; interorbital space 2.50; maxillary 3.25; mandible 3; pectorals 1.10; ventrals longer than head, 3.15 in length, caudal peduncle 1.60 in head.

Body is oblong compressed, its depth is about the same at origin of ventrals as at origin of anal, depth of caudal peduncle is slightly greater than its length.

Head is evenly rounded. The jaws when closed are equal. The greatest width of head is 1.75 in its greatest depth, the profile both from the origin of dorsal to snout and from origin of ventrals to snout is a low even curve. The interorbital space is slightly and evenly convex. The snout is rounded, its depth at nostril being greater than its width. Preorbital is rather wide and unscaled, the anterior margin not notched, its width at angle of jaw 1.50 in orbit, its width below middle of eye very little less than its angle. Maxillary ending on a line midway between posterior nostril and anterior margin of eye. The end of mandible not reaching to orbit. Teeth in a single series in jaws, rather strong, fixed, almost conical, and with a slight curve, 20 on each side of lower jaw. No teeth on vomer or palatine. Gill openings large, ending on a line slightly anterior to orbit. Gill rakers slender and pointed, the longest about equal to pupil, 14 on lower limb.

Scales covering entire body and head except the orbital ring, maxillary, and mandibles; the scales are large smooth with their margins finely ctenoid. Fins scaled, except the ventrals; a high scaly sheath to dorsals and anal. A large axillary scale at ventrals; scales largest on the median anterior part of body; small scales at base of fins and thorax. Six scales between origin of dorsal and head and about 13 series on top of head. Two rows of large scales on the preopercle with two or three small scales on its lower margin.

Origin of dorsal fin about the width of eye posterior to pectoral axil, the first spine being midway between tip of snout and origin of twelfth dorsal spine, the spines gradually increase in length posteriorly, the first spine being 1.30 in eye while the last 2 in head (measured to base of scaly sheath). Soft dorsal rounded, its longest ray 1.25 in head. The anal is similar in shape to soft dorsal, its second spine is 2 in head, the longest ray is about equal to longest ray of soft dorsal; origin of second anal spine on a line with base of 13th dorsal spine, being midway between end of caudal vertebra and origin of ventrals, the first anal spine is quite a little in advance of the second. Origin of ventrals midway between first anal spine and tip of snout; ventrals are slightly filamentous at tip but do not quite reach to anal pore. Pectorals are rounded, the width of their base being 2.50 in their length. Caudal rounded, scarcely emarginate, the upper lobe the longer, being about equal to length of head.

Color in life uniform dark brown or blackish.

Color in alcohol olivaceous black, fins black, opercular flap black. A black dot at axil of pectorals. No ocelli anywhere.

Type is No. 4908. A specimen 123 millimeters in length taken by the writer and C. Canonizado at Sitanki Island, Jolo Archipelago, 18 July, 1908.

This species very closely resembles *A. melas* but is easily distinguished by the naked orbital ring

Family LABRIDÆ.

Halichœres iris Seale, sp. nov.

Head 3.10 (measured to end of opercular flap); depth 3; dorsal IX, 13; anal II, 11; scales 26; 13½ in vertical series; eye 4.50 in head; snout 2.75; interorbital 4.10; maxillary 4.50; mandible 3.

Body oblong, compressed, the upper and lower outlines evenly curved to the rather pointed head and snout. Depth of caudal peduncle 2.1 in head, its length 3 in head. Mouth rather small, the jaws equal, the upper jaw protractile, upper lip with wide fold, lower lip with fold less developed. Teeth in a single series in each jaw, the anterior ones consisting of enlarged projecting canines; they graduate in size posteriorly. No canines at angle of jaws. No teeth on vomer or palatines. Gill openings extend forward to line with angle of preopercle. Gill rakers small, fine-pointed, about 13 on lower limb.

Body covered with large smooth scales, which are much smaller on thorax. Head entirely naked, fins unscaled, except a row at base of dorsal and anal, and basal half of caudal. Lateral line continuous.

The dorsal spines are short and pungent, the origin of the fin is midway between tip of snout and base of sixth dorsal ray, the longest spine about 4.25 in head, the longest ray 3. Caudal is slightly lunate, its length 1.35 in head. Origin of anal midway between the end of last caudal vertebra and the posterior margin of hard opercle, being on a line with the base of third dorsal ray, its base is 1.20 in head, its second spine is longest, 3.25 in head, its longest ray 2.50. Origin of ventrals slightly nearer angle of mouth than to anal, the length 2.10 in head. Pectorals 1.30 in head, ending on a line with ninth scale of lateral line.

Color in life. The general color is greenish above and bluish below; there are seven purplish bands over back which extend obliquely back and down to about the median line of sides, the anterior band is from nuchal region to axil of pectoral, the second from origin of dorsal, third from posterior portion of spinous dorsal, fourth from anterior portion of soft dorsal, fifth from middle of soft dorsal, sixth from posterior portion of soft dorsal and the seventh over the middle of caudal peduncle; these bands are almost as wide as the interspaces. The top of head and nuchal region are purple, there are three wide rosy bands tinted with purplish on sides of head, one from posterior of eye to posterior margin of opercle near base of pectoral, one from lower portion of orbit to lower posterior margin of opercles, one from lower anterior margin of orbit to behind angle of mouth; these bars are of slightly greater width than pupil, the coloring of cheeks between these bars is yellowish, with portions shading into orange and greenish, the lower jaw and throat blue, base of pectorals purplish, the base of rays yellow. Spinous dorsal purplish with deep green on base, the purplish coloring extending back as a graduating line through the lower half of soft dorsal, general color of soft dorsal, pale yellowish, caudal yellowish with tint of green, the upper and lower rays green with the second ray a heavy brownish red. Anal pale yellowish, ventrals pinkish, pectorals washed with yellowish at base and slightly dusky at tip.

Color in alcohol similar to above, except the bluish below fades into whitish, the deep green on dorsal and between the purple bars fades and becomes dull bluish, the stripes on head brown-purplish, the anal shows a dusky blotch on middle of anterior rays.

Type is No. 4582 from Sitanki Island, Jolo Archipelago, P. I., 2 July, 1908. Length, 112 millimeters.

Choerops palawanensis Seale, sp. nov.

Head 3; depth 2.80; dorsal XIV, 7; anal III, 10; scales 28; 11 scales in vertical series; eye 6; snout 2.35; interorbital 5.50; cheeks with about 6 rows of imbricate scales.

Body oblong, compressed, the upper outline more rounded than lower. Depth of caudal peduncle 2.35 in head.

Upper profile of head a strong even curve back to origin of dorsal. Interorbital space convex. Greatest depth of head 1.14 in its length; mouth rather large, the upper jaw protractile. Lips thick, with fold, four strong projecting canines in the front of each jaw, a canine at angle of upper jaw. Posterior margin of preopercle is finely denticulate. Lower limb of preopercle naked. Gill openings moderate, ending on a line slightly posterior to eye. Gill rakers thick, sharp-pointed, short, about 8 on lower limb.

The scales are large and smooth, fully covering head and body except top of head, snout, limb of preopercle, and chin. Tubules of lateral line strongly branched.

Origin of dorsal midway between tip of snout and base of 12th dorsal spine, the longest spine 3.50 in head, its posterior rays the longest, 2.50 in head. Base of anal 1.15 in head, its posterior ray 2.20, origin of anal is midway between last caudal vertebra and angle of preopercle. Origin of ventrals midway between anal and angle of mouth, the anterior rays elongate, reaching to base of anal. Pectorals 1.25, ending on a line with 12th scale of lateral line. Caudal slightly lunate, 1.15 in head.

Color in life. General color brownish above, whitish below, margins of the scales drab. An oblong bright yellow patch on sides under posterior third of spinous dorsal, a row of about five black spots along the median line, sides of head greenish with tint of yellow, the color below this is blue, a red line back from angle of mouth marks the meeting of these two colors, four greenish lines on sides of snout from eye to mouth, about 6 oblique yellow lines on opercle, three red lines on lower jaw, two rows of dusky dots near base of dorsal fin. Dorsal blue with about 4 irregular rows of red dots tending to form broken vertical lines on soft dorsal. Margin of spinous dorsal blue. Anal similar to dorsal in color except that the round red spots tend to form two or three longitudinal lines on distal portion of fin. Caudal yellowish green with alternating blue and red dots on sides. Ventrals blue, the webs yellow. Pectorals yellow, blue at base with a ring of red.

Color in alcohol dull light brown with tint of green, the golden blotch and the black dots on sides show distinctly. Markings of dorsal scarcely showing; markings of anal more distinct, the dots being yellow, caudal almost uniform greenish with the slightest trace of markings.

Type is No. 5501, from Puerto Princesa, Palawan Island, P. I., 22 August, 1907. Length, 235 millimeters.

Family SCARICHTHYIDÆ.

Callyodon rostratus Seale, sp. nov. (Ogos.)

Head 2.75, measured from tip of opercular flap to tip of upper teeth; depth 3; dorsal IX, 10; anal III, 9; scales 23; 8½ scales in vertical series; eye 7 in head; snout 2.20; interorbital 3.15, two rows of scales on cheeks, the lower limb of preopercle being entirely naked; only the slightest indication of canine teeth at angle of upper jaw, none on lower; teeth green, the margins crenulate; lips narrow, not covering half of either jaw.

Body oblong compressed, the upper and lower outlines equal, the snout is heavy and deep, the teeth large and exposed, giving a blunt appearance to the head. Depth of caudal peduncle 2.50 in head.

Depth of head 1.40 in its length, the upper and lower outlines with very low angle. Interorbital space convex. Gill openings are carried forward to below eye. Gill rakers numerous, minute and hair-like. Scales large and smooth, 3½ in front of dorsal. Origin of dorsal midway between tip of teeth and second dorsal ray, its longest spine 3 in head, the last ray 3.25. Caudal slightly rounded in middle, the lower ray slightly produced. Base of anal 1.70 in head, its origin being midway between last caudal vertebra and axil of pectoral, its longest ray 3. Origin of ventrals slightly nearer to angle of jaws than to anal, their length 2.10 in head. Pectorals 1.50 in head.

Color in life deep blue-green, more decidedly bluish on belly, which shows three or four longitudinal stripes of darker blue. A yellowish area encircles and occupies the entire caudal peduncle. Cheeks washed with reddish, two darker lines extend back from eye. A red line around lips, a second red line across base of lower jaw. Dorsal red with a green line through center and a deep blue margin. Caudal deep blue, with some of the webs washed with red. Base of anal red, the distal two-thirds blue. Pectorals green, the first ray blue. Teeth green.

Color in alcohol yellowish shaded with dull brownish. A yellow area occupies caudal peduncle, two wide dusky stripes from posterior part of eye, snout greenish. Cheeks and opercles yellowish except the upper portion of opercle which is crossed by the dusky bar. An indistinct line from below angle of jaws around lower lip, dorsal grayish with yellowish margin and clouded with dusky in center. Caudal yellowish with some lighter markings on webs. Anal whitish at base, the distal two-thirds yellowish. Ventrals yellowish, pectorals yellowish, teeth green.

Type No. 2928 from Zamboanga, Mindanao, P. I., 10 April, 1908. Length, 215 millimeters.

Callyodon hadji[7] Seale, sp. nov.

Head 3; depth 2.45; dorsal IX, 9; anal III, 9; scales 24 to end of caudal vertebra, 8½ scales in vertical series; eye 5.75 in head; snout 2.60; interorbital space about equal to snout; scales on cheeks in three rows, the lower row covering the limb of preopercle; lips rather wide covering about two-thirds of jaws; each jaw with a strong canine near angle; teeth rosy; pectorals 1.30 in head; ventrals 1.75.

Body oblong, compressed, the upper and lower outlines about evenly curved, the head moderately pointed; least depth of caudal peduncle 2.1 in head, being about equal to its length.

Greatest depth of head about equal to its length. Interorbital space convex. Snout not particularly blunt. Lips thin, without folds. Gill openings of moderate size, ending anteriorly on a line with posterior margin of eye. Gill rakers very minute, short, hair-like, at least 22 on lower limb. Pseudobranchia large.

Scales large and smooth. Body and head fully scaled except snout and chin. Six scales in front of dorsal. Origin of dorsal is midway between tip of snout and base of second dorsal ray, its longest spine 2.75 in head, its longest ray 2.75 in head. Base of anal 1.20 in head, its origin midway between end of caudal vertebra and angle of preopercle, its longest ray about 3 in head, origin of ventrals midway between anal and angle of jaws, the fin not reaching to anal pore. Origin of pectorals below origin of dorsal, its tip on a line with ninth scale of lateral line. Caudal slightly lunate, its longest rays equal to pectoral, the mid rays 1.50 in head.

Color in life is chiefly pinkish and bluish green. The throat, thorax, belly and sides below the median line being a bright pink; each scale on entire side in front of caudal peduncle is margined with pink, upper part of sides and back green, upper half of head reddish brown, caudal peduncle blue-green, upper lip bright green with a blue-green line around its base, this line is bordered by pink above and extends to below and slightly posterior to eye. Three short blue-green lines radiate from eye, two backward and one forward. An irregular-shaped bright green area extends from angle of mouth to below eye and down almost to chin. Under lip pink crossed by two deep blue lines, one near margin the other near base of lip. About 8 deep blue spots or dashes on each side of throat. A row of deeper green spots along base of dorsal fin. Dorsal

[7] Hadji=Moro pilgrim or chief.

fin salmon-red with a broad blue-green border. A row of green spots along middle of red portion. Caudal fin pea-green with deep blue upper and lower margin. Anal fin deep red with outer half blue. Pectorals deep blue with 4th to 5th rays bright pink. Ventrals pinkish and yellow with anterior ray blue-green.

Color in spirits uniform dull grayish, whitish on belly, the bright greenish irregular area back of angle of mouth shows distinctly. All markings of the fins dull but show the general arrangement described above, the pectorals are greenish with a darker stripe on second to fourth rays.

Type is No. 5367 from Puerto Princesa, Palawan, 19 August, 1909. Length, 225 millimeters, and cotype 5494 from same locality.

Callyodon albipunctatus Seale, sp. nov.

Head 2.75; depth 3; dorsal IX, 10; anal III, 9; scales 23, 8½ in vertical series; eye 5.25; snout 2.50; interorbital 3.25; two rows of scales on cheeks; lower limb of preopercle entirely naked; lips narrow, the teeth being more than half exposed; teeth pinkish.

Body oblong compressed, under normal conditions the upper and lower outlines are evenly curved; the snout, however, is very deep, giving a blunt appearance to head. Depth of caudal peduncle 2.75 in head. Greatest depth of head 1.35 in its length. Mouth rather large. Teeth prominent, no canines. Gill openings carried forward to a line with posterior third of eye. Gill rakers numerous, minute and hair-like. Pseudobranchia large.

Scales large and smooth, four in front of dorsal. Body and head fully scaled except on interorbital space and snout, preopercular limb and chin.

Origin of dorsal midway between tip of teeth and second dorsal ray, the longest spine 3.10 in head, the longest ray 3.10. Origin of anal midway between axil of pectoral and last caudal vertebra, its base 1.75 in head, its longest ray 3.10. Origin of ventrals midway between angle of jaw and anal, their length 2.10 in head. Pectorals 1.50, caudal truncate.

Color in life. General color of lower parts pinkish, the scales on upper portion of body with greenish bases and margins. About ten distinct round white spots on sides usually in pairs at regular intervals, belly with slight wash of purplish. Dorsal fin uniform pink. Caudal uniform pink. Anal bluish at base, fading to pink distally. Pectorals and ventrals uniform pink, iris golden, snout and chin uniform pink, cheeks with a slight tint of bluish. A wide yellow area surrounding caudal peduncle.

Color in alcohol grayish, base of scales darker, belly purplish, gape and chin and area at base of caudal yellowish. Twelve to fourteen round white spots on posterior half of body, fins uniform grayish green.

Type is No. 4876 from Sitanki Island, Jolo Archipelago, P. I., 18, July, 1908. Length, 170 millimeters.

Callyodon ogos Seale, sp. nov.

Head 3.20; depth 2.70; dorsal IX, 10; anal III, 9; scales 22, 8½ in vertical series; eye 5.50 in head; snout 2.85; interorbital 3.15; two rows of scales on cheeks; the lower limb of preopercle naked; lips wide; a canine tooth at angle of each jaw.

Body oblong compressed, the upper and lower outlines evenly curved; head rather more pointed than is usual in this genus. Depth of caudal peduncle somewhat greater than its length, being 2 in head.

Greatest depth of head 1.14 in its length. Interorbital space convex. The lips are wide, the upper almost wholly covering the teeth, the lower covering more than two-thirds of lower teeth. The teeth in life were rosy. The canine teeth of the lower jaw are largest, those of the upper jaw being rather blunt. Gill rakers fine almost hair-like, short, about 26 on lower limb. Gill openings of moderate width, ending on a line with posterior margin of eye. Pseudobranchia large.

Scales are large and smooth, body and head are fully scaled except interorbital space, snout, lower limb of preopercle and chin, which are naked. Lips thin, without folds.

Origin of dorsal midway between tip of snout and base of first dorsal ray, longest spine 2.25 in head, about equal to longest ray. Base of anal 1.20 in head, the origin of the fin is considerably nearer the end of caudal vertebra than to angle of preopercle, its posterior ray 2.50 in head. Origin of ventrals considerably posterior to origin of pectorals, being midway between anal and angle of mouth, their length 1.50 in head. Pectorals 1.25 in head, their tip on a line with 8th scale of lateral line. Caudal is slightly lunate.

Color in life chiefly blue-green; however, there is a large area occupying the upper and median portion of the sides which is reddish yellow, the margins of the scales in this area are green. The upper anterior portion of back is deep green, the lower portion of sides, belly, and caudal peduncle is deep blue-green. About twelve short red lines radiate from eye. A large wedge-shaped deep green area with red margins extends from posterior margin of eye to posterior margin of opercles, ending just in front of axil of pectorals. Snout deep green. A red line from eye to angle of jaws. Lower lip rosy with blue margin and crossed by blue line at base. Two short longitudinal blue lines on sides of throat, base of pectorals rosy with a deep green line across base of rays. Dorsal rosy at base and broadly margined with deep blue, the median portion of the fin between these colors being bright red above and deep green below, the green color fading out and changing into a bright yellow on posterior portion of soft dorsal. Caudal with upper and lower rays bright blue, the second and third upper and lower rays bright pink, the remainder of fin rather dark blue. Anal blue-green, the margin and base darker blue, the median portion with tint of pinkish, showing some darker greenish blotches between the rays. Ventrals with rays deep blue-green except second rays which are bright pink. Pectorals uniform red, a green line across base.

Color in alcohol. The above striking colors almost entirely disappear and the fish becomes a dull yellowish brown, the fins show very indistinctly the markings described above, the blue of the margins fading into a yellowish white; the deep green wedge-shaped area between eye and axil of pectorals becomes a yellowish area of no distinct shape, while the lines which radiate from eye almost entirely disappear. The pectoral becomes yellowish white with a dusky dot on its upper axil.

Type is No. 5414 from Puerto Princesa, Palawan Island, 20 August, 1908. Length, 225 millimeters, and cotype No. 5411 from the same locality.

Family PSEUDOCHROMIDÆ.

Pseudochromis aurea Seale, sp. nov.

Head 3.40; depth 3; dorsal III, 26; anal III, 14; scales 41, vertical series 14; eye 4; snout 3.75; interorbital 5; maxillary 2.50, its distal end on a line with pupil; mandible 1.90.

Body oblong, compressed, the upper anterior outline from origin of dorsal to tip of snout is a low even curve, the lower outline comparatively straight. Depth of caudal peduncle 1.85 in head, its length one-half its depth. Mouth of moderate size, the lower jaw projecting. Teeth in front of jaws in several series with about 4 large curved canines, teeth on sides of jaws in single series, teeth on vomer and palatines. Cheeks with 4 rows of scales, opercle with a single flat obtuse spine and covered with large scales. Gill openings carried forward slightly past angle of preopercle. Gill rakers rather flat and wide, about 13 on lower limb. Three membranous points to lower limb of preopercle. Pseudobranchia present.

Entire body covered with fine smooth scales which have a finely denticulate border.

Origin of dorsal midway between tip of snout and base of 11th ray of soft dorsal, the spines rather weak, the longest 3 in head, the longest ray 1.30 in head; caudal rounded, its length equal to head. Origin of anal about midway between end of caudal vertebra and posterior margin of opercles, the length of its base equal to head, its third spine the longest, 2.30 in head, its longest ray 1.50 in head. Origin of ventrals but slightly nearer anal than to tip of snout, the rays elongate reaching to base of anal. Pectorals 1.14 in head.

Color in life bright orange, most of the scales below the lateral line, except on thorax, have a bright blue dot. Two blue lines cross the eye-ball but do not extend out of orbit, head uniform yellow orange, very slightly dark above, fins all uniform orange without markings.

Color in alcohol uniform yellow, most of scales showing indication of a dot on each scale, blue lateral line except on thorax and head; fins yellow, some indistinct indications of dots on anal.

Type is No. 4899 from Sitanki Island, Jolo Archipelago, P. I., 18 July, 1908. Length, 90 millimeters. Numerous cotypes.

Pseudochromis rex Seale, sp. nov.

Head 3.50; depth 2.90; dorsal III, 25; anal III, 14; pores in lateral line 44, 16 scales in vertical series; eye 4.50 in head; snout 3.20; interorbital 4.20; maxillary 2.50, its distal end under anterior margin of eye; mandible 1.90; width of preorbital 1.75 in orbit.

Body oblong, compressed. Upper anterior profile from origin of dorsal to tip of snout, a moderate and even curve. Depth of caudal peduncle 1.55 in head, its length about one-half its depth. Mouth of moderate size. Lower jaw slightly projecting. Teeth in anterior of jaws in several rows with several large curved canines, those in side of jaws in single row, conical, sharp-pointed. Teeth on vomer and palatines. Cheeks with five rows of scales. Preorbital with two or three membranous points; opercles with a single flat spine. Gill openings rather narrow, scarcely extending forward to angle of preopercle. Gill rakers short and thick, with asperites on inner surface, 12 on lower limb. Pseudobranchia present. Entire body and head, except snout and chin, covered with fine smooth scales; scales on opercles largest; fins, except caudal, unscaled. Origin of dorsal midway between tip of snout and 10th ray of soft dorsal, the dorsal spines very thick and stiff, the third the longest, equal to length of snout, the first dorsal ray considerably longer, 1.75 in head. Base of anal almost equal to length of head, its origin midway between end of caudal vertebra and posterior margin of opercle, its longest ray 2 in head. Ventrals 1.40 in head, their spine 2, their origin is midway between anal and gape of mouth. Pectorals 1.20 in head. Caudal rounded in young, but with upper and lower rays slightly produced in old specimens, length of caudal 1.12 in head.

Color in life. Upper anterior portion of head and body dark bluish with a jet black line equal to width of pupil from tip of snout through eye to below the anterior third of soft dorsal, some dusky dots below the posterior half of this line, general color of body yellow, belly and chin pale blue, dorsal dusky on base with bluish wash, the outer two-thirds of fin yellowish white posteriorly, caudal and anal uniform yellow, ventrals bluish white, pectorals yellowish.

Color in alcohol. Upper anterior portion of body and head brownish with some fine black specks. A black line from snout through eye, extending back and becoming more diffused, fading out under posterior third of soft dorsal. Other portions of body yellowish white without markings, dorsal dusky at base, lighter on its distal half, other fins uniform yellowish white.

Numerous specimens. Type is No. 4631 from Sitanki Island, Jolo Archipelago, P. I., 4 July, 1908. Length, 120 millimeters.

Labracinus flavipinnis Seale, sp. nov.

Head 3.50; depth 3.75; dorsal II, 20; anal III, 10; scales 36, lateral line interrupted; vertical series $10\frac{1}{2}$; eye 3.10; snout 4.75; interorbital equal to snout; maxillary 3.75, its distal end under anterior margin of pupil.

Upper and lower outlines of body evenly and equally curved, depth of caudal peduncle 1.75 in head, its length 2 in head. Head moderately pointed. The lower jaw slightly longer. Mouth oblique, small. Teeth of upper jaw fine, in several bands, with about 6 enlarged anterior canines. Teeth of lower jaw in a single series on sides with two enlarged canines and bands of small teeth in front. Teeth on vomer and palatine. Scales on cheeks in three rows; opercular and preopercular margins entire. Gill openings wide, being carried forward to a line with posterior margin of orbit. Gill rakers thin, sharp-pointed, short, about 12 on lower limb.

Body and head, except snout and chin, covered with rather small smooth scales, caudal scaled for half its length, other fins unscaled, about ten rows of scales in front of dorsal. The two dorsal spines short, the second being about half length of first ray, the longest ray about 2.10 in head. The caudal is rounded, 1.30 in head. Origin of anal midway between end of last caudal vertebra and a line with middle of opercle, its rays about 2 in head. Origin of ventrals slightly in front of origin of pectorals, being considerably nearer the tip of snout than to anal, its length 1.14 in head. Pectorals 1.25.

Color in life yellowish brown, darkest anteriorly, the posterior half of body with some small vertical blue marks. Top of snout, interorbital space and nuchal region back along base of spinous dorsal black. Lower half of spinous dorsal jet black, the upper half orange, a narrow yellow line between the colors. Caudal yellow, a jet black line extends from along top of caudal peduncle into the fin where it forms a submarginal wedge-shaped band; anal and ventrals pink; pectorals yellowish brown.

Color in alcohol similar to above but less bright, the bluish markings obsolete.

Type is No. 4410 from Zamboanga, Mindanao, P. I., 11 June, 1908. Length, 46 millimeters.

Family OSPHROMENIDÆ.

Osphromenus insulatus Seale, sp. nov.

Head 3.18; depth 2.75; dorsal VII, 8; anal XI, 32; scales about 45 in lateral series, from 20 to 34 pores in lateral line which is very irregular, in the type specimen the line is broken on one side and jumps 4 scales, in some cotypes the line is broken in two or three places and jumps several scales, in the type the lateral line has a distinct arch anteriorly as in the carangoids, becoming more or less straight about the middle of fish; ventrals 5, the first ray filiform, extending to caudal, the other rays very small, almost atrophied. Maxillary short, slightly less than diameter of eye; interorbital space 2.50 in head.

Body oblong, compressed, the head is pointed, the profile from nuchal region to tip of snout is very slightly concave. Depth of caudal peduncle 2.35 in head.

The interorbital space is slightly convex, the mouth is small and directed upward, the lower jaw strongly projecting; width of preorbital is two-thirds of eye, it has a strong notch which receives the tip of the maxillary, lower margins of preorbital provided with about 8 distinct teeth. Jaws with bands of small sharp teeth including several enlarged canines, the latter being curved and more or less projecting; no teeth on vomer or palatine. The posterior margin of preopercle is entire, but its lower limb is margined by a row of long sharp teeth. Opercle without spine, ending in a sharp membranous flap. Three rows of scales on opercles and four on cheeks. Gill openings united on isthmus. Gill rakers numerous, short, flat, sharp-pointed.

Entire body including head covered with fine ctenoid scales, scales largest on opercles, soft dorsal with large scales on base, caudal and anal scaled, throat scaled.

Origin of dorsal is midway between pupil and end of last vertebra, the spines graduate in size, the last one the longest, about 2.1, the rays in male specimens elongate, greater than length of head, caudal slightly inclined to be bilobed, its length slightly greater than head. Spinous anal fitting into a scaly sheath, origin of its first spine midway between tip of upper jaw and ninth anal ray, the spinous portion contained about twice in soft posterior portion, the longest spine about 3 in head, the longest ray 1.35. Origin of ventrals in advance of pectorals, their anterior ray reaching to, or almost to, base of caudal. Pectorals about equal to length of head.

Color in life brown with some irregular blackish marks on shoulders, some yellowish on opercles and on thorax, some vivid pink at base of anal, extending almost length of base. Dorsal, yellowish brown in females, brown in males, the rays marked with yellowish dark-ringed spots. Caudal brown with numerous yellowish spots, anal brown with some yellowish spots, pectorals brown, ventrals yellowish, a distinct black spot at base of caudal, another on middle of side.

Color in alcohol similar to above but yellow much faded, and the pink at base of anal disappears.

Type is No. 4951 from lake on Cagayan-Sulu Island, Sulu Sea. Length, 73 millimeters. Numerous cotypes.

It is rather interesting to find this form in a crater lake on this volcanic island, isolated as it is in the Sulu Sea.

Family GOBIIDÆ.

Genus **BIAT** Seale, new genus.[8]

This genus is related to *Oxyuricthys* Bleeker but differs in being without nuchal crest or tentacle and in having the upper teeth in two or more series. From *Gobionellus* Girard it differs in having the teeth firm instead of movable. From *Gobiichthys* Klunzanger it differs in having no tentacle over eye and in other respects. It is characterized by the smooth head, without scales, tentacles, or crest, the extremely elongate fully united ventrals, the fine ctenoid scales which are larger posteriorly and the many rayed (16–17) dorsal and anal.

Type is *Biat luzonica* Seale, No. 2040 in collection of Bureau of Science, Manila, from east coast of Luzon Island. Length, 190 millimeters.

Biat luzonica Seale, sp. nov.

Head 4.10; depth 5.10; dorsal VI, 16; anal 17, scales about 110 in a median line; about 25 in lateral series; head entirely naked; eye 4.75 in head; snout 4; eyes close together, the interorbital space less than width of pupil; maxillary 2.45 in head; mandible 2.10.

Body elongate, cylindrical, its greatest width 1.50 in its depth. Depth of caudal peduncle 2.30. Head rather blunt, the anterior profile of head from eye to tip of snout has an angle of about 45 degrees. The mouth is slightly oblique, the lower jaw a little the longer. Gill openings rather wide, being carried forward to a line with angle of preopercle. Gill rakers short and blunt, 10 on lower limb. Margins of opercle and preopercle smooth. The teeth of each jaw are in several series with the addition of an irregular row of short curved canines, the anterior ones being enlarged. Tongue is rounded and adnate to floor of mouth for its entire length. No teeth on vomer or palatine. No barbules or tentacles. Lips with fold of skin, no lines of cirri, or prominent mucous pores, except one with a bifurcated opening on back part of interorbital space.

The entire body is covered with fine ctenoid scales which become larger posteriorly. About 25 series of scales in front of dorsal which, however, do not encroach upon the head.

Spinous dorsal of 6 thin flexible spines which tend to become filamentous, the longest about 1.50 in head, the origin of spinous dorsal is midway between tip of snout and base of third soft ray. Longest ray of soft dorsal 1.45 in head. Origin of anal midway between end of caudal vertebra and angle of preopercle, its base 3.10 in length of fish without caudal, its longest ray 1.50 in head. Caudal lanceolate in shape, its length almost a fourth greater than head. Origin of ventrals midway between anal and angle of mouth, the fin united its entire length, and with a deep membranous cup which has a smooth margin, the fin very

[8] Biat=Philippine name for goby.

long extending to base of anal, its length greater than head being almost equal to caudal. Pectorals 1.14 in head, their bases rather thick but not nearly so strongly developed as in *Periophthalmus*.

Color in alcohol (the specimen was not seen by us in a fresh state) yellowish brown with six wide dark bluish bars over back and sides, the first occupying anterior part of head including the snout and eyes. Second on nuchal region down to opercles. Third from median portion of spinous dorsal. Fourth from anterior third of soft dorsal. Fifth from posterior part of soft dosal. Sixth on base of caudal fin. These bands are but little narrower than the interspaces and the margins are not sharply defined although the bands themselves are quite distinct. A few small yellowish spots probably red or blue in life on upper portion of head behind eye. Spinous dorsal grayish with dusky center, soft dorsal dull yellowish as is also the caudal. Anal yellowish, darker at tip with two or three narrow submarginal lines. Ventrals dark gray. Pectorals yellowish.

Type is No. 2040, from the east coast of Luzon, P. I., June, 1907. Secured by Mr. W. D. Carpenter. Length, 190 millimeters.

MACGREGORELLA,[9] new genus.

This genus is characterized by the presence of numerous striking ridges and pockets of membrane with fringed margins on various portions of the head. The head otherwise entirely naked. No scales in front of dorsal. No pectoral filaments, no barbules, although the folds of membranes from a side view give the appearance of barbules in the figure. Body finely scaled, teeth in bands in each jaw, no large canines, tongue rounded, free at tip. Soft dorsal and anal of 9 to 12 rays. The rays or spines not elongate. Type of genus is *Macgregorella moroana* Seale from Jolo, No. 3575 in fish collection of Bureau of Science.

Macgregorella moroana. Seale, sp. nov.

Head 3.60; depth 5.50; dorsal VI, 11; anal 9; scales about 46, 16 in vertical series; eye 5 in head; snout 3; interorbital, a mere ridge about equal to pupil; maxillary 3.20, its tip not reaching to margin of eye; mandible 2.50; head and nuchal region without scales. The head is curiously marked by numerous membranes with fringed margins, the three large vertical ones on the cheeks being somewhat pocket-like. There are about twelve of these membraneous cross-ridges between the tip and the angle of the preopercle, with two wide longitudinal membranes on the median line of lower jaw, preorbital and snout each with two or more membranous ridges, longitudinal as well as vertical membranous ridges on cheeks. Lips with folds, mouth small, bands of small teeth in each jaw, the outer series in upper jaw slightly enlarged, no decidedly

[9] Named for Richard Crittenden McGregor in recognition of his noteworthy work in Philippine zoölogy.

enlarged canines; the orbital ridges are not prominently developed nor roughened. No filiform rays to pectorals, no barbules. Gill openings confined to sides. The origin of dorsal is midway between tip of snout and seventh dorsal ray, none of the spines elongate, the longest about 1.50 in head, longest dorsal ray 1.40 in head. Caudal acuminate, about one-third longer than head, longest anal ray 1.30 in head, pectorals almost equal to length of head.

Color in life yellowish white, marbled and mottled with brown and grayish. Three irregular-shaped oblique dusky bands backward and downward, one from spinous dorsal, two from soft dorsal; some dusky stripes on sides of head, one from snout to eye, another from eye to upper margin of opercle, another from posterior margin of eye obliquely backward, two others on lower sides of cheeks. Dorsal yellowish with dusky blotch in lower central portion and some other slight shadings of dusky scattered over the fin. Soft dorsal with about three oblique dusky bars, the middle one most distinct, posterior tip of fin dusky. Caudal yellowish gray with three dark bands triangular in shape, the angle pointing backward. Anal yellow with three dusky oblique bars, posterior tip of fin dusky. Ventrals pinkish with slight blotches of dusky. Pectorals yellowish, a dusky irregular bar running out on upper half of fin.

Color in alcohol. Similar to above but with the brown markings showing more distinctly, there being a dusky bar on sides of belly and another at origin of anal. A brown bar across nuchal region, a distinct brown bar obliquely downward and backward from eye, another in front of eye, and three on lower part of cheeks, fins colored as in life.

Type is No. 3575 from Jolo, Jolo Island, P. I. Length, 54 millimeters.

Rhinogobius perpusillus Seale, sp. nov.

Head 3.85; depth 4; dorsal VI, 14; anal 14; scales 56, about 20 in vertical series; eye 3.85; snout 4; interorbital about equal to snout; maxillary 2.75 in head, its tip under anterior margin of pupil; mandible 2.30. Head naked except about 3 rows of scales on upper third of opercle, nuchal region finely scaled. No filamentous pectoral rays.

Body somewhat oblong and compressed, the upper and lower outlines about equally curved, the depth of caudal peduncle 2 in head. The head is rather bluntly pointed, the median width of snout being about equal to its median depth. The mouth is oblique, the lower jaw slightly longer. The tongue is rounded and adnate to floor of mouth. Teeth in upper jaw in two rows those of the outer row enlarged, curved, those of lower jaw in two rows rather large, curved, the outer ones projecting; an enlarged, recurved canine on side of jaw, no teeth on vomer or palatine. Gill openings small, restricted to sides. Body and nuchal region covered with fine scales which are slightly roughened at their margins. Origin of dorsal is midway between tip of snout and base of fourth dorsal ray, its spines not elongate, the longest 2 in head, longest dorsal ray 1.50.

Origin of anal about midway between base of anal rays and angle of preopercle, its rays not elongate. Origin of ventrals much nearer tip of snout than to anal, being directly below the origin of pectorals, their length 1.20. Pectorals about equal to head, caudal slightly rounded, about equal to length of head.

Color in life a distinct whitish with a slight wash of yellow, with 3 very dark brown stripes on each side, the first from between interorbitals to and along base of dorsals, the second from tip of snout to caudal, running along the top of caudal peduncle; the third a wide heavy band from around lower lip across cheek and upper base of pectoral to middle of caudal where it ends in a black spot on the middle of caudal base, on the rays; lower half of body uniform whitish unmarked, dorsal whitish crossed by a dark band on upper third, soft dorsal grayish, darker on posterior half and with dark bar near top of fin. Caudal yellowish with dark brown line extending out on upper and lower margins. Anal yellowish at base, becoming dark on outer half; ventrals yellowish with slight grayish shading. Pectorals yellow.

Color in alcohol is similar to above but is less bright. In two specimens Nos. 1276 and 5106 the side bands are almost obliterated or small, except the wide heavy band from lower jaw, and the black spot on caudal, these specimens also show very indistinct indications of about 5 grayish cross-bands over back, they may be a distinct form.

Type is No. 4022 from Zamboanga, Mindanao. Length, 45 millimeters.

Rhinogobius carpenteri Seale, sp. nov.

Head 3; depth 6; dorsal VI, 9; anal 9; scales about 38, $8\frac{1}{2}$ in vertical series, a few scales directly in front of dorsal, otherwise the entire nuchal region and head naked; eye 5; snout 2.80; interorbital about equal to pupil; maxillary 2.55; mandible 2.10.

The upper and lower outlines are but little curved; the head is bluntly pointed, the depth of caudal peduncle is about 3, its length 1.50 in head, greatest width is at head which is 1.50 in its length, its depth being 2.25. Jaws even, mouth small, tongue almost square at tip. Jaws with several rows of teeth, the outer of which are sharply curved, canine-like. No teeth on vomer or palatines, cheeks fat. Gill openings restricted to sides. Gill rakers short, flat, about 7 on lower limb.

Origin of dorsal posterior to ventral, its longest spine 1.85 in head, the longest dorsal ray 2 in head. Origin of anal nearer to base of caudal than to origin of ventrals, being under the base of fourth dorsal ray, the longest ray 2.50 in head. Ventrals very short and disk-like, length 1.75 in head, their origin much nearer tip of snout than to anal. Caudal rounded, its length 1.30 in head. Pectorals 1.30 in head.

Body covered with small smooth scales with very fine ctenoid edges, no scales on nuchal region or head.

Color in life dull yellow-brown, uniform whitish on under jaw, eyes blue, fins grayish, 2 anterior spines silvery white, rays of anal silvery white, caudal washed with dusky at tip.

Color in alcohol similar but less bright. Numerous specimens. Type is No. 914.

All specimens and type from the Trinidad River, Baguio; elevation, 1,500 meters; Luzon, P. I.

Pleurogobius boulengeri Seale, sp. nov.

Head 3; depth 3.75; dorsal VI, 12; anal 10; scales about 30, 9 in vertical series; eye 3 in head; snout 4.50; interorbital a mere ridge, being less than pupil; maxillary about equal to eye, ending on a line with margin of eye; mandible 1.85 in head; head naked except a few scales on upper edge of opercle and on nuchal region.

Upper outline of body more curved than lower, the greatest depth at origin of dorsal, the greatest width being at opercles where it is 1.35 in head. Head rather blunt, the lower jaw projecting, the mouth being somewhat oblique. Depth of caudal peduncle 2.50 in head.

Head without barbules or cross-lines of cirri on cheeks, median portion of snout, however, somewhat roughened by two prominent lines of mucous pores. Mouth rather large, tongue free, sub-truncate at tip. Teeth in several rows in each jaw, the outer row enlarged, curved, canine-like, but without prominent recurved canine on sides of lower jaw. Gill openings restricted to sides.

Body fully covered with fine smooth scales which cover nuchal region and extend slightly on upper margin of opercles, otherwise head entirely naked.

Origin of dorsal midway between tip of snout and base of fifth dorsal ray, the spines fine, not elongate, their longest 2.25 in head. Longest soft dorsal ray 1.75 in head; caudal rounded 1.25 in head. Origin of anal is midway between end of caudal vertebra and the angle of the preopercle, its longest ray 1.85 in head; origin of ventrals nearer tip of snout than to anal pore, their length 1.10 in head. Pectorals scarcely equal to head.

Color dark brown banded by 12 narrow white, dark-margined vertical bands which completely encircle the body and are of much less width than the interspaces, four of these bands are on the head, the first over the snout just in front of eyes and down to angle of mouth, the second from outer part of nuchal region down through eyes, the third and fourth from nuchal region down sides of head, the fifth from origin of dorsal over base of pectorals, the remainder at regular intervals on body, there being one around the middle of caudal peduncle and another at base of caudal; these last two indistinct. Vertical fins uniform dark grayish, pectorals and ventrals yellowish white.

Type is No. 5505 from Puerto Princesa, Palawan Island, P. I. Length, 35 millimeters.

Named for Doctor Boulenger of the British Museum whose work on Palawan fishes I have found of great assistance.

Gnatholepis davaoensis Seale, sp. nov.

Head 3.75; depth 4.20; dorsal VI, 12; anal 11; scales about 26, in lateral series; cheek and opercle scaled; eye 3.75 in head; snout 3.75; interorbital a mere ridge; maxillary 2.85, ending on a line with anterior margin of eye; mandible 2.

Upper and lower outlines of body about evenly and equally curved, depth of caudal peduncle 2 in head, its length 1.25 in head. Head rather bluntly rounded, the mouth oblique, jaws equal, tongue strongly bilobed, teeth in upper jaw in several series, the outer one being enlarged curved canines. Teeth of lower jaw in two series, the outer one of curved projecting canines, a large recurved canine on each side. No barbules, margin of preopercle entire. No filamentous pectoral rays. No mucous cirri.

The body and head, except snout and chin, are fully scaled, the scales being large, thin and smooth, three rows on cheeks.

Origin of spinous dorsal, midway between tip of snout and base of fifth dorsal ray, the longest spine 1.30 in head, about equal to longest ray. Caudal rounded, a fourth longer than head. Origin of anal is midway between end of caudal vertebra and angle of mouth, being on a line with the second dorsal ray, its longest ray equal to head. Ventrals very long, equal to caudal, their tips reaching to anal, their origin much nearer tip of snout than to anal, being directly below the base of the pectoral. Pectorals equal to head.

Color dull yellowish gray with 6 dusky blotches along sides, three or four distinct black dots at base of caudal, a black band from eye to middle of throat, some scattered black specks over body and indistinct indication of some dusky bars over back. Spinous dorsal grayish with several scattered dusky spots and ten black dots on lower part of fin. Soft dorsal grayish, anterior rays with slight indications of darker cross bars. Caudal grayish with numerous indistinct brownish dots and several larger distinct black spots on lower half of fin. Anal is most peculiarly colored with round black and white spots alternating as on a checker board. Ventral grayish with a black margin, pectorals grayish.

Type is No. 3858 from Samal Island, Gulf of Davao, Mindanao, P. I. Length, 45 millimeters.

This may be identical with the fish called *G. deltoides* by Jordan and Seale in Fishes of Samoa, but their specimens differ decidedly from the type of *G. deltoides* in lacking the characteristic markings which were present in all our 18 specimens from Guam, and in our Philippine specimens also, which are, however, different from the Guam form, therefore we deem it best to give this present species a new name, and it is probable that the Samoan specimens, also represent a new species.

Vaimosa microstomia Seale, sp. nov.

Head 3.80; depth 3.50; dorsal VI, 8; anal 8; scales 27, 8 in vertical series; eye 3.75; snout 5.25; interorbital about one-half diameter of eye; maxillary 2.75 in head, its tip under anterior margin of eye; no filaments on pectorals, nuchal region and opercles fully scaled, cheeks otherwise naked, the cheeks proper being crossed by 2 short lines of mucous pores. No elongate rays or spines.

Upper and lower outlines of body about equally curved, snout is bluntly rounded, heavy, overhanging the mouth; upper jaw slightly projecting. Depth of caudal peduncle 1.50 in head, its length about equal to head. Mouth small. Tongue truncate. Teeth in minute bands in each jaw, no enlarged canines. No teeth on vomer or palatine. No barbules. Gill openings restricted to sides.

Body covered with firm smooth scales which have a slightly roughened margin. Origin of dorsal fin midway between tip of snout and last dorsal ray, the longest dorsal spine about 1.50 in head, there are seven scales in front of dorsal, there are seven rows of scales between origin of spinous dorsal and origin of soft dorsal, longest dorsal ray 1.50 in head. Caudal rounded and considerably longer than head. Origin of anal midway between end of caudal vertebra and the angle of preopercle, its longest ray 1.50 in head, ventrals much nearer tip of snout than to anal, their length equal to head. Pectorals equal to head.

Color yellowish, specked and blotched with brown, some larger dusky blotches along median line, under surface white, about seven indistinct dusky bars over back. A dusky line from eye obliquely downward and backward to in front of preopercular angle. Opercles with a large dusky blotch, spinous dorsal with a large black blotch on its posterior portion, soft dorsal crossed by about six rows of small brown dots. Caudal with eight vertical brown lines. Anal yellowish with an indistinct dusky submarginal area. Ventrals and pectorals yellowish.

This species is especially characterized by the large rounded overhanging snout, the small mouth, and the small spinous dorsal.

Type is No. 827. Length, 45 millimeters. From Malabon, Luzon Island, July, 1909.

Family CALLIONYMIDÆ.

Callionymus inversicoloratus Seale, sp. nov.

Head 3.65 (measured from pore to tip of snout) depth 5.75; width at base of pectorals 4.50; dorsal IV, 8; anal 7; no scales; lateral line distinct running along dorsal surface to slightly above the center of caudal; snout 2.30; interorbital space scarcely equal to pupil; maxillary about equal to orbit; mandible equal to snout; eye 2.40; preopercular spine short and strong with three branches of almost equal size, one dircted backward, one directed outward and forward, one directed inward and upward.

This species has the characteristic shape of the callionymids, the depth of the caudal peduncle is less than eye, the snout is depressed and pointed, the interorbital space a mere ridge, not concave. The preorbital bones expecially prominent. The mouth is large, the upper jaw rather heavy. Bands of small sharp teeth in jaws, none on vomer or palatine. Nuchal region with four bony asperites one in middle and back of interorbital space, one on each side of nuchal region and a small one in a median line behind these two. Gill openings confined to a pore on distal surface. Origin of dorsal midway between tip of snout and base of sixth dorsal ray, the spines not elongate, the longest 1.75 in head, the membranous portion somewhat quadrangular, longest dorsal ray 1.14 in head, the anterior and the posterior rays being longer than the others. Anal rounded, its length 2 in body. Origin of anal midway between tip of snout and base of caudal rays, its posterior ray the longest, being about equal to head, the first ray is directly on a line with second ray of soft dorsal, ventrals in front of pectorals, without free rays, their length greater than head. Pectorals scarcely equal to head.

The peculiar thing about this species is that the color pattern is inverted from the usual order; the back being uniformly grayish without markings while the entire ventral surface below the median line of sides is beautifully variegated and covered with brown spots with white ray-like markings, these white markings uniting into more or less distinct network, top of head plain gray, sides of head with blue lines and dots with some brownish blotches, a black spot at base of opercular spine and with a narrow dusky line extending from this spot to angle of jaws. Dorsal fins plain grayish, caudal white with three rows of vertical black dots and with the two lower rays dusky. Anal white at base, dusky on its outer half, some narrow blackish marks on center. Ventrals grayish with some dusky and some bluish specks. Pectorals whitish with several rows of smaller inconspicuous brown dots, about three brown spots on base of fin.

Type is No. 3748, from Samal Island, Gulf of Davao, Mindanao, P. I. Length, 60 millimeters. Ten cotypes.

Calliurichthys neptunia Seale, sp. nov.

Head 4.75 (measured from tip of snout to pore of gill openings); depth 11.75; dorsal IV, 9; anal 8; no scales; lateral line distinct and on the dorsal surface, extending out on caudal posteriorly; eye 3 in head; snout 2.30; interorbital less than pupil; a strong straight spine at angle of opercle, six short teeth on its anterior surface and a short spine directed forward at its base, caudal extremely elongate, about one and a half times longer than body without caudal; maxillary 2.75 ending on a line with anterior orbital ridge; mandible 2.55 in head.

Body rather flat, depressed and triangular shaped anteriorly in its lateral outline, cylindrical posteriorly; snout depressed. Interorbital space a mere ridge. Depth of caudal peduncle 4 in head. Snout flat, its median depth about one-half its width. Jaws equal, the upper jaw protractile. Bands of short sharp teeth on each jaw, those in anterior of lower jaw largest, projecting, brush-like. Preopercle armed with spine described above, opercle unarmed. Gill opening confined to a small pore on dorsal surface just exterior to origin of lateral line. A roughened plate with ten tubercles on top of head posterior to eyes. Outline of spinous dorsal almost square, the 1st to 3rd rays elongate filiform, longer than the webbed portion, the longest dorsal ray is almost 2 in length of fish without caudal, the origin of spinous dorsal is midway between tip of snout and 3rd dorsal ray. Posterior ray of soft dorsal the longest 1.1 in head. Caudal lanceolate and elongate, the two median rays extremely filiform. Origin of anal slightly nearer tip of under jaw than to base of caudal, its anterior ray being on a line with second ray of dorsal, its longest ray equal to head. Ventrals jugular, their base connected by membrane with base of pectorals, their longest ray 3.50 in body without caudal. Pectorals about equal to head.

Color in alcohol brownish above with numerous black specks and line-like blotches, mingled posteriorly with small bluish white markings, uniform yellowish white below the middle of side, belly bluish white. A dark brown mark extending the length of throat becoming cross-shaped on the thorax. Branchiostegal membranes with numerous fine white longitudinal wave-like lines. A dusky bar vertically downward from eyes. Spinous dorsal dusky, somewhat lighter on its upper and lower borders. Soft dorsal white with numerous fine black broken lines and dots. Anal white at base, outer half black, bordered by a fine white line. Caudal with alternating white and black areas or bars. Ventrals grayish mottled with fine dots and lines. Pectorals with fine brownish specks, outer third of lower rays white.

Type is No. 2317 from Balayan Bay, Luzon, P. I., 20 January, 1908. Length, 190 millimeters, and cotype from same locality, length, 160 millimeters.

This species is quite different from *C. longicaudalis* with which I have compared it.

Synchiropus zamboangana Seale, sp. nov.

Head 3.70; depth 5.20; dorsal IV, 8; anal 7; body and head without scales, a single well-developed lateral line; eye 4 in head; snout 3; interorbital about equal to pupil; maxillary slightly less than eye, its tip scarcely reaching a line with eye; mandible 2.75 in head; preopercle with a single strong spine directed backward with two small spines on its interior side and two slightly larger spines directed forward on its outer side, the tip of the large spine ends in a line with the gill openings. Villiform teeth in jaws, none on vomer or palatine.

Body cylindrical, snout depressed and pointed, width of head almost a third greater than its depth; depth of caudal peduncle equal to snout.

A roughened asperite on nuchal region behind each eye, the space between these smooth, slightly concave. Interorbital space strongly concave, profile of snout concave, anterior ocular ridge especially prominent. Gill openings confined to a small pore on dorsal surface.

Origin of dorsal is midway between tip of snout and base of second dorsal ray, the anterior spine prolonged, the first 2.14 in length of fish without caudal, the remaining spines are graduate, the last being 2 in head, the origin of the soft dorsal is the width of the eye posterior to last dorsal spine, its longest ray equal to head and longer than its posterior ray. Caudal rounded, its length a third greater than head. Origin of anal midway between base of caudal and angle of ventrals, being below the third dorsal ray, its posterior ray is the longest 1.30 in head, differing in this respect from the shape of the soft dorsal, ventrals are in front of pectorals, a single detached anterior ray which is slightly less than length of head, length of ventrals 2.25 in fish without caudal; pectorals scarcely equal to head.

Color in life brown, marbled and mottled with drab and pale blue. Spinous dorsal brown on lower half, black on upper half, six large yellow spots in the membrane, four between the second and third spines, two between third and fourth spines. Soft dorsal mottled with yellow and brown, its distal third black. Caudal yellow, broadly margined with brown, a submarginal row of brown spots and two additional rows of brown spots on 4 upper rays near base and middle of fins respectively. Anal yellowish at base, dusky on outer two-thirds, about three longitudinal rows of bright blue dots extending the length of fin. Pectorals yellowish brown, with darker markings, ventrals yellowish brown, darker on outer third, the lower ray with about four brown bands and tipped with yellow.

Color in alcohol similar to above except that about five darker cross-bands show on the back, and the sides have whitish rings and ocelli; belly white; the spinous dorsal seems to have 3 or 4 dusky cross-bars and a dusky spot between the two last spines. The pectorals have about 5 cross-rows of dots, the lower rays uniform yellow, the ventrals are brownish except at base which has four pale brown bars extending into fin. Top of eyes dusky, some dusky markings on cheeks.

Type is No. 4456 from Zamboanga, Mindanao, P. I., 16 June, 1908. Length, 73 millimeters. Cotype No. 3070.

ILLUSTRATIONS.

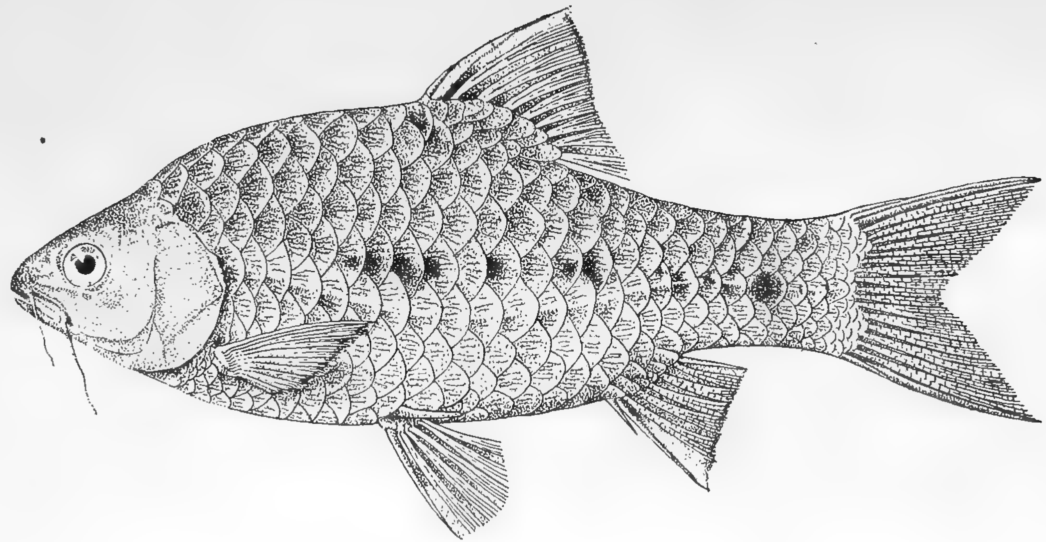


PLATE I. BARBUS IVIS SEALE, SP. NOV.

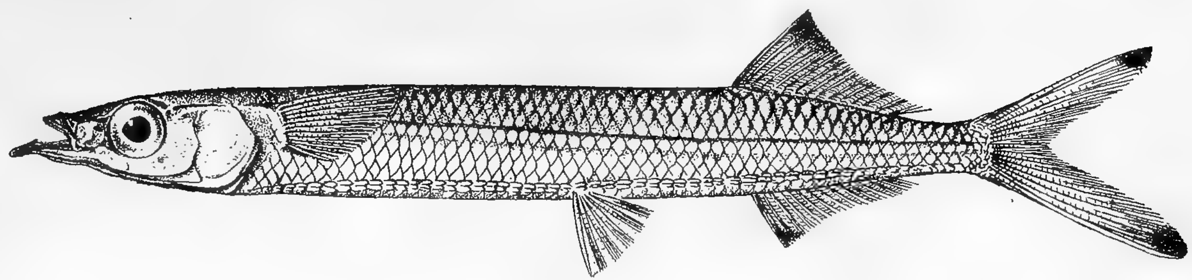


PLATE II. OXYPORHAMPHUS BREVIS SEALE, SP. NOV.

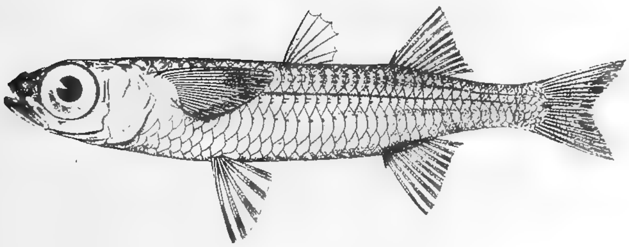


FIG. 1. ATHERINA REGINA SEALE, SP. NOV.

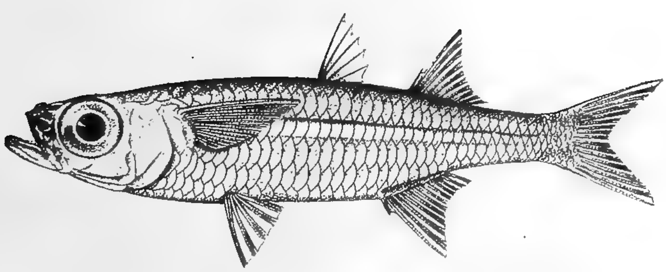


FIG. 2. ATHERINA BALABACENSIS SEALE, SP. NOV.

PLATE III.

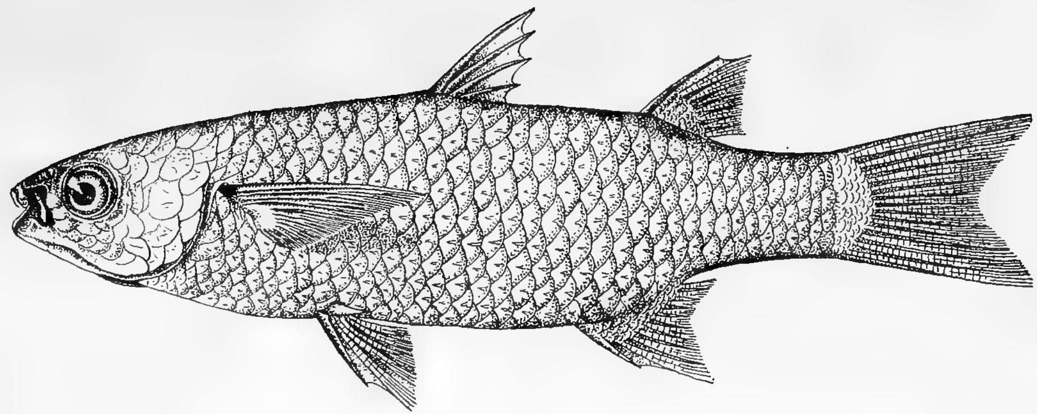


PLATE IV. MUGIL JOLOENSIS SEALE, SP. NOV.

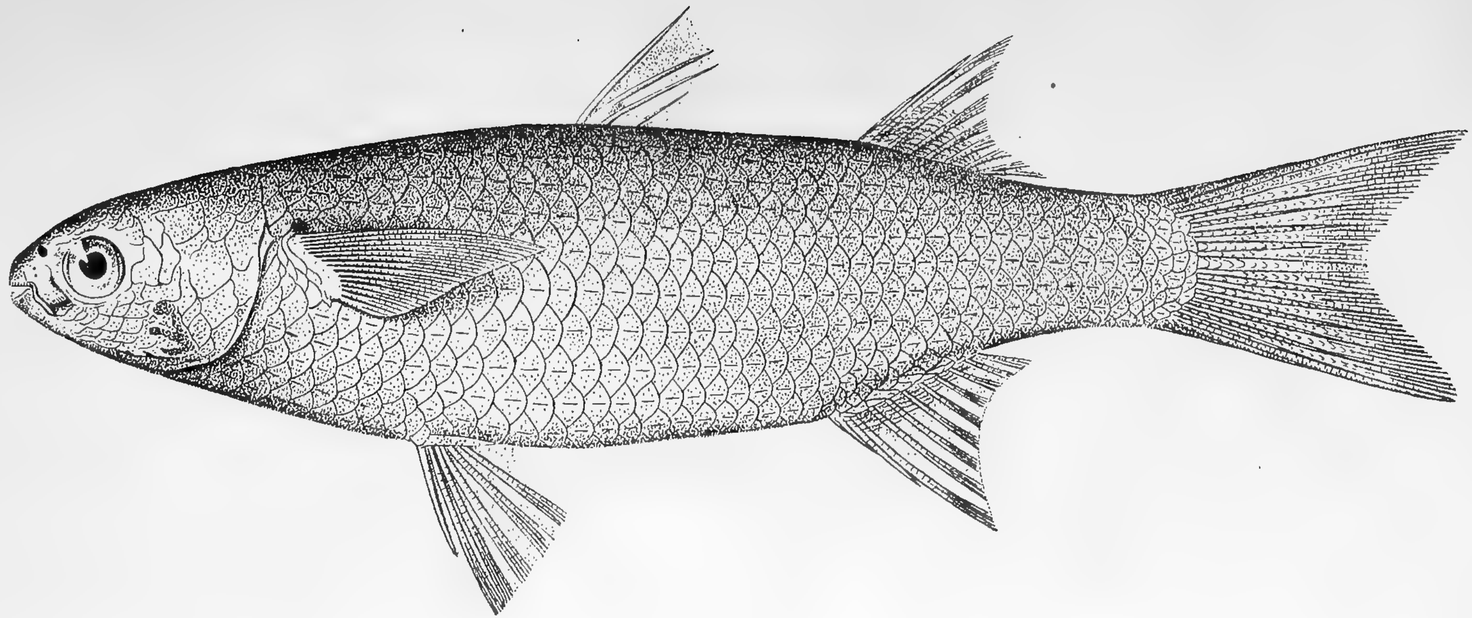


PLATE V. MUGIL BANKSI SEALE, SP. NOV.

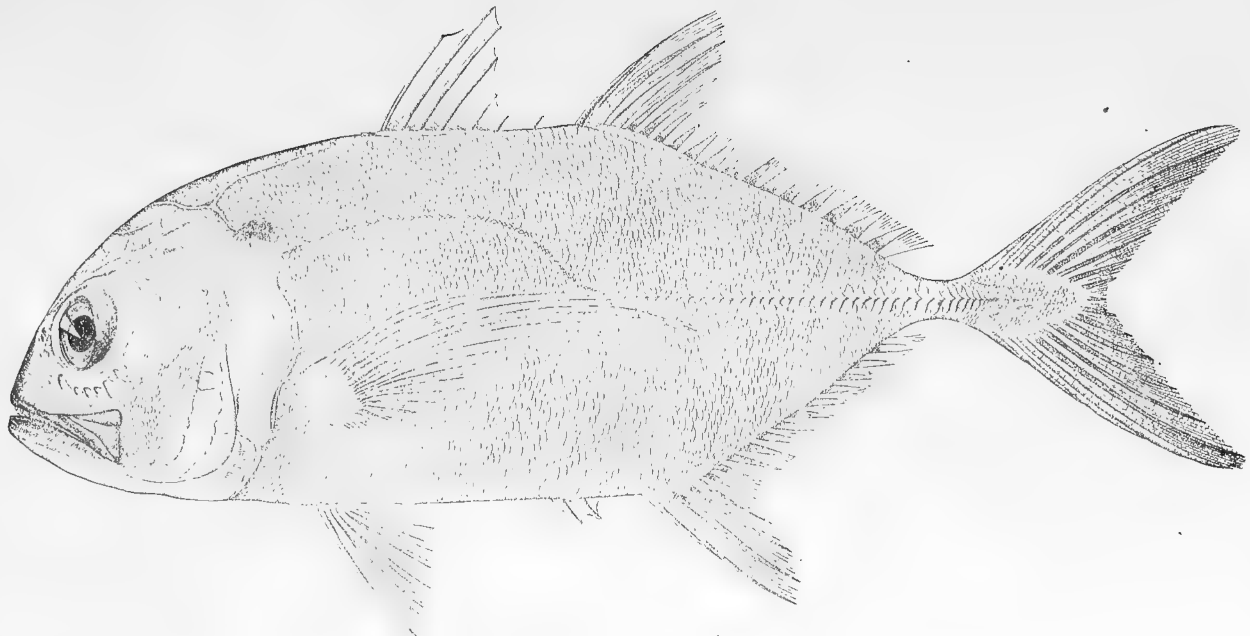


PLATE VI. CARANX AURIGA SEALE, SP. NOV.

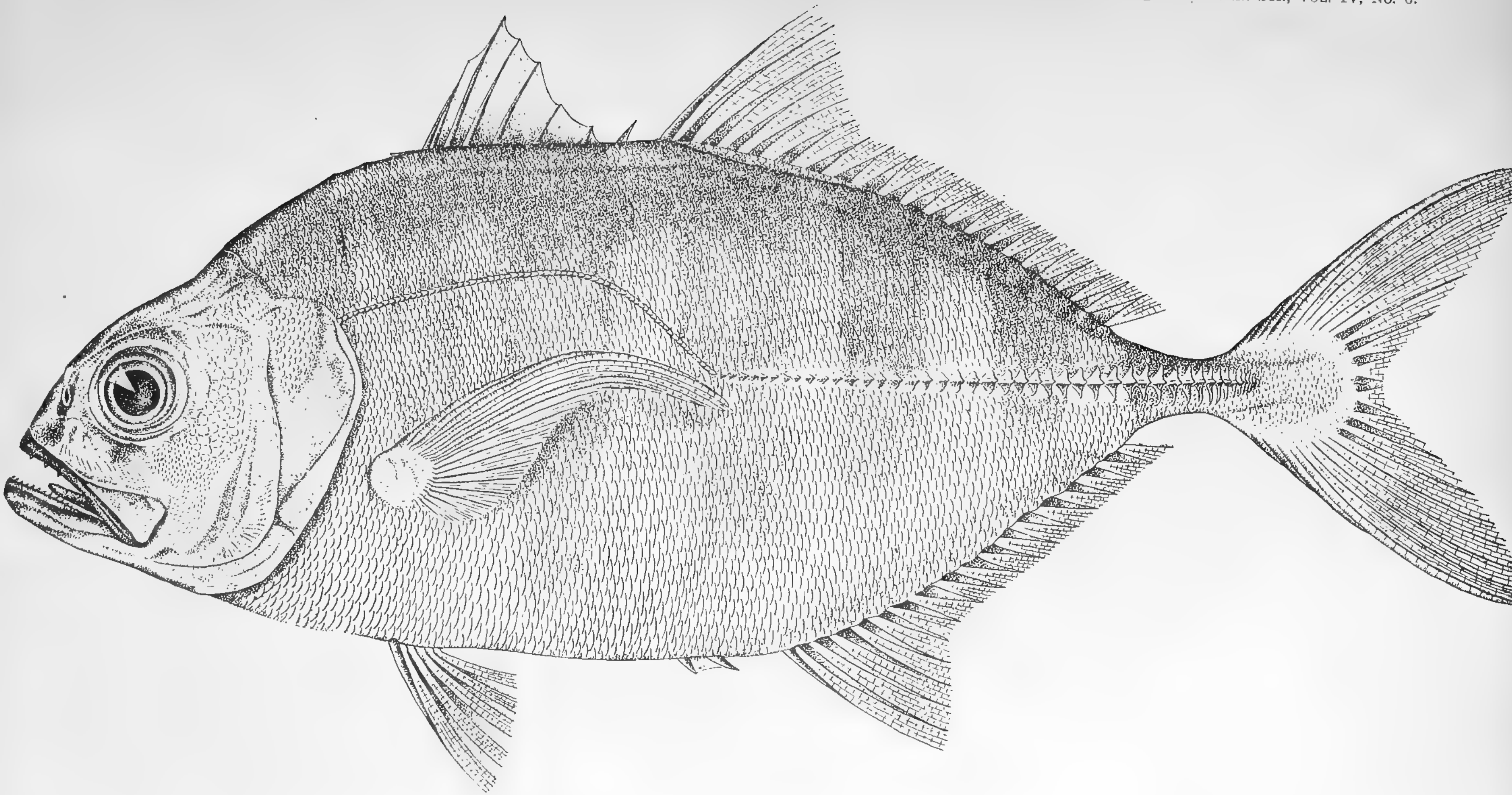


PLATE VII. CARANX BUTUANENSIS SEALE, SP. NOV.

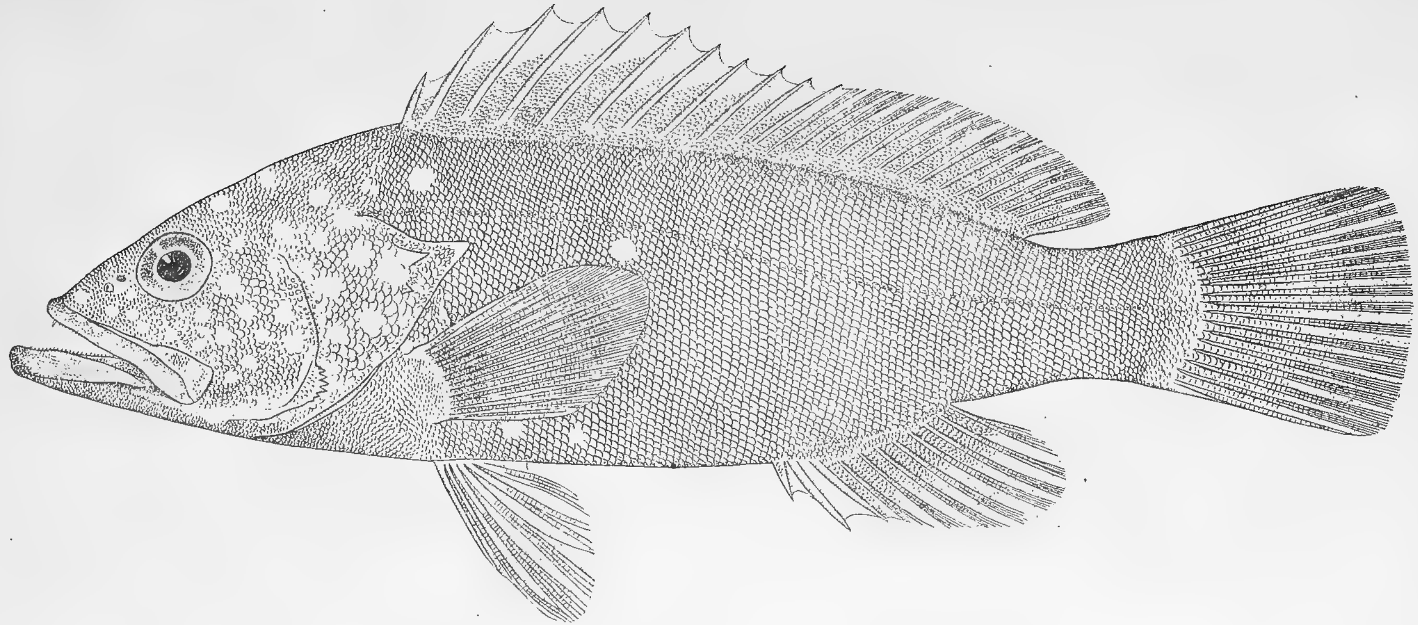


PLATE VIII. EPINEPHELUS ALBIMACULATUS SEALE, SP. NOV.

PLATE IX. DENTEX FILIFORMIS SEALE, SP. NOV.

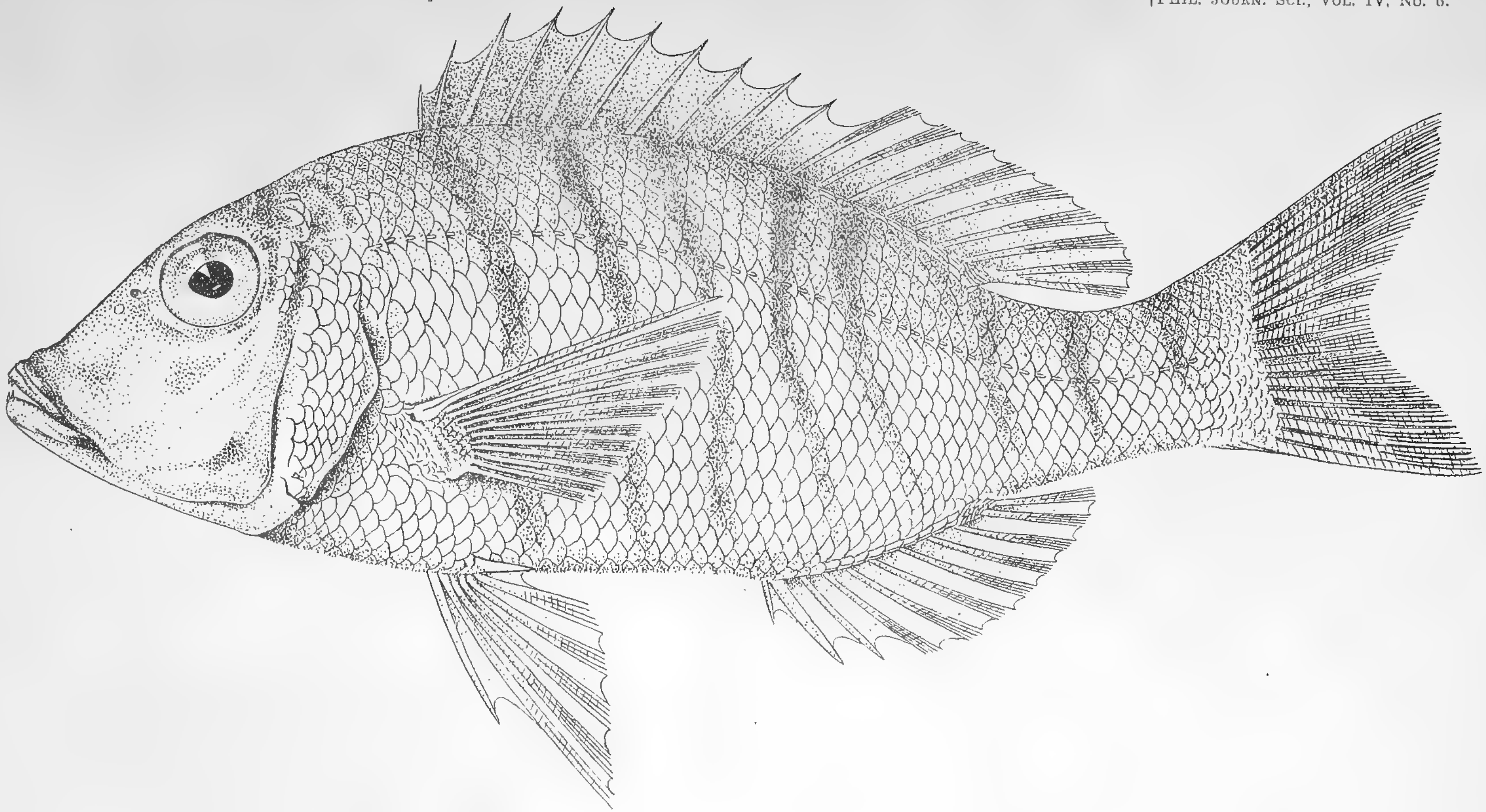


PLATE X. LETHRINUS CUTAMBI SEALE, SP. NOV.

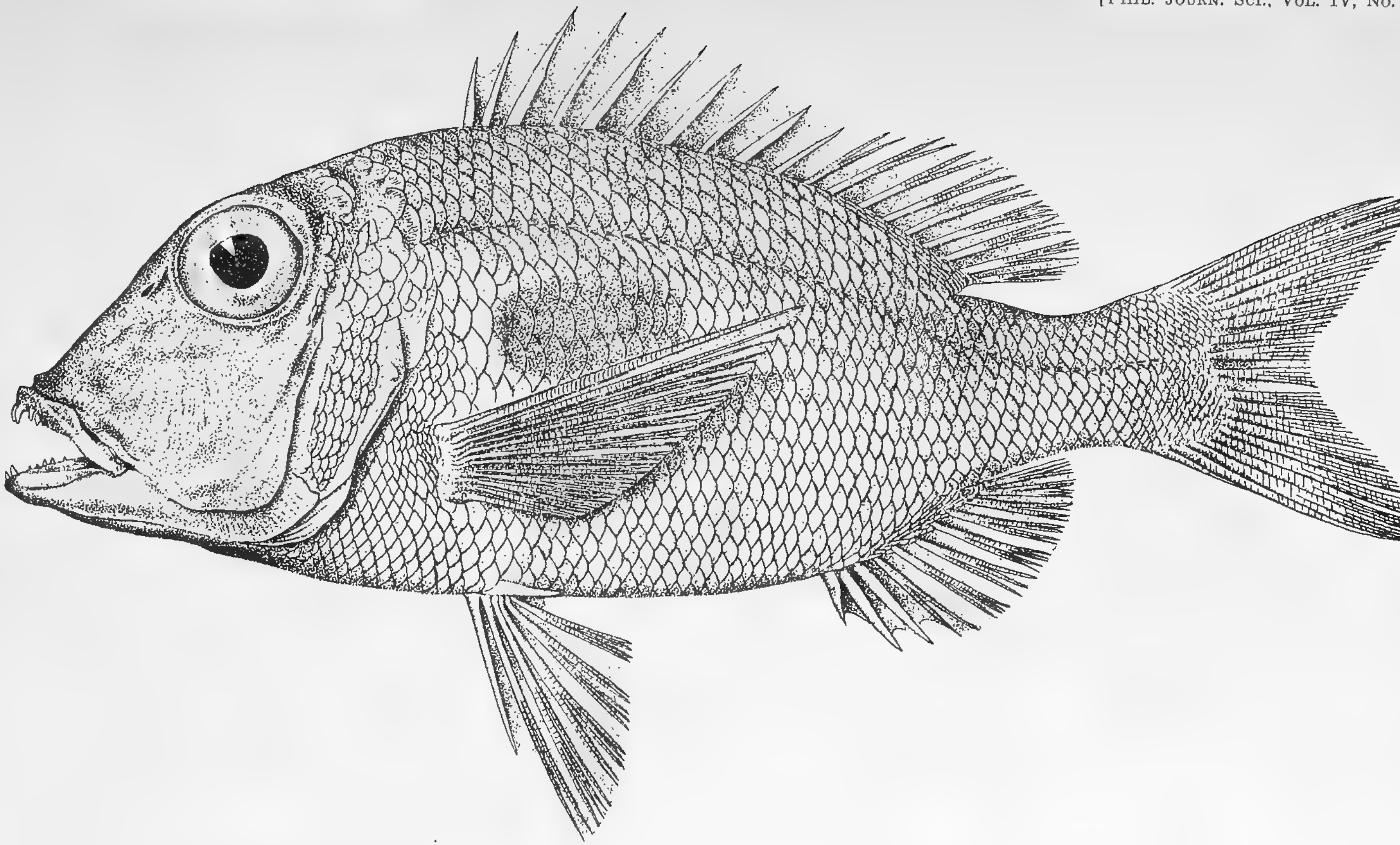


PLATE XI. LETHRINUS ATKINSONI SEALE, SP. NOV.

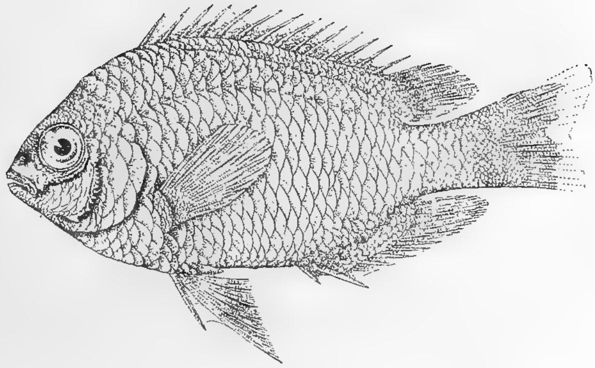


FIG. 1. POMACENTRUS TROPICUS SEALE, SP. NOV.

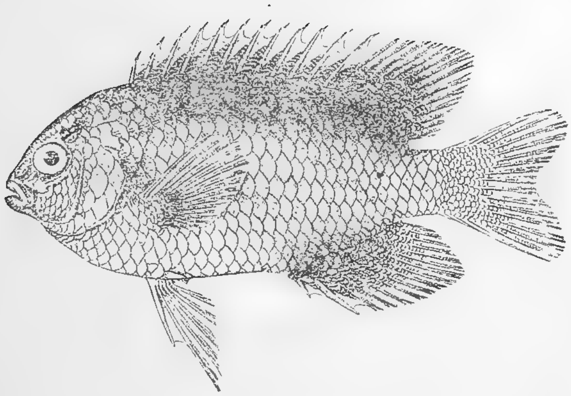


FIG. 2. POMACENTRUS ELONGATUS SEALE, SP. NO

PLATE XII.

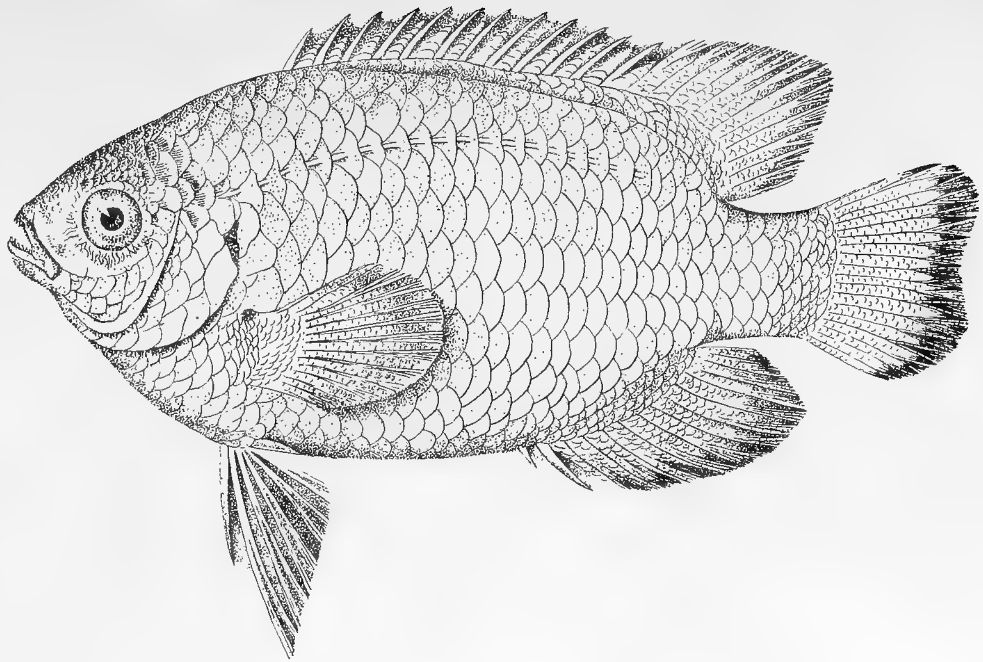


PLATE XIII. ABUDEFDUF CORACINUS SEALE, SP. NOV.

FOUR NEW CULICIDÆ FROM THE PHILIPPINES.

By Charles S. Banks.

(From the Entomological Section, Biological Laboratory, Bureau of Science, Manila, P. I.)

In the course of an investigation of the mosquitoes and other insects of the town of Taytay, Rizal Province, during the present year, I was fortunate in being able to obtain full-grown larvæ and breed out adults of two members of the genus *Culex* which prove to be new to science. These forms are so different from known ones and so distinct in their markings that their identification is comparatively easy. They were both found breeding under similar conditions and I hope in the near future to be able to work out their entire life histories.

During a trip to Benguet in 1907, larvæ were taken from water in the pitcher plant (*Nepenthes alata* Bl.) and from these there were obtained a great many adults of a species which also proves to be new. This species belongs to the genus *Wyeomyia* and is thus the first species of this genus to be reported from the Philippines.

In 1906 Mr. R. C. McGregor, of the Bureau of Science, during a trip to the Island of Basilan south of Mindanao, collected a considerable amount of very interesting Culicid material among which is a new species of the genus *Kertészia;* the first record of this genus in the Islands. The two specimens taken by Mr. McGregor are both males and are in perfect condition.

Culex taytayensis, sp. nov.

♀, length 3.5–4 millimeters, length of wing 2.5 millimeters, length of proboscis 1.5 millimeters. Pale brown, head pale grey, abdomen lighter than thorax; legs pale grey-brown; pleuræ with alternate horizontal areas of brown and white.

Head with pale grey narrow scales on occiput and sides, interspersed on occiput with dark, upright, forked scales; eyes red-brown; antennæ, including cilia, dark brown; proboscis unbanded, pale brown, apex darker; palpi less than one-eighth length of proboscis, dark brown, inconspicuous.

Prothoracic lobes brown, with numerous curved setæ; mesonotum with uniform, pale brown, narrow scales interspersed with grey on anterior and posterior areas; scutellum with white or silver-grey scales on median and pale brown or golden scales on lateral lobes; scutellar setæ long, brown. Metanotum pale brown with four rows of dark brown setæ, those laterad being dense and long; meso- and metapleuræ pale, with a dark brown, horizontal, interrupted fascia extending from the prothoracic lobes to posterior margin of metapleura, ventrad to which is a horizontal fascia of white scales, followed ventrad by another brown fascia. The brown fasciæ are colorations of the integument, the white one is caused by scales.

Halteres pale, dark-tipped.

Abdomen paler than thorax, uniformly colored and with apical golden cilia on each segment.

Femora very pale grey-brown basally, darker apically, as are tibiæ and tarsi; wings with short oval and long narrow scales on costa, subcosta and first longitudinal vein; the second to sixth longitudinal veins with long, oval, median and long, narrow, lateral scales, all pale brown except those on subcosta which are grey; second posterior cell two-thirds length of first submarginal; its stem one-half longer than that of the latter. Supernumerary and mid cross veins touching at their extremities and forming an obtuse angle (140°). Posterior cross vein double its length from mid cross vein. Fringe scales uniformly pale brown.

♂, length 3.5–4 millimeters, length of wing 2.5 millimeters, length of proboscis 1.5 millimeters; differs from ♀ in having the pleural fasciæ more sharply defined; in having white scales on the occiput with few interspersed, erect, forked scales, and in having the abdominal segments clothed laterally and ventrally with dense, long hairs standing at right angles to the body axis. The extreme apex of the proboscis is pale; palpi 1½ times length of proboscis; two apical segments recurved and clothed with dense lateral hairs of the same color as those on antennæ which are concolorous with mesonotum.

Ungues of fore and mid tarsi long, curved, unequal, the larger being unidentate before the middle.

Wings similar to those of ♀ except that there are practically no lateral scales on the veins save at the extremities of the first and second longitudinal and the forks of veins II and IV. All other veins have median scales only.

RIZAL, Taytay, P. I., (*Banks,* collector.)

Bred from water of esteros. Eggs hatched 14 May 1909, adults emerged 24 May 1909.

Type of ♂ and ♀ No. 11459 in Entomological Collection, Bureau of Science, Manila, P. I.

This species resembles *C. fatigans* Wied., only in the color of the mesonotum and the general appearance of the legs. It has not the abdominal banding of *fatigans,* nor does *fatigans* have the pleural fasciae as in *taytayensis.*

Culex argentinotus, sp. nov.

♀, length 4.5 millimeters, length of wing 3.5 millimeters, length of proboscis 2 millimeters, general color of mesonotum red-brown, of abdomen dark brown, scutellum entirely covered with silver-white scales giving the appearance of a transverse silver line.

Head with dark grey scales above, flat, pale ocher scales beneath; very long, upright, dark, forked scales over entire occiput; three long, incurving bristles on each side of front over eyes which are nearly black. Antennæ pale brown, first segment ocher; segmental bristles dark brown proximad to white distad. Palpi pale brown, one-sixth the length of proboscis which is also pale brown, except apical sixth which is darker brown.

Prothoracic lobes pale brown with narrow, golden scales; mesonotum with fine, red-brown and golden scales; pleuræ pale; dorsal areas of epimera and episterna with small patches of white scales; golden recurved scales ventrad to base of wing. Scutellum clothed with silver-white scales which form a complete transverse band, and numerous very long, brown bristles from posterior margin.

Abdominal segments dark brown apically, paler basally with white hairs on posterior margins of all except first which is clothed with erect, white hairs among flat scales; ventral surface pale ocher.

Halteres very pale, stem and knob concolorous.

Femora externally dark brown, internally nearly white, paler basally than apically, extreme apices with silver scales which overlap the articulation; tibiæ with dark brown scales, as also all tarsi.

Ungues of fore and mid tarsi equal and with large basal teeth; those of posterior tarsi small, equal and simple.

Wings sparsely clad toward apex with short median and very long, narrow lateral scales noticeable especially on veins II, III, IV and V; supernumerary and mid cross veins in nearly same line; posterior cross vein removed by $1\frac{1}{2}$ times its own length. Lateral fringed scales increasing noticeably in length from vein VI to base of wings.

♂, length 4.5 millimeters, length of wing 3 millimeters, length of proboscis 1.75 millimeters; similar to ♀ in color and markings, including the scutellar silver band. Palpi slightly longer than proboscis, seal brown, recurved as in *C. microannulatus* Theob.; articulations not pale. The occiput clothed with flat, pale ocher scales, dark grey at the nape. Upright, forked scales as in ♀. The seventh abdominal segment in the type specimen is apparently strongly lobed caudolaterally, and the genitalia are different from those of any of the Culicidæ heretofore observed by me. The harpes are unlike those of any species that I have examined previously. The eighth segment is truncately obconical.

The wing veins are almost destitute of long, narrow lateral scales, these being present only near apex of vein III and anterior fork of IV. The distal half of vein VI is nude.

Ungues of fore tarsi unequal, the larger having a long, acute, curved tooth, the smaller a very short, obtuse dentation; mid ungues unequal, the larger nearly as long as last tarsal segment and having a long curved tooth, the smaller similar to that of fore tarsi.

RIZAL, Taytay, P. I., (*Banks*, collector.) Taken at Pinagsalaan well, 13–16 May 1909.

Type of ♂ and ♀ No. 11460 in Entomological Collection, Bureau of Science, Manila, P. I.

This peculiar mosquito merits anatomical study. Its general characters are those of *Culex*. The silver marking and wing squamation suggest *Uranotænia*, while the genitalia appear to be unique. I am at present working on the anatomy of Culicid genitalia and shall leave further discussion of this species until more careful study has been made.

Kertészia, mcgregori, sp. nov.

♂, length 6 millimeters; length of wing 3.75 millimeters; length of proboscis 2.5 millimeters; general color ocher and grey; antennæ golden at tips, brown at bases, legs mottled yellow and brown; wings with brown scales and six white spots on costal vein; cilia all white, except at apex of wing where there is a tinge of yellow. Hind legs with last three joints of tarsi and apex of preceding, pure white.

Head clothed with narrow, cream-colored, appressed scales interpersed with erect, cream-colored forked scales over the entire occiput and front, except a narrow line around and between the eyes; two dark brown bristles project cephalad between eyes and a pair curves over each eye dorsolaterally. Eyes bronze. Antennæ longer than palpi by length of last antennal segment; clothed with brown hairs basally and golden ones apically. First to sixth antennal segments with white scales on their inner sides; apical and penultimate segments with fine golden hairs and a small whorl of bristles at the bases of the former. Clypeus bare, brown; palpi five-sevenths length of proboscis; clothed with brown scales except: base and apex of each segment narrowly, and apical half of apical segment somewhat broadly, white-scaled; a tuft of three brown bristle springs from the points on the apical segment where the white apical scaling ends. Proboscis darkly brown-scaled with a broad band of white near the apex and another narrow one at the middle. Apical segment of proboscis light brown.

Squamation of prothoracic lobes similar in form and color to that of occiput.

Mesonotum clothed with narrow, curved, cream-colored scales dorsolaterally, irregularly placed and sparse. The disc with three distinct longitudinal areas of brown and golden scales, the spaces between being completely bare and brown. The brown and golden scales form a pattern as follows: a brown patch on the median longitudinal area at the middle of the disc, two brown patches on each of the submedian areas, one before and the other behind the middle, thus forming the corners of a rectangle with a brown spot in its center.

These longitudinal areas have in addition many very long, brown bristles. The submedian areas terminate posteriorly in a tuft of white, curved, spindle-shaped scales, which extend over upon the scutellum; the latter is clothed with three palmate tufts of cream-colored scales from which spring brown bristles which are nearly $1\frac{1}{3}$ the length of the mesonotum; metanotum bare, brown. The bases of the wings are ochraceous and there appear to be well-developed tegulæ. The anterior three veins including costa all darkly brown-scaled, the remainder of the wing very much lighter. The following white spots appear: on the costa six, the first two approximate and sub-basal, the third at first third of costa, the fourth just beyond middle, the fifth halfway from fourth to apex and the sixth just before apex. Spots 3, 4, 5, and 6 appear also on the subcosta and the first longitudinal. A spot appears on subcosta and first longitudinal between spots 3 and 4 of the costa while another smaller spot appears near the bases of veins I and V. The upper fork of vein V has a white spot after the juncture of the posterior cross vein. First submarginal only a little more than half as wide as second posterior, but is slightly longer and its base is more remote from base of wing. There are white scales at the bases of the petioles of the first submarginal and second posterior cells as also at the bases of these cells and the point on vein III where it joins the supernumerary and mid cross veins. The apices of the forks of the first submarginal cell are white, these spots being continuous with the sixth costal spot. The cilia are white except apically where they are tinged with yellow.

Halteres pale.

Basal abdominal segments light brown dorsally, middle and apical dark brown or nearly black, all having apical margins of cream-colored scales, which broaden laterally. There are two submedian discal white spots dorsally on segments 6 and 7, and faint remains of similar spots on 5. The apical half of the abdomen is more or less golden pubescent. Legs generally mottled; all femora and tibiae brown and gold mottled; all tibiae apically tipped with cream-colored scales; fore first tarsi[1] dark, cream tipped; mid first tarsi, pale ochraceous, pale tipped at base and apex as are their other tarsi and those of fore feet. Apex of posterior second tarsal segment and all of remaining tarsi nearly pure white. Ungues of fore and mid tarsi unequal and having upon the larger a single tooth which is one-fourth of its length. The smaller unguis is

[1] Formerly improperly called metatarsi.

two-thirds the length of the larger on fore and mid tarsi; the ungues of the posterior tarsi simple and of about the length of the tooth on the unguis of the fore tarsi.

♀, unknown.

Basilan Island, P. I. (*R. C. McGregor*, collector.)

Time of capture, 28 December 1906.

Type of ♂ No. 6666 in Entomological Collection, Bureau of Science, Manila, P. I.

This species is dedicated to the collector.

Wyeomyia nepenthicola, sp. nov.

♂, length 4.5 millimeters, length of wing 3.25 millimeters, length of proboscis 2.5 millimeters. Very dark grey dorsally, silvery white ventrally, legs, antennæ and proboscis black or nearly so.

Head clothed with blue-black, appressed scales; underside and cheeks white-scaled; vertex somewhat lighter, a few erect forked scales on occipital margin. Eyes black, margined with a row of white scales; a white line on vertex between eyes. Antennal segments black, with black whorls and whitish bases; first segment subglobose, pale above; last two segments fuscous; base of proboscis pale, especially beneath nearly white; remainder blue-black; tip curved slightly downward. Palpi black, very short, one-ninth length of proboscis; three-jointed, the first joint very small, subglobular, the second joint 4¼ times as long, the third joint one-half the length of the first, small, conical. Clypeus bare, brown with very slight dark line around margin. A small tuft of bristles projects beneath base of proboscis.

Prothoracic lobes black, shining, with slight grey pruinescence and a few hairs. Mesonotum with blue-black, narrow scales and a slight pruinescence; anterior angles with an area of bluish-white scales sharply defined. A few fuscous hairs at base of wings, together with a row of bristles laterad, extending halfway to anterior margin. Pleuræ with irregular patches of bluish-white scales defined by limits of sclerites. Scutellum clad with flat scales and numerous bristles on each lobe. Metanotum brown, a tuft of four bristles near posterior margin.

Halteres cream-colored with white knobs.

First abdominal segment brown-scaled dorsally, with golden bristles laterally; second to seventh segments uniformly black-scaled with pale brown apical hairs, eighth segment and genitalia brown. A dorsal view shows at either side a very narrow strip of white which represents the white scales on the lateral margins of each tergite. Ventrum of abdomen pure white, except eighth segment which is brown as on dorsum.

Wings hyaline; costa, subcosta and vein I heavily black-scaled; supernumerary, mid cross vein and posterior cross vein are all in the same line; forks of veins II and IV of nearly the same length, the first submarginal being very slightly longer and narrower than the second posterior; vein VI strongly curved outward at apex; forks clothed with long, slender hair-like scales as on veins III and V apically; stems of forked veins with no diverging scales; all fringe scales light seal-brown.

Legs black; femora pale ochraceous at bases, black at apices; mid and posterior femora white beneath; tibiæ and tarsi of all legs black, or dark seal-brown according to reflections. Ungues of fore legs unequal, the longer twice the length of the shorter and with a single tooth. Mid ungues unequal, the longer simple; posterior ungues equal, small and simple.

♀, length 4.5 millimeters, length of wing 3.25 millimeters, length of proboscis 2.5 millimeters, seal-brown, blue-black in certain lights; thorax blue-grey.

Legs dark brown or black according to angle of reflection. All markings exactly as in ♂, except that the tip of the proboscis is brown. The abdomen is widest at the 5th segment and tapers to posterior end while in the ♂ the sides are parallel. Palpi similar to those of the ♂. Antennæ sparsely clad with long hairs and rather thickly with very short ones.. The posterior cross vein is removed by its own length from mid cross vein.

BENGUET, Trinidad, P. I. (*Banks*, collector).

Collected as larva in pitchers of *Nepenthes alata* Bl., 30 December 1907.

Type of ♂ and ♀ No. 8159 in Entomological Collection, Bureau of Science, Manila, P. I.

RHYNCHOTA PALAWANICA, PART I: HETEROPTERA.

By Charles S. Banks.

(*From the Entomological Section, Biological Laboratory, Bureau of Science, Manila, P. I.*)

The geographical position of the Island of Palawan (Lat. 8° 25′ to 11° 30′ N., Long. 117° to 119° 45′ E.) is such that it forms a natural link between the southwestern part of Luzon and the northern extremity of west Borneo. At no place is there a stretch of water between these two islands or their outlying islands of more than 75 kilometers. However, the fauna of Palawan has been considered in the past to be much more isolated from that of the remainder of the Philippines than from that of Borneo; at the same time it has certain elements peculiar to itself. The same feature has been found to a limited extent, as far as collecting has been done, botanically.

Semper, in his "Schmetterlinge der Philippinen",[1] and Staudinger, in "Lepidoptera von Palawan," describe many species as occurring only in Palawan, which have since been found in other parts of the Philippines. There are likewise many species which have been recorded from Palawan, the remainder of the Philippines and Borneo.

On the 10 April 1909, Mr. W. Schultze of this laboratory collected on the Island of Cuyo a single specimen of *Euchromia horsfieldi* Moore [2] (Lepidoptera), originally from Java and further reported from Bali, Sumbawa and Borneo. As the Island of Cuyo lies 150 kilometers east of Palawan, it is probable that this species reached Cuyo by way of Palawan.

In examining two collections of Rhynchota from this island, made by C. M. Weber during the period from January 1908, to April 1909, and by W. Schultze during the period from 27 February to 8 April 1909, so many forms were found which had been collected previously in other parts of the Philippines that a complete list of the determined species may be of value.

There are 85 species recorded in the first part of this article, including

[1] Reisen auf den Philippinen (1886–1902), II, 5 and 6.

[2] *Proc. Zool. Soc. London* (1859), **27**, 200, Pl. LX, fig. 13.

12 which are new and representing 65 genera, one of which is new. There are many species here reported from the Philippines for the first time. Practically all the species taken by Schultze were collected within a distance of 10 kilometers southwest of the capital, Puerta Princesa, while those collected by Weber range from Iwahig to Tara Island north of Palawan Island but belonging to that Province.

In the case of one or two undertermined species, only a single specimen and that one in unsatisfactory condition, was received, so that further material will be necessary before these can be identified and listed. However, sufficient determinable material is at hand to enable me to make a list which will serve for comparison with other regions.

The second part of this paper, Homoptera, will appear in the January, 1910 number of this JOURNAL.

RHYNCHOTA.

HETEROPTERA.

Fam. PENTATOMIDÆ.

Subf. PLATASPIDINÆ.

BRACHYPLATYS Boisduval.

Voy. Astrol. Ent. (1835), 2, 627.
Type: *B. vanikorensis* Boisd.

1. BRACHYPLATYS DEPLANATUS Esch.
 Scutellera deplanata Esch., *Dorp. Abh.* (1822) 1, 158.
 Thyreocoris complanatus Burm, *Nov. Act. Ac. Leop.* (1843), 16, suppl. 1, 289, Pl. 41, fig. 3.
 ——————— Germ., *Ztschr.* (1839), 1, pt. 1, 32.
 ——— deplanatus Germ., *tom. cit.* p. 33.
 — ——— ——— Herr-Schäff., *Wanz. Ins.* (1839), 5, 14 and 31.
 Plataspis scipio White, *Gray's Zool. Misc.* (1842), 80.
 Brachyplatys complanata Dall., *List. Hem.* (1851), 1, 70.
 ——————— Stål, *Ö. V. A. F.* (1870), 611.
 ——— deplanatus Stål, *Enum. Hem.* (1876), 5, 7.

PALAWAN, Tara Island, P. I., (11709 *C. M. Weber*), 4 specimens.

2. BRACHYPLATYS VAHLII Fabr.
 Cimex vahlii Fabr., *Mant. Ins.* (1787), 2, 283.
 ——— Coq., *Illustr.* (1801), 2, 79, pl. 18, fig. 14.
 Tetyra ——— Fabr., *Syst. Rhyng.* (1803), 142.
 Thyreocoris vahlii var., Germ., *Ztschr.* (1839), 1, 33.
 Plataspis ——— Amy. & Serv., *Hém.* (1843), 64.
 Brachyplatys ——— Stål, *Ö. V. A. F.* (1870), 611.
 — ——— id., *Enum. Hem.* (1876), 5, 7.
 ——— continua et frontalis Walk., *Cat. Het.* (1867), 1, 104 & 106.
 ——— vahlii Dist., *Fauna British Ind., Rhyn.* (1902), 1, 10.

PALAWAN, Tara Island, P. I., (11717 *C. M. Weber*), 1 specimen.

This specimen has the small spots on the pronotum and scutellum, mentioned by Distant and also by Fabricius in his original description.

3. BRACHYPLATYS SILPHOIDES Fabr.

Cimex silphoides Fabr., *Ent. Syst.* (1794), 4, 86.
——————— id., *Syst. Rhyng.* (1803), 141.
Brachyplatys silphoides Stål, *Hem. Fabr.* (1868), 1, 5.
——————— liturifrons Walk., *Cat. Het.* (1867), 1, 102.
——————— silphoides Dist., *Ann. Mag. Nat. Hist.* (1899) (7), 4, 214.
——————— ——————— id., *Fauna British Ind., Rhyn.* (1902), 1, 12.

Distant says:

"The distribution of this species is at present very difficult to trace owing to the various species wrongly identified under its name. It is certainly known from Borneo."

In the specimens from Palawan, there can be not the slightest uncertainty as to identity, as the markings on the head and abdomen correspond exactly with Distant's description. The fact that the species is positively known from Borneo adds another link to the chain of evidence connecting the fauna of this island with that of the Philippines.

PALAWAN, Tara Island; Iwahig, P. I., (11724 and 11926 *C. M. Weber*), 60 specimens, all characteristically marked, except that spots between the eyes in the ♂'s and some of the ♀'s are obsolescent.

4. BRACHYPLATYS sp.

A single specimen from Tara Island in which the anterior half of the head is ochraceous except the outlines to juga and tylus, which are narrowly brown. The pronotum has, in addition to the one on the entire anterior margin, an extra ochraceous line extending around the anterior submarginal area, beginning interiad to posterior angles and broken on the median line. The base of the scutellum is marked interiad with a transverse ochraceous spot, while its posterior margin is broadly ochraceous. I do not feel justified in describing it as new from a single example, but it appears to conform to no description that I have read.

PALAWAN, Tara Island, P. I., (11716 *C. M. Weber*), 1 specimen.

COPTOSOMA Laporte.

Ess. Hem. (1832), 73.
Type: *C. globosus* Fabr.

5. COPTOSOMA CINCTA Eschsch.

Coptosoma cincta Eschsch., *Dorp. Abh.* (1822), 1, 161.
Thyreocoris seminulum Burm., *Nova Acta Acad. Leop.* (1834), 16, Suppl., p. 290, No. 10.
——————— variegatus Herr-Schäff., *Wanz. Ins.* (1839), 4, 83, Tab. 134, fig. 414.
——————— cinctus Germ., *Ztschr.* (1839), 1, 27, 8.
——————— ——————— Herr.-Schäff., *Wanz. Ins.* (1839), 5, 30.
Coptosoma cinctum Dall., *List. Hem.* (1851), 1, 64.
——————— ——————— Stål, *Ö. V. A. F.* (1870), 7, 613.

PALAWAN, Iwahig, P. I., (10902 *W. Schultze*). Seven specimens of this species were taken. It occurs in Negros and in Luzon.

6. COPTOSOMA EROSUM Montand.

Coptosoma erosum Montand., *Ann. Mus. Civ. Gen.* (1894), **34**, 131.
——————— Distant, *Fauna British Ind. Rhyn.* (1902), **1**, 30.

The single specimen agrees with Distant's description in every detail except that the apical margin of its scutellum is light ochraceous instead of "brownish ochraceous and coarsely and darkly punctuate."

PALAWAN, Iwahig, P. I., (10901 *W. Schultze*), 1 specimen.

7. COPTOSOMA sp.

A single specimen was collected. It appears somewhat closely related to *C. nepalense* Westw., but owing to lack of sufficient material I am unable to place it with any degree of certainty.

PALAWAN, Bintuan, P. I., (11698 *C. M. Weber*), 1 specimen.

Subf. SCUTELLERINÆ.

Div. SCUTELLERARIA.

CALLIPHARA Germar.

Ztschr. (1839), **1**, 122.
Type: *C. nobilis* Linn.

8. CALLIPHARA NOBILIS Linn.

Cimex nobilis Linn., *Cent. Ins. Rar.* (1763), 17.
— ——— — id., *Amoen.* (1763), **6**, 400.
——— pustulatus Panz., *Voet. Coll.* (1798), **4**, 111, pl. 47, fig. 11.
Scutellera buquetii Guér., *Voy. Coq., Ins.* (1830), 159, 162.
Callidea nobilis Dall., *List. Hem.* (1851), **1**, 25.
Calliphara buquetii Stål, *Berl. Ent. Ztschr.* (1866), **10**, 153.
——————— id. *Ö. V. A. F.* (1870), 618.
————— nobilis id., *Enum. Hem.* (1873), **3**, 17.
———— ——— Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 53, fig. 23.
——————— (Subg. *Chrysophara*) Schout., *Gen. Ins., Het. Pent.* (1904), fasc. 24, p. 33, pl. 2, fig. 5.

PALAWAN, Mangahan and Iwahig, P. I., (11685 and 11706 *C. M. Weber.*), 3 specimens, the one from Iwahig being of a deep purple-blue.

9. CALLIPHARA EXCELLENS Burm.

Tetyra excellens, Burm., *Nov. Act. Acad. Leop.* (1834), 16, Suppl. 1, 287, pl. 41, fig. 2.
Tectocoris obscura Westw., *Hope Cat.* (1837), **1**, 14.
Callidea nobilis Germ., *Ztschr.* (1839), **1**, 117.
——— excellens Amy. et Serv., *Hém.* (1843), 32.
——— praslinia Dall., *List Hem.* (1851), **1**, 24.
Calliphara excellens Stål, *Berl. Ent. Ztschr.* (1866), **10**, 153.
——————— id. *Ö. V. A. F.* (1870), 618.
——————— *Dist., Ann. Mag. Nat. Hist.* (1889) (7), **4**, 38.
——————— id., *Fauna British Ind., Rhyn.* (1902), **1**, 53.
——————— (Subg. *Chrysophara*) Schout., *Gen. Ins., Het. Pent.* (1904), fasc. 24, p. 32.

This is a somewhat variable species. It is common in most parts of the Philippines.

PALAWAN, Bacuit, P. I. (11649 *C. M. Weber*), 1 specimen.

CHRYSOCORIS Hahn.

Wanz. Ins. (1834), **2**, 38.
Type: *C. dilaticollis* Guér.

10. CHRYSOCORIS GERMARI Esch.

Scutellera germari Esch., *Dorp. Abh.* (1822), **1**, 156, pl. 2, fig. 1.
——— ——— Guér., *Voy. Coq., Zool.* (1830), **2**, 158.
Callidea ——— Burm., *Handb. d. Ent.* (1835), **2**, 394.
——— ——— Herr.-Schäff., *Wanz. Ins.* (1836), **3**, 102, pl. 106, fig. 327.
——— ——— Germ., *Ztschr.* (1839), **1**, 113.
——— ——— Dall., *List. Hem.* (1851), **1**, 27.
——— ——— Voll., *Fauna Ind. Néerl.* (1863), **1**, 36.
Chrysocoris ——— Stål, *Hem. Fabr.* (1868), **1**, 11.
——— ——— id., *Ö. V. A. F.* (1870), 618.
——— ——— id., *Enum. Hem.* (1873), **3**, 20.

Specimens of this insect were identified by me in the British Museum, where I found those with red and those with green on the ventral surface of the abdomen, under the same label. I am not sure but that a careful study of the two forms will reveal specific differences, but for the present I have included specimens with green abdomen, collected in Palawan, under this specific name.

PALAWAN, Bacuit, and Iwahig, P. I., (11648 and 11704 *C. M. Weber*), 4 specimens in all.

COSCOMORIS Stål.

Hem. Afr. (1864), **1**, 34.
Type: *C. sellatus* White.

11. **Cosmocoris distanti** sp. nov.

Broadly ovate, metallic indigo above with longitudinal and transverse brassy-green fasciæ, abdomen beneath ochraceous, basal and apical segments and legs indigo.

Head above and beneath (except at base) indigo, tylus and rectangular space between ocelli black. Eyes brown, ocelli ochraceous; antennæ uniformly dull black, except articulations which are brown, ochraceously pilose; rostrum uniformly brown, glabrous; pronotum indigo, with two submedian, longitudinal, anteriorly claviform, metallic green fasciæ on posterior two-thirds, diverging posteriorly, and a lateral, submarginal fascia of the same general shape but narrower. Posterior lateral angles slightly virescent externad to fascia. Scutellum with basal, callous elevation nearly black medially, obsoletely carinate posterior to callosity, remainder indigo; a sub-basal, transverse, metallic green fascia on each side just posterior to basal callosity; a broad transverse, brassy-green fascia, its anterior margin at middle of scutellum, its width equal to that of basal callosity and its lateral margins not extending to lateral margin of scutellum; a brassy-green, transverse isosceles-triangular spot on subapical area.

Sternum and costal margins of tegmina indigo. Posterior margin of posternum, submedially and of mesosternum sublaterally, dull ochraceous as are coxæ and margins of stethi broadly.

Abdomen ventrally ochraceous, median area of second, third and posterior area of sixth and nearly all of first segment, except lateral extremities, indigo. Parastigmatal area irrorated with metallic brown. Posterior marginal area of genitalia metallic indigo.

Bases of all femora more or less ochraceous, the remainder of leg, including tarsi, indigo, tibiæ densely setose ventrally on apical half, and sulcate dorsally.

♂ exactly as ♀ except that only the basal third of the genitalia is ochraceous.

Length 13–14 millimeters; width of pronotum 7.5–8 millimeters.

PALAWAN, Bacuit, P. I., (*C. M. Weber*, collector).

Types of ♂ and ♀ No. 11652 in Entomological Collection, Bureau of Science, Manila, P. I.

Another pair, ♂ and ♀ labelled as paratypes. The ♀ of the paratype has only four segments in the right antenna, it being shorter than the left which is normal. The right apical segment is as long as the preapical, plus one-half the apical of the left antenna.

I take great pleasure in dedicating this strikingly beautiful insect to my friend, W. L. Distant, whose work with the Rhynchota needs no comment.

12. **Cosmocoris pulcherrimus** sp. nov. (Plate I, fig. 1.)

♀ dark blue, green, black and red. Head with basal area and tylus black, lateral lobes purplish blue, obsoletely transversely striate and punctuate; eyes and ocelli reddish brown; pronotum punctate, black and blue on posterior area and medially to anterior margin, irrorated at posterior lateral angles with metallic green and with two submedian, longitudinal blue fasciæ; anterior lateral areas, including margins and angles, vermilion, which color extends over propleuræ and to anterior margins of mesopleuræ; mesonotum black, opaque; basal fourth of scutellum vermilion, median half blue with a faint transverse metallic green, waved fascia medially; apical fourth broadly, lunately vermilion; basal lateral margins purplish blue, coarsely punctate or granulate; entire scutellum minutely punctate, the punctures being connected by microscopic lines on median apical area.

Dorsum of abdomen vermilion with a transverse black, lunate spot on last segment.

Ventral surface of head, thorax and basal abdominal segment dark blue; stethi coxæ and basal halves of mid and posterior femora pale luteous; anterior femora pale luteous basally; remainder of legs and tarsi brown or blue-black and green, anterior femora being streaked with brown on basal area. Tibiæ apically strongly setose laterally and inferiorly. Second abdominal segment blue ventrally, two transverse, submedian vermilion spots on posterior margin; remainder of ventrum vermilion except a blue spot on basal, lateral angle of third and a black spot occupying median half of sixth. This spot is excavated with a vermilion spot on anterior margin medially. Genitalia brassy-green except on median area which is brown.

Antennæ black, thickly setose; three ultimate segments subequal in length; much less foliate than in *C. sellatus* White. Rostrum black, pilose; apices of second and third segments pale. Tegmina and wings fuliginous; costa of former dark blue.

Length 15 millimeters; width between pronotal angles 7.5 millimeters.

PALAWAN, Bacuit, P. I., (*C. M. Weber*, collector).

Type No. 11650 in Entomological Collection, Bureau of Science, Manila, P. I.

Three female specimens of this insect were taken. It is certainly one of the most beautiful of the Scutelleraria.

Two of the specimens collected by Weber and one imperfect specimen by Schultze at Iwahig (10912 *W. Schultze*) are labeled paratypes.

Distant does not separate this genus from *Chrysocoris*, though he gives the characters which differentiate it from the remainder of his genus;[3] while Schouteden makes it distinct in his monograph[4] of the family.

Subf. GRAPHOSOMATINÆ.

PODOPS Laporte.

Ess. Hém. (1832), 72.
Type: *C. inuncta* Fabr.

13. PODOPS SERRATA Voll.

Scotinophara serrata Voll., *Fauna Ind. Néerl.* (1863), 1, 43, pl. 3, fig. 9.
——— Stål, *Ö. V. A. F.* (1870), 7, 608 [ref.]
Podops ——— Distant, *Fauna British Ind., Rhyn.* (1902), 1, 75.
——— Schouteden, *Gen. Insect., Het. Pent. Grapho.* (1905), 30, 135.

This species is recorded from Sikhim, Mungphu, Naga Hills, Burma, Malay Peninsula, Borneo, Celebes and previously from the Philippine Islands.

The Palawan specimen is slightly under the size indicated by Distant.

PALAWAN, Iwahig, P. I., (10911 *W. Schultze*).

[3] *Fauna British Ind., Rhyn.* (1902), 1, 56.
[4] *Gen. Insect., Het. Pent.* (1904), fasc. 24, pp. 16 and 37.

Subf. PENTATOMINÆ.

Div. HALYRIA.

DALPADA Amyot & Serville.

Hém. (1843), 105.
Type *D. aspersa* Amy. & Serv.

14. DALPADA TAGALICA Stål. (Plate II, fig. 9.)
Dalpada tagalica Stål, *Ö. V. A. F.* (1870), 622.

Although the members of this genus are scattered throughout the Malay region, but two species have so far been recorded from the Philippines, viz: *D. simplicipes* Stål, and the one here mentioned. All the species are showy insects easily captured. The specimens from Palawan, including 7 adults and 3 nymphs, were taken from the smaller branches of cacao trees (*Theobroma cacao* L.)

PALAWAN, Iwahig, P. I., (10910 *W. Schultze;* 11912 *C. M. Weber*) 15 specimens. Bacuit, P. I., (11656 *C. M. Weber*) 5 specimens.

Div. CARPOCORARIA.

TOLUMNIA Stål.

Ö. V. A. F. (1867), 515.
Type: *T. trinotata* Westw.

15. TOLUMNIA LONGIROSTRIS Dall. (Plate I, fig. 3.)
Tolumnia longirostris Dall., *List Hem* (1851), 1, 238.
——— Stål, *Ö. V. A. F.* (1870), 7, 630.

A single specimen of this very characteristic species was taken. The femora of the specimen in hand are somewhat reddish yellow. In Dallas' specimen the fifth antennal segments were missing. In this specimen they are black with white bases, as are the fourth. This is evidently a rare insect.

PALAWAN, Iwahig, P. I., (10909 *W. Schultze*).

Div. EUSARCOCORIARIA.

EUSARCOCORIS Hahn.

Wanz. Ins. (1834), 2, 66.
Type: *E. æneus* Scop.

16. EUSARCOCORIS GUTTIGER Thunb.
Cimex guttigerus Thunb., *Nov. Ins. Sp.* (1783), 2, 32, Pl. 2. f. 47.
Pentatoma nepalensis et punctipes Westw., *Hope. Cat.* (1837), 1, 228.
Eysarcoris guttigerus Dall., *List Hem.* (1851), 1, 228.
Stollia guttigera Stål, *Enum. Hem.* (1876), 5, 81.
Eusarcocoris guttiger Dist., *Fauna British Ind., Rhyn.* (1902), 1, 165.

A single specimen of this species was taken.

PALAWAN, Iwahig, P. I., (11221 *W. Schultze*).

17. EUSARCOCORIS VENTRALIS Westw.

Pentatoma ventralis Westw., *Hope Cat.* (1837), **1**, 36.
Eysarcoris distactus Dall., *List Hem.* (1851), **1**, 226.
Stollia distacta Atk., *J. A. S. B.* (1888), **57**, 40.
——————— Stål, *Ö. V. A. F.* (1870), 628.
Eusarcocoris ventralis Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 167.

Of this species, which very closely resembles the preceding, except that the former has prominent pronotal angles and larger basal scutellar spots, 6 specimens were taken.

PALAWAN, Iwahig, P. I., (10906 *W. Schultze*).

18. EUSARCOCORIS BOVILLUS Dall.

Eysarcoris bovillus Dall., *List Hem.* (1851), **1**, 229.
Stollia bovilla Stål, *Ö. V. A. F.* (1870), 628.
——————— id., *Enum. Hem.* (1876), **5**, 81.

This species was described originally from the Philippine Islands. It is by no means a common form.

PALAWAN, Bintuan, P. I., (11695 *C. M. Weber*), 2 specimens.

Div. HOPLISTODERARIA.

PARACRITHEUS Bergroth.

Rev. d' Ent. (1891), **10**, 214.
Type: *P. trimaculatus* Lep. et Serv.

19. PARACRITHEUS TRIMACULATUS Lep. & Serv.

Paracritheus trimaculatus Lep. & Serv., *Enc. Méth.* (1825), **10**, 411.
Graphosoma trimaculata Germ., *Ztschr.* (1839), **1**, 54.
Hoplistodera ——————— Dall., *List Hem.* (1851), **1**, 217.
Astyanax trimaculatus Stål, *Ö. V. A. F.* (1870), 629.
Paracritheus ——————— Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 178, fig. 106.

A single specimen of this easily recognizable species was taken in Palawan. It is reported from Burma, and many islands in the Malay Archipelago.

PALAWAN, Iwahig, P. I., (10907 *W. Schultze*).

Div. ANTESTIARIA.

PLAUTIA Stål.

Ö. V. A. F. (1867), 514.
Type: *P. fimbriata* Fabr.

20. PLAUTIA VIRIDICOLLIS Westw.

Pentatoma viridicollis Westw., *Hope Cat.* (1837), **1**, 35.
——————— inconspicua Dall., *List Hem.* (1851), **1**, 250.
——————— viridicollis ibid., p. 251.
——————— Stål, *Enum. Hem.* (1876), **5**, 126 (among *spp. incert. loci. syst.*).
Plautia ——————— Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 182.

This species is so nearly like *P. fimbriata* Fabr., that, were it not for the size, I should place it unhesitatingly there. The differences given by Distant form so slight a characterization and the designations "scutellum with apical margin narrowly greyish" for *fimbriata* and "scutellum somewhat broadly greyish" for *viridicollis*, are characters which might easily vary greatly in individuals of the same species. I am inclined to believe that the two species will be united ultimately as *fimbriata*.

PALAWAN, Bacuit and Bintuan, P. I., (11653 and 11692 *C. M. Weber*), 1 specimen from each place.

ANTESTIA Stål.

Hem. Afr. (1864), **1**, 700.
Type: *A. maculata* Dall.

21. ANTESTIA CRUCIATA Fabr.
Cimex cruciatus Fabr., *Syst. Ent.* (1775), 714.
Pentatoma pantherina Westw., *Hope Cat.* (1837), **1**, 34.
Pentatoma cruciata Amy et Serv., *Hém.* (1843), 132.
Strachia geometrica Motsch., *Bul. Soc. Nat. Mosc.* (1863), **36**, pt. 2, 75.
——————— Nietn., *Enem. of Coffee Tree* (1864), 8.
——— velata Walk., *Cat. Het.* (1867), **2**, 329.
——— sulacta Walk., *ibid.*
Antestia cruciatia Stål, *Ö. V. A. F.* (1870) 630.
——————— Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 185.

This species has been taken in Manila and at Baguio, Benguet. Eleven specimens were taken in Palawan. It is distributed quite generally over the Malay region. In Manila it was found breeding on imported olive trees at the agricultural experiment station.

PALAWAN, Iwahig, P. I., (10905 *W. Schultze*), 11 specimens.

APINES Dallas.

List Hem. (1851), **1**, 232.
Type: *A. concinna* Dall.

22. **Apines grisea** sp. nov. (Plate II, fig. 5.)

Grey and black, shining, coarsely punctate above, more finely beneath; head black, anterior area of scutellum broadly black; discal area of pronotum creamy white with its posterior portion and a narrow median area punctured with black; posterior lateral lobes of pronotum, lateral margins to base and apex of scutellum creamy white, black punctured except apex of scutellum. Base of corium grey, punctured with black; apical fourth black, preceded by a transverse, white callosity; membrane dark brown, pale at tips of tegmina.

Body beneath black, shining, punctate; pro-, meso- and metastethi, coxæ, femora (except apical fourth which is black), submedian rectangular patches on first to fourth abdominal segments, and lateral margins of metapleuræ and of all abdominal segments creamy white; sutures black. Anterior tibiæ black, mid and posterior creamy white, with black bases and apices; tarsi black; antennæ black except first and base of second segments which are obscurely, creamy white; basal half of rostrum pale, distal half black.

Length 5.5 to 6.5 millimeters.

PALAWAN, Iwahig, P. I., (10903 *W. Schultze*) and Manila, P. I., (9984 *Guerrero.*)

Type No. 10903 in Entomological Collection, Bureau of Science, Manila, P. I.

There are but two specimens of this interesting species in the collection. The one from Manila is the smaller of the two but otherwise the specimens are identical in appearance.

Div. NEZARIA.

CATACANTHUS Spinola.

Ess. (1837), 352.
Type: *C. incarnatus* Dru.

23. CATACANTHUS NIGRIPES Sulz.

Cimex nigripes Sulz., *Gesch. Ins.* (1776), 96, pl. 10, fig. 9.
——— punctum Fabr., *Ent. Syst.* (1794), 4, 105, 100.
Edessa ——— Fabr., *Syst. Rhyn.* (1803), 149, 16.
Raphigaster carrenoi Le Guill., *Rev. Zool.* (1841), 4, 262, 9.
——————— Stoll, *Les Pun.* (1788–90), 29, pl. 6, fig. 40.
Catacanthus nigripes Dall., *List Hem.* (1851), 1, 271.
Pentatoma tricolor Montr., *An. Sci. Phys. et Nat.* (1855), (2), 7, 96.
Catacanthus tricolor Stål, *Ö. V. A. F.* (1870), 631.

This species, of lengthy synonymy, is undoubtedly the species described by Sulz in 1776 as shown by my researches in the British Museum.

It has been recorded previously from other parts of the Philippines, having been collected by Cuming and Semper and on Fuga Island (626 *McGregor*) on Romblon (1975 *McGregor*), at Manila (7356 *R. Parás*), at Lamao (7623 *Cuzner*), on Camaguin Island (7888 *McGregor*).

PALAWAN, Iwahig, P. I., (10904 *W. Schultze*), 5 specimens in good color. Captured in dense forest in flight. Bacuit, P. I., (11651 *C. M. Weber*), 1 specimen.

NEZARA Amyot et Serville.

Hém. (1843), 143.
Type: N. *viridula* Linn.

24. NEZARA ANTENNATA Scott, Ann. Mag. Nat. Hist. (1874), (4), 14, 299.
var. Nezara icterica Horv., *Termész. Füzetek.* (1887), 12, 31.
var. ——— balteata Horv., *loc. cit.*
Nezara antennata, Distant, *Fauna British Ind., Rhyn.* (1902), 1, 220.

A single specimen, which agrees perfectly with Scott's description, save in the absence of the black spot on the genæ. The extreme tip of the fifth antennal segment is pale.

Recorded also from the Himalayas, China, Japan.

PALAWAN, Iwahig, P. I., (10908 *W. Schultze*).

Subf. TESSARATOMINIÆ.

Div. EUSTHENARIA.

PYCANUM Amyot & Serville.

Hem. (1843), 171.
Type: *P. rubens* Fabr.

25. PYCANUM RUBENS Fabr.
Cimex rubens Fabr., *Ent. Syst.* (1794), **4**, 107.
——— amethystinus Weber, *Obs. Ent.* (1801), 115.
Edessa amethystina Fabr., *Syst. Rhyng.* (1803), 150.
Tessaratoma alternata Lepel. et Serv., *Encyc. Méth.* (1825), **10**, 591.
Aspongopus amethystinus Burm., *Handb. d. Ent.* (1835), **2**, 351.
——————— Herr.-Schäff., *Wanz. Ins.* (1839), **4**, 85, pl. 135, fig. 417.
Dinidor amethystinus Herr.-Schäff., *ibid.* (1844), **7**, 76.
Pycanum amethystinum Dall., *List Hem.* (1851), **1**, 345.
——— rubens Stål, *Hem. Fabr.* (1868), **1**, 40.
————— Dist., *Fauna British Ind., Rhyn.* (1902), **1**, 274, fig. 174.

This beautiful insect has not been reported from the Philippines previously, though Stål describes a species closely related to it.

PALAWAN, Bacuit, P. I., (11647 *C. M. Weber*). A single perfect specimen, almost entirely suffused with green, with some purplish brown showing on the bases of the tegmina.

Div. EUMENOTARIA.

EUMENOTES Westwood.

Tr. Ent. Soc. (1847), **4**, 246.
Type: *E. obscura* Westw.

26. EUMENOTES OBSCURA Westw. (Plate II, fig. 4, *a*.)
Eumenotes obscura Westw., *Tr. Ent. Soc.* (1847), **4**, 247, pl. 18, fig. 4.
————— Voll., *Fauna Ind. Néerl.* (1868), **3**, 49.
Odonia truncata Stål, *Ö. V. A. F.* (1870), 645.
Aradus truncatus Walk., *Cat. Het.* (1873), 39.
Odonia truncata Bergr., *Ann. Mus. Civ. Gen.* (1889), **27**, 733, pl. 12, fig. 4.
————— Stål, *Enum. Hem.* (1870), **1**, 89.
————— Dist., *Fauna British Ind., Rhyn.* (1904), **2**, 155, fig. 114.
————— ibid., *Ann. Mag. Nat. Hist.* (1903) (7), **12**, 476.

PALAWAN, Mangahan Swamp near Iwahig, P. I., (11687 *C. M. Weber*). A single perfect specimen.

This by no means common species is here added to our collection for the first time. It would appear that Distant's figure gives an incorrect idea of the venation of the membrane. Westwood represents the veins as reticulated and my specimen agrees with Westwood's figure in this.

Very great confusion seems to have existed as to the family position of this genus. I must confess that a cursory examination would lead one to place it among the Aradidæ, but Bergroth[5] has given the whole subject a most careful study and has again placed the genus in its proper position among the Tessaratominæ, creating a new division for it.

I have examined most scrupulously the single specimen in our collection and find the ocelli very conspicous. This feature alone would take the genus out of Aradidæ.

A notable feature of the specimen collected in Palawan is the possession of a tri-articulate right antenna, that on the left being normal. I have endeavored to give the exact features in the drawing, as a satisfactory illustration of this insect has not yet appeared.

Subf. DINIDORINÆ.

MEGYMENUM Laporte.

Ess. Hém. (1832), 52.
Type: *M. dentatum* Boisd.

27. MEGYMENUM SUBPURPURASCENS Westw.

Platydius subpurpurascens Westw., *Zool. Journ.* (1834), 5, 446, pl. 22, fig. 8.
Megymenum cupreum Guér., *Voy. Coq., Zool. Ins.* (1838), 2, pt. 2, 172.
Amaurus cupreus Herr.-Schäff., *Wanz. Ins.* (1839), 5, 61, fig. 503.
Megymenum meratii Le Gillou, *Rev. Zool.* (1841), 261.
——— subpurpurascens Stål, *Enum. Hem.* (1870), 1, 87.
——— ——— Dist., *Fauna British Ind., Rhyn.* (1902), 1, 287.

This species has been taken in other parts of the Philippines, including the Islands of Ticao and Negros and at Manila.

PALAWAN, Mangahan Swamp, near Iwahig, P. I., (11682 *C. M. Weber*), 1 specimen.

Also taken as follows: Manila (3477 *Banks*, 5987 *J. A. Gilkerson*); NEGROS OCCIDENTAL, Bago, P. I., (6644 *Banks*) and Ticao Island, (9623 *R. C. McGregor*).

Subf. COREINÆ.

Div. PETASCELARIA.

PETILLIA Stål.

Hem. Afr. (1865), 2, 2.
Type: *P. tragus* Fabr.

28. PETILLIA CALCAR Dall.

Mictis calcar Dall., *List. Hem.* (1852), 2, 397.
Trematocoris subvittata Walk., *Cat. Het.* (1871), 4, 34.
——— vittata *ibid.* p. 36.
Melucha notatipes *ibid.* p. 56, immature form.
Petillia calcar Dist., *Ann. Mag. Nat. Hist.* (1900) (7), 6, 376.
——— id., *Fauna British Ind., Rhyn.* (1902), 1, 351.

[5] *Deutsch. Ent. Ztschr.* (1907), 498 *et seq.*

PALAWAN, Iwahig, P. I., (11901 *C. M. Weber*). A single specimen. The basal dentations of the tibiæ are not very prominent in this specimen, otherwise it agrees with the description.

Div. HOMŒOCERARIA.

HOMŒOCERUS Burmeister.

Handb. d. Ent. (1833), 2, pt. 1, 316.
Type: *H. puncticornis* Burm.

29. HOMŒOCERUS IMMACULATUS Stål, *Ö V. A. F.* (1870), 650.
Homœocerus immaculatus id. *Enum. Hem.* (1873), 3, 62.

This species, collected previously by me in other parts of the Philippines and originally described by Stål from these Islands, is represented in the Palawan collection by a single specimen.

PALAWAN, Iwahig, P. I., (10945 *W. Schultze*).

30. HOMŒOCERUS sp.

A single specimen of an apparently new species was taken, but the material is considered as insufficient to warrant describing it as new, especially as considerable variation exists in the same species of this large genus.

PALAWAN, Iwahig, P. I., (10868 *W. Schultze*), 1 specimen.

31. HOMŒOCERUS sp.

Like the above, only a single specimen, mutilated as to the antennæ, but otherwise perfect.

PALAWAN, Iwahig, P. I., (10950 *W. Schultze*).

Div. CLORESMARIA.

NOTOBITUS Stål.

Ö. V. A. F. (1859), 451.
Type: *N. meleagris* Fabr.

32. NOTOBITUS AFFINIS Dall.
Nematopus affinis Dall., *List Hem.* (1852), 2, 423.
Notobitus ——— Stål, *Ö. V. A. F.* (1870), 648.
——————— Dist., *Fauna British Ind., Rhyn.* (1902), 1, 372.

This species was originally described from the Philippines and has been collected in various parts by me.

PALAWAN, Iwahig, P. I., (10900 *W. Schultze*), 9 specimens. Iwahig, P. I., (11909 and 11978 *C. M. Weber*), 2 specimens.

Div. ANISOSCELARIA.

LEPTOGLOSSUS Guérin.

Voy. Coq., Zool. (1830), 2, pt. 2, 174.
Type: *L. dilaticollis* Guér.

33. LEPTOGLOSSUS MEMBRANACEUS Fabr.

Cimex membranaceus Fabr., *Spec. Ins.* (1781), 351.
Lygæus ——————— Fabr., *Ent. Syst.* (1794), 4, 139.
Anisoscelis —————— Burm., *Handb.* (1835), 2, 332.
Cimex mormodicæ Forst., *Descr. An.* (1844), 16.
Anisoscelis orientalis Dall., *List Hem.* (1852), 2, 454.
————— flavopunctatus Sign., *in Maillard, Notes sur l'île de la Réun., Annexe J.* (1863), 27, pl. 21, fig. 4.
Leptoglossus membranaceus Stål, *Ö. V. A. F.* (1870), 648.
————————————— id., *Enum. Hem.* (1873), 3, 68.
Anisomelis orientalis Kirby, *J. Linn. Soc. Zool.* (1891), 24, 92.
Leptoglossus membranaceus Dist., *Fauna British Ind., Rhyn.* (1902), 1, 382, fig. 224.

Recorded from Africa, Ceylon, Malay Archipelago to Australia, and common in all parts of the Philippines.

PALAWAN, Iwahig, P. I., (10935 *W. Schultze*), 2 specimens; Iwahig, P. I., (11911 *C. M. Weber*), 3 specimens.

Div. PHYSOMERARIA.

PHYSOMERUS Burmeister.

Handb. d. Ent. (1835), 2, 341.
Type: *P. grossipes* Fabr.

34. PHYSOMERUS GROSSIPES Fabr.

Lygæus grossipes Fabr., *Ent. Syst.* (1794), 4, 135.
———— calcar Fabr., *Syst. Rhyng.* (1803), 241.
Coreus (Cerbus) œdymerus Burm., *Nov. Act. Ac. Leop.* (1834), 16, Supp. p. 296.
Physomerus calcar Herr.-Schäff., *Wanz. Ins.* (1842), 6, 60, fig. 621.
————— œdymerus Dall., *List Hem.* (1852), 2, 213.
————— grossipes Stal, *Hem. Fabr.* (1868), 1, 45.
————— calcar ibid.
————— œdymerus Stål, *Ö. V. A. F.* (1870), 648.
————— delineatus Walk., *Cat. Het.* (1871), 4, 59.
————— grossipes Dist., *Fauna British Ind., Rhyn.* (1902), 1, 383, fig. 225.

A very common species throughout this region. Abundant in all parts of the Philippines. Found in great numbers breeding on *Ipomoea cairica* Sweet. The eggs are laid in regular patches upon fences or piazzas, where this vine grows, especially on bamboo lattices.

PALAWAN, Bacuit, P. I., (11659 *C. M. Weber*), 8 specimens.

ACANTHOCORIS Amyot & Serville.

Hém. (1843), 43.
Type: *A. scabrator* Fabr.

35. ACANTHOCORIS SCABRATOR Fabr.
Coreus scabrator Fabr., *Syst. Rhyng.* (1803), 195.
Crinocerus ——— Burm., *Handb.* (1835), 2, 319.
——— scabripes Herr.-Sch., *Wanz. Ins.* (1842), 6, 18, fig. 574.
Acanthocoris scabrator Amy. et Serv., *Hém.* (1843), 214.
——— Dall., *List Hem.* (1852), 2, 215.
——— Stål, *Hem. Fabr.* (1868), 1, 45.
——— Stål, *Enum. Hem.* (1873), 3, 71.
——— Dist., *Fauna British Ind., Rhyn.* (1902), 1, 385. fig. 226.

A species recorded from India and "also found on many islands of the Malay Archipelago." Collected in all parts of the Philippines: very common.

PALAWAN, Iwahig, P. I., (10936 *W. Schultze*), 2 specimens.

Div. GONOCERARIA.

CLETUS Stål.

Freg. Eug. Resa, Ins., Hem. (1859) 236.
Type: *C. trigonus* Thunb.

36. CLETUS TRIGONUS Thunb.
Cimex trigonus Thunb., *Nov. Ins. Sp.* (1783), 2, 37.
——— pugnator Fabr., *Mant. Ins.* (1787), 2, 287.
Gonocerus acutus Dall., *List Hem.* (1852), 2, 495.
Cletus trigonus Stål, *Freg. Eug., Resa, Ins., Hem.* (1859), 237.
——— bistillatus Dohrn, *Stett. Ent. Zeit.* (1860), 21, 403.
Cletus pugnator Stål, *Hem. Fabr.* (1868), 1, 60.
——— acutus Stål, *Ö. V. A. F.* (1870), 652.
——— trigonus Dist., *Fauna British Ind., Rhyn.* (1902), 1, 394.

This insect, which was previously recorded from the Philippines by Stål in 1859, is very abundant in the vicinity of Manila (487, 5368 *Banks*) and in the province of Tarlac (383 *Fernandez*).

PALAWAN, Iwahig, P. I., (10917 *W. Schultze*) 4 specimens. Tara Island, P. I., (11723 *C. M. Weber*), 1 specimen.

Subf. ALYDINÆ.

Div. MICRELYTRARIA.

STACHYOLOBUS Stål.

Ö. V. A. F. (1870), 658.
Type: *S. macilentus* Stål.

37. STACHYOLOBUS MACILENTUS Stål, *Ö. V. A. F.* (1870), 659. (Plate 7. fig. 4.)
Stachyolobus macilentus Stål, *Enum. Hem.* (1873), 3, 89.

This species, of which but the single specimen here mentioned is in our collection, was originally described from the Philippines by Stål.

PALAWAN, Iwahig, P. I., (10919 *W. Schultze*). A single delapidated specimen.

Div. LEPTOCORISARIA.

LEPTOCORISA Latreille.

Fam. Nat. (1825), 421.
Type: *L. tipuloides* De Geer.

38. LEPTOCORISA ACUTA Thunb.
Cimex acutus Thunb., *Nov. Ins. Sp.* (1783), 2, 34.
——— angustatus Fabr., *Mant. Ins.* (1787), 2, 308.
————— Gmel., *Syst. Nat.* (1788) (1), 4, 2193.
Gerris oratorius Fabr., *Ent. Syst.* (1794), 4, 191.
Leptocorisa bengalensis Westw., *Hope Cat.* (1842), 2, 18.
Rhabdocoris arcuata Kolenati, *Melet. Ent.* (1845), 2, 68.
Myodochus trinotatus Herr.-Schäff., *Wanz. Ins.* (1848), 8, 95, fig. 863.
Leptocorisa maculiventris Dall., *List Hem.* (1852), 2, 484.
Gerris angustatus Stål, *Hem. Fabr.* (1868), 1, 66.
————— Stål, *Ö. V. A. F.* (1870), 658.
Leptocorisa acuta Dist., *P. Z. S.* (1901), 1, 331.
————— Dist., *Fauna British Ind., Rhyn.* (1902), 1, 410.

Reported from China, Java, Celebes, Gilolo and previously from the Philippines.

In the Philippine Islands this species is very destructive to rice "in the milk." It may be found in all stages of growth in the rice fields. The insect is known in Visayan as *tiañga*. Its odor is decidedly offensive. The adults are quick fliers and are constantly on the alert so that their capture is affected with some difficulty.

PALAWAN, Iwahig, P. I., (10918 *W. Schultze*), 14 specimens.

Div. ALYDARIA.

RIPTORTUS Stål.

Ö. V. A. F. (1859) 460.
Type: *R. dentipes* Fabr.

39. RIPTORTUS LINEARIS Fabr.
Lygæus linearis Fabr., *Syst. Ent.* (1775), 710.
Alydus dentipes Herr.-Schäff., *Wanz. Ins.* (1848), 8, 99, fig. 867.
————— clavatus Dohrn, *Stett. Ent. Zeitung* (1860), 21, 402.
Riptortus linearis Stål, *Hem. Fabr.* (1868), 1, 64.
————— Dist., *Fauna British Ind., Rhyn.* (1902), 1, 415.

The specimen from Tara Island is evidently a pale form in which the darker markings are almost obsolete.

PALAWAN, Tara Island, P. I., (11718 *C. M. Weber*). A single specimen.

MARCIUS Stål.

Hem. Afr. (1865), 2, 7.
Type: *M. generosus* Stål.

40. MARCIUS QUINQUESPINUS Stål. (Plate II, fig. 6.)
Marcius quinquespinus Stål, *Ö. V. A. F.* (1870), 657.
————— Stål, *Enum. Hem.* (1873), 3, 89.

This species was described originally from the Philippines by Stål. Only 2 specimens were taken by Schultze, though he says the species is common at Iwahig. The male is somewhat smaller than the female.

PALAWAN, Iwahig, P. I., (10914 *W. Schultze*).

Subf. CORIZINÆ.

Div. CORIZARIA.

CORIZUS Fallen.

Spec. Nov. Hem. Disp. Meth. Exhib. (1814), 8.
Type: *C. crassicornis* Linn.

41. CORIZUS HYALINUS Fabr.

Lygæus hyalinus Fabr., *Ent. Syst.* (1794), 4, 168.
Coreus ——— Fabr., *Syst. Rhyng.* (1803), 201.
Corizus gracilis Sign., *Ann. Soc. Ent. Fr.* (1859) (3), 7, 88.
——— dilatipennis Sign., *ibid.* p. 89, No. 18.
——— variegatus Sign., *ibid.* p. 89, No. 20.
——— siculus Sign., *ibid.* p. 91, No. 24.
Rhopalus truncatus (Ramb.) Fieb., *Eur. Hem.* (1861), 234.
Corizus ——— Stål, *Hem. Afr.* (1865), 2, 117.
——— (Liorhyssus) hyalinus Stål, *Enum. Hem.* (1870), 1, 222.
——— hyalinus Stål, *Ö. V. A. F.* (1870), 659.
——— ——— Hambleton, *Ann. Ent. Soc. Am.* (1908), 1, 136.

Signoret gives the best description of this species, under *C. gracilis*, while Stål shows that Signoret's other species, given as distinct in his monograph of the genus, as above, are synonymous with *C. hyalinus*.

It is recorded as follows: *Americæ insulis*, Cape of Good Hope, Egypt, Nubia, middle Europe, America and New Holland. It was recorded previously from the Philippines by Stål.

PALAWAN, Iwahig, P. I., (10915 *W. Schultze*). Four specimens.

Div. SERINETHARIA.

SERINETHA Spinola.

Ess. (1837), 247.
Type: *S. abdominalis* Fabr.

42. SERINETHA ABDOMINALIS Fabr.

Lygæus auger Fabr., *Ent. Syst.* (1794), 4, 161, [part.]
——— abdominalis Fabr., *Syst. Rhyng.* (1803), 226.
Leptocoris rufus Hahn., *Wanz. Ins.* (1831), 1, 201, fig. 102.
——— abdominalis Burm., *Handb.* (1835), 2, 305.
Lygæomorphus ——— Blanch., *Hist. des Ins.* (1840), 3, 116.
Pyrrhotes ——— Westw., *Hope Cat.* (1842), 2, 26.
Serinetha taprobanensis Dall., *List Hem.* (1852), 2, 461.
——— abdominalis Stål, *Hem. Fabr.* (1868), 1, 68.
Leptocoris ——— *id.*, *Ö. V. A. F.* (1870), 659.
Serinetha ——— *id.*, *Enum. Hem.* (1873), 3, 99.
Leptocoris bahram Kirkaldy, *Bull. Liverp. Mus.* (1899), 2, 46.
Serinetha abdominalis Dist., *Fauna British Ind., Rhyn.* (1902), 1, 419 fig. 246.

Although this species is recorded from the Philippines by several authors, it has never been brought to this laboratory before. It bears a strong superficial resemblance to *Antilochus nigripes* Burm., of the family Pyrrhocoridæ.

PALAWAN, Iwahig, P. I., (11933 *C. M. Weber*). A single specimen.

Fam. LYGÆIDÆ.

Subf. LYGÆINÆ.

Div. LYGÆARIA.

SCOPIASTES Stål.

Enum. Hem. (1874), 4, 98.
Type: *S. degeeri* Stål.

43. **Scopiastes ruficollis** sp. nov. (Plate II, fig. 2.)

General color cupreous brown, anterior two-thirds of pronotum coralline, as are meso- and metapleuræ. Head black; basal half of first antennal segment dark coralline, remainder of antennæ black, pubescent, second and third segments equal, fourth one-half longer than third and slightly incrassate. Ocelli brown-red, entire prothorax, except a posterior dorsal triangular brown-red portion, bright coral red, scutellum æneous as also corium and posterior portion of abdomen. Connexivum and disc of ventral surface stramineous; meso- and metasterna brown as also a lateral abdominal fascia ventrad. Last abdominal segment dark brown, entire ventrum glabrous, pubescent. Femora dark brown apically, pale yellowish brown basally. Remainder of legs dark brown. Membrane of elytra and wings uniformly fuscous.

Length 5.5 millimeters, width 1.5 millimeter.

PALAWAN, Iwahig, P. I. (*W. Schultze*, collector).

Type No. 10947 in Entomological Collection, Bureau of Science, Manila, P. I.

Described from a single specimen in perfect condition.

ONCOPELTUS Stål.

Hem. Fabr. (1868), 1, 75.
Type: *O. famelicus* Fabr.

44. ONCOPELTUS NIGRICEPS Dall.

Lygæus nigriceps Dall., *List. Hem.* (1852), 2, 537.
——— Stål, *Enum. Hem.* (1874), 4, 119.
——— Leth. & Serv., *Cat. Gén. Hém.* (1894), 2, 157.
Oncopeltus nigriceps id., *tom. cit.* p. 137.
——— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 4, fig. 2.

This species is here recorded from the Philippines for the first time. It was described from India. The specimens at hand show a light variety in which the basal, angular pronotal spots in the typical form are extended transversely to form a fascia on its posterior border.

Palawan, Bacuit, P. I. (11661 *C. M. Weber*). Two specimens in both of which the abdomen is badly shrunken.

LYGÆUS Fabricius.

Ent. Syst. (1794), 4, 133 *pro parte.*
Type: *L. militaris* Fabr.

45. Lygæus hospes Fabr.

Lygæus hospes Fabr., *Ent. Syst.* (1794), 4, 150.
——— affinis Wolff., *Icon.* (1802), 3, 110, fig. 104.
——— hospes Fabr., *Syst. Rhyng.* (1803), 219.
——— lanio Herr-Schäff., *Wanz. Ins.* (1844), 7, 21, fig. 705.
——— squalidus Montr. & Sign., *Ann. Soc. Ent. Fr.* (1861) (4), 1, 66.
——— hospes Stål, *Hem. Afr.* (1865), 2, 136, foot note.
——— ——— var. familiaris Fabr., *Species Ins.* (1781), 2, 363.
——————— Stål, *Ö. V. A. F.* (1870), 609.
——————— Dist., *Fauna British, Ind., Rhyn.* (1904), 2, 6, fig. 3.

This species has been reported from the Philippines previously, under the varietal name of *familiaris.*

Palawan, Bacuit, P. I., (11665 *C. M. Weber*), 1 specimen.

GRAPTOSTETHUS Stål.

Hem. Fabr. (1868), 1, 73.
Type: *G. servus* Fabr.

46. Graptostethus servus Fabr.

Cimex servus Fabr., *Mant. Ins.* (1787), 2, 300.
Lygæus ——— Fabr., *Ent. Syst.* (1797), 4, 156.
——————— var. maculicollis Germ., *Fauna Ins. Europ.* (1817), 24.
——— incomptus Herr-Sch., *Wanz. Ins.* (1848), 8, 104, fig. 875 et (1853), 9, 196.
——— manillensis Stål, *Freg. Eug. Resa, Ins.* (1859), 240.
——— ornatus Uhler, *Proc. Ac. N. S. Philad.* (1860), 227.
——— (Graptostethus) servus Stål, *Hem. Fabr.* (1868), 1, 74.
——— (Graptostethus) servus et manillensis Stål, *Ö. V. A. F.* (1870), 660.
——— inaequalis Walk., *Cat. Het.* (1872), 5, 57.
——— servus vars. nigriceps et manillensis Stål, *Enum. Hem.* (1874), 4, 117.
——————— Dist., *Ann. Mag. Nat. Hist.* (1901) (7), 7, 537.
Graptostethus ——— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 8, fig. 4.

This species, much confused in the synonymy, is distributed throughout the Malay and Australian regions, China, the southern Palæartic region, South Africa and Madagascar, and it is extremely variable. Specimens from the Philippines exhibit all possible gradations from nearly wholly red to nearly wholly back. The prothoracic markings are very diverse in a series from Manila.

Palawan, Iwahig, P. I., (10916 *W. Schultze*), 9 specimens; Bacuit, P. I., (11658 *C. M. Weber*), 2 specimens.

Subf. COLOBATHRISTINÆ.

MALCUS Stål.

Freg. Eug. Resa, Ins., Hem. (1859), 241.
Type: *M. flavidipes* Stål.

47. MALCUS FLAVIDIPES Stål, *Freg. Eug. Resa, Ins., Hem.* (1859), 242, pl. 3, fig. 2.
Malcus flavidipes Distant, *Fauna British Ind., Rhyn.* (1904), **2**, 33, fig. 22.

This well-marked little insect, though collected by me previously in the vicinity of Manila, has never been recorded before from the Philippines. It was originally described from Java.

PALAWAN, Iwahig, P. I., (10951. *W. Schultze*); RIZAL, Montalban, P. I., (5402 *Banks*). Schultze took a single specimen.

Subf. HETEROGASTRINÆ.

CHAULIOPS Scott.

Ann. Mag. Nat. Hist. (1874), (4) **14**, 427.
Type: *C. fallax* Scott.

48. **Chauliops bisontula** sp. nov. (Plate I, fig. 4, *a*.)

Pale yellowish brown, uniformly and deeply punctured, each puncture containing a pale, scale-like, appressed hair. Head vertically deflected, brown, densely pilose, especially internad to each eye, where the scale-like hairs form a pale ochraceous patch. Ocelli dark red-brown, the area surrounding them less pilose; first antennal segment luteous, second pale fuscous on basal half, paler apically; third and fourth entirely pale fuscous, the latter with minute whitish pubescence. Rostrum fuscous, piceous at apex; infraocular spine piceous. Pronotum strongly deflected anteriorly, brown, ochraceously irrorated, and with coarse punctures evenly placed; a triangular pilose area near anterior margin medially; posterior angles slightly tumescent, subglabrous. Scutellum dark brown with thick pile on lateral margins from base to near apex, which latter is elevated, nearly black and sulcate. Corium concolorous with pronotum; clavus with a single longitudinal row of piliferous punctures. Membrane translucent white; its extreme length equal to that of pronotum and scutellum. Connexivum strongly, lobately reflected; margins of lobes piceous. Ventral surface of thorax and abdomen concolorous with pronotum, and with regular piliferous punctation in addition to pilose areas irregularly placed. Legs entirely pale translucently ochraceous.

Length 2 millimeters; width 1 millimeter.

PALAWAN, Tara Island, P. I., (*C. M. Weber*, collector.)

Type No. 11801 in Entomological Collection, Bureau of Science, Manila, P. I.

A single specimen in which the right mid leg and the left hind leg are missing, otherwise perfect. A profile view presents a striking likeness to a miniature bison.

Subf. Pachygronthinæ.

PACHYGRONTHA Germar.

Silb. Rev. Ent. (1837), 5,152.
Type: *P. lineata* Germ.

49. **Pachygrontha bicornuta** sp. nov. (Plate I, fig. 5, *a*.)

♀ ochraceous to sordid white, varnished, thickly, darkly punctate; punctation extending to median dorsal area of first four abdominal segments (covered by wings and elytra). Head, including lateral lobes, two-thirds as wide as long; regularly punctate, a recurved, dark sulcus extending from base of eyes to ocelli, thence slightly anteriad; lateral lobes strongly carinate and directed forward and downward, terminating acutely. Lower surface of head and thorax in ♀ pitchy brown; pronotum nearly one-fourth longer than broad at base, anterior margin slightly concave, lateral margins straight; posterior margin obscurely sinuate, posterior lateral angles dark brown as is posterior margin, except a pale hairline exactly on margin; a ferrugineous, slightly elevated lunate area on each side of the anterior half of pronotum, these separated by a pale median line. Scutellum dark at base with levigate carina from before middle to apex, which is pale and acute; an obsolescent, pale levigate spot between anterior termination of carina and basal angle.

Corium pale ochraceous, darker on inner margin; a piceous fascia broadening from near base to middle of apical margin where a darker spot occurs, as also a minute spot at apical angle; membrane fuliginous; veins and vein areas much paler.

Disc of third and fourth abdominal segments dorsally and ventrally ochraceous, the dorsal sparsely brown, punctate; all dorsal segments minutely transversely striate, connexivum stramineous, with pale, rufous, longitudinal line dorsally, and darker stigmata ventrally. Ventral surface of abdomen except as indicated above and except inner margin of fifth segment, black; legs pale ochraceous; femora and tibiæ punctate; anterior femora black beneath and densely punctate above; spines pale, black at apices. Antennæ one-sixth longer than body; first segment equal to third and fourth together, dark ochraceous, black at apex; second and third darker, apical half of third, pale stramineous; fourth piceous.

Length 9 millimeters; width 2 millimeters.

♂ differs from ♀ in being paler dorsally and ventrally, both surfaces of abdomen reddish ochraceous; anterior femora and all coxæ concolorous with abdomen; third and fourth ventral segments of abdomen medially paler; dorsal abdominal punctation very sparse.

First segment of antennæ one and a half times length of the corresponding ♀ segment and nearly as long as second and third together; apical half of third and whole of fourth, pale stramineous; apex of first brown. Total length of antenna one and five-sevenths that of body.

Length 9 millimeters; width 2 millimeters.

PALAWAN, Iwahig, P. I., (*W. Schultze;* collector).

Types ♂ and ♀ No. 10866 in Entomological Collection, Bureau of Science, Manila, P. I.

In the type ♂ the right antenna is partially destroyed. Three other specimens of ♀'s bearing the same number as the types are in this collection. They measure 7.5 millimeters in length and 1.5 millimeter in width, but otherwise are identical with the types; they are labelled paratypes.

Subf. APHANINÆ.

Div. MYODOCHARIA.

PAMERA Say.

New Horm. Ind. (1831), 777.
Type: *P. vincta* Say.

50. PAMERA NIETNERI Dohrn.

Plociomerus nietneri Dohrn, *Stett. Ent. Zeit.* (1860), 21, 404.
Plociomera ——— Stål, *Ö. V. A. F.* (1870), 663.
Pamera ——— Stål, *Enum. Hem.* (1874), 4, 151.
——— Distant, *Fauna British Ind., Rhyn.* (1904), 2, 53.

Described from Ceylon and found also in India. Reported by Stål from the Philippines. It occurs in all parts of these Islands where I have collected.

PALAWAN, Iwahig, P. I., (10863 *W. Schultze*). A single specimen.

51. PAMERA VINCTA Say, *New Harm. Ind.* (1833).

Pamera Vincta Say, *Compl. Writings* (1859), 1, 333.
Lygæus (Plociomerus) amyotii Guér., *Sagra, Hist. de Cuba, Ins.* (1857), 400.
Rhyparochromus gutta Dall., *List. Hem.* (1852), 2, 573.
——— parvulus Dall., *ibid.* p. 576.
——— vinulus Stål, *Freg. Eug. Resa, Ins., Hem.* (1859), 246.
Plociomera parvula, var. *a.* Stål, *Hem. Afr.* (1865), 2, 159.
Ligyrocoris bipunctatus Kirby, *J. Linn. Soc., Zool.* (1890), 20, 547.
Pamera vincta Dist., *Ann. Mag. Nat. Hist.* (1901) (7), 8, 480.
——— Distant, *Fauna British Ind., Rhyn.* (1904), 2, 52.

This species, which is spread over the entire tropics and subtropics, has not been recorded previously from the Philippines.

PALAWAN, Iwahig, P. I., (10953 *W. Schultze*), 3 specimens.

Div. APHANARIA.

DIEUCHES Dohrn.

Stett. Ent. Zeit. (1860), **21**, 159.
Type: *D. syriacus* Dohrn.

52. Dieuches uniguttatus Thunb.
Pendulinus uniguttatus Thunb., *Hem. Rost. Cap.* (1822), **4**, 6.
——— guttatus Thunb., *Ins. Hem. tria gen.* (1825), 5.
Rhyparochromus bengalensis Dall., *List Hem.* (1852), **2**, 572, No. 34.
——— assimilis Dall., *ibid.*, p. 572, No. 35.
Deiuches yeh Dohrn, *Stett. Ent. Zeit.* (1860), **21**, 61.
Beosus uniguttatus Stål, *Berl. Ent. Ztschr.* (1866), **10**, 382.
——— Stål, *Ö. V. A. F.* (1870), 664.
Dieuches ——— Stål, *Enum. Hem.* (1874), **4**, 162.
——— ——— Distant *Fauna British Ind., Rhyn.* (1904), **2**, 82 fig. 64.

This species has been recorded from India, Ceylon, Andamans and other islands of the Malay Archipelago as well as from Hongkong. It has been recorded previously from the Philippines.

Palawan, Iwahig, P. I., (10913 *W. Schultze*). A single specimen.

Fam. PYRRHOCORIDÆ.

Subf. Pyrrhocorinæ.

ECTATOPS Amyot & Serville.

Hém. (1843), 273.
Type: *E. limbata* Amy. & Serv.

53. Ectatops seminiger Stål, *Berl. Ent. Zetschr.* (1863), **7**, 397.
Ectatops seminiger id., *Enum. Hem.* (1870), **1**, 105.
——— id., *Ö. V. A. F.* (1870), 666.

This species, in which there is considerable variation as to color, was taken in what might be considered as four varieties, if seen separately.

Var. *a.* Thorax black, remainder of dorsum, including membrane, coral red.

Var. *b.* Thorax black, remainder red, with small black basal spot to membrane.

Var. *c.* Entire dorsum coral red, including dorsum of thorax and membrane.

Var. *d.* Entire dorsum red, membrane entirely black.

A pair, caught and preserved *in coitû*, shows ♂ of var. *c* and ♀ of var. *a*.

Palawan, Iwahig, P. I., (10943 *W. Schultze*), 10 specimens, one pair *in coitû;* Iwahig, P. I., (11637 and 11703 *C. M. Weber*).

DINDYMUS Stål.

Ö. V. A. F. (1861), 196.
Type: *D. bicolor* Herr.-Schäff.

54. Dindymus pulcher Stål.
Didymus pulcher Stål, *Berl. Ent. Ztschr.* (1863), **7**, 400.
——— id., *Enum. Hem.* (1870), **1**, 110.
——— ——— id., *Ö. V. A. F.* (1870), 666.

Of this insect, which is not common, there were collected as nymphs and adults, 5 specimens by Schultze, and 3 specimens by Weber.

PALAWAN, Iwahig, P. I., (10942 *W. Schultze*); Bacuit, P. I., (11676 *C. M. Weber*).

One of the specimens captured by Weber has its rostrum inserted in a tiny hole which it has bored in the shell of a very small snail.

55. DINDYMUS MUNDUS Stål.

Didymus mundus Stål, *Berl. Ent. Ztschr.* (1863), 7, 398.
——— id. *Enum. Hem.* (1879), 1, 110.
——— id. *Ö. V. A. F.* (1870), 666.

This species differs from *D. pulcher* in the absence of the white marking on the posterior area of the pronotum. The antennæ, except the apical segments, are entirely black.

PALAWAN, Bacuit, P. I., (11662 *C. M. Weber*), 2 specimens, ♂ and ♀ *in coitû.*

DYSDERCUS Amyot and Serville.

Hém. (1843), 272.
Type: *D. cingulatus* Fabr.

56. DYSDERCUS CINGULATUS Fabr.

Cimex cingulatus Fabr., *Syst. Ent.* (1775), 719.
——— Goeze, *Ent. Beytr.* (1778), 2, 256.
——— Fabr., *Spec. Ins.* (1781), 2, 364.
——— id., *Mant. Ins.* (1787), 2, 299.
——— Gmel., *Syst. Nat.* (1788), 1, pt. 4, 2172.
——— superstitiosus Thunb., *Nov. Ins. Spec.* (1784), 3, 55.
——— Stål, *Hem. Afr.* (1865), 3, 15 (note).
——— koenigii Fabr., *Syst. Ent.* (1775), 720.
——— Goeze, *Ent. Beytr.* (1778), 2, 257.
——— Fabr., *Spec. Ins.* (1781), 2, 364.
——— id., *Mant. Ins.* (1787), 2, 299.
——— Gmel., *Syst. Nat.* (1788), 1, 4, 2172.
Lygæus cingulatus Fabr., *Syst. Ent.* (1794), 4, 153.
——— id., *Syst. Rhyng.* (1803), 221.
——— Montr., *Ann. Sci. Phys. et Nat.* (1855) (3), 7, 1, 105.
——— koenigii Fabr., *Ent. Syst.* (1794), 4, 155.
——— Wolff, *Icon. Cim.* (1800), 1, 28, fig. 28.
——— Fabr., *Syst. Rhyng.* (1803), 222.
——— var. capensis Wolff, *Icon. Cim.* (1802), 3, 107, fig. 101.
Pyrrhocoris koenigii Hahn, *Wanz. Ins.* (1834), 2, 12, fig. 122.
Astemma koeningii Blanch., *Hist. des Ins.* (1840), 128, pl. 4, fig. 8.
Dysdercus ——— A. & S. *Hist. des Hém.* (1843), 272.
Pyrrhocoris solenis H.-S., *Wanz. Ins.* (1844), 7, 18, fig. 700.
Dysdercus koenigii Mayr, *Reise der Freg. Novara., Hem.* (1866), 134.
——— Stål, *Hem. Fabr.* (1868), 1, 84.
——— cingulatus id., *Enum. Hem.* (1870), 1, 119.
——— id., *Ö. V. A. F.* (1870), 667.
——— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 118, fig. 87.

This extremely common and widespread species, of lengthy synonymy, is found throughout the Philippines,

PALAWAN, Iwahig, P. I., (10937 *W. Schultze*), 5 specimens taken merely for the sake of locality.

57. DYSDERCUS POECILUS Herr.-Schäff., *Wanz. Ins.* (1844), 7, 17, fig. 699.

This variable species has been given heretofore in synonymy with *D. cingulatus.*[6] Although I have not been able to see Herrich-Schäffer's description, I have compared specimens in the British Museum with those from the Philippines and also large series of the two species with each other. I have concluded that they are quite distinct species, even though there is considerable variation in *poecilus.* There are certain constant features, as the black anterior area of the pronotum and the black sterna and abdominal segments interspersed with white, which are not found in *cingulatus,* these portions always being red in the latter at least in Philippine material.

It is therefore proposed to consider this a valid species, at least until an opportunity to see the original description presents itself.

PALAWAN, Iwahig, P. I., (10938 *W. Schultze*), 3 specimens showing the same characters as specimens collected in other parts of the Islands.

Bacuit and Iwahig, P. I., (11665 and 11908 *C. M. Weber*), 6 specimens.

58. **Dysdercus ellanorae** sp. nov.

Elongate regular oval, pale vermilion, grey and black with white markings beneath.

Head uniformly pale vermilion above and below; eyes dark brown as are all segments of antennæ except first which is vermilion on basal half and bears three minute bristles on the interior surface of its basal nodule. Antenniferous tubercles white-ringed apically. Collar of prothorax dorsally and ventrally white; anterior lobe of pronotum finely punctate, posterior lobe and corium more coarsely; anterior area of posterior lobe at transverse depression luteous, the remainder vermilion; scutellum concolorous with pronotum, finely punctate and transversely rugose on margins.

Corium pale vermilion on costal third; remainder, including clavus pale ash-grey. Each tegmen with a discal, subcircular, transverse, black spot, similar in shape and position to that of *D. cingulatus* Fabr. Membrane black-brown with metallic luster, its posterior margin albescent.

Beneath, vermilion with white markings as follows: posterior margins of pro-, meso- and metapleurae, anterior margin of propleura and prosternum, apical margins of abdominal segments and all stethi.

[6] *Vide* Stål *Enum. Hem.* (1870), 1, 119.

All femora vermilion, fuscous apically; all tibiæ and tarsi dark fuscous. Rostrum vermilion, the apical half of last segment dark fuscous.

Length 14 to 16 millimeters; width 4.5 to 5.5 millimeters.

RIZAL, Montalban Gorge, P. I., (*Banks* collector).

Type No. 5360 in Entomological Collection, Bureau of Science, Manila, P. I.

PALAWAN, Bacuit, P. I., (11677 *C. M. Weber*); BATAAN, Lamao, P. I., (10342 *E. M. Ledyard*); BENGUET, Baguio, P. I., (10329 *W. Schultze*).

It is noteworthy that all of these specimens were taken in regions elevated from 50 to 1,500 meters.

This beautiful insect, which I have dedicated to my wife, Ella Nora Banks, does not vary in color and markings, though there is a slight variation in size, the type specimen being of the maximum measurement.

Fam. ARADIDÆ.

Subf. BRACHYRHYNCHINÆ.

Div. BRACHYRHYNCHARIA.

ACANTHARADUS[7] Banks.

Gen. nov.

Type: *A. giganteus* Banks, sp. nov.

Head and pronotum subequal in length, former slightly longer; juga porrect, stylate, passing tylus by its own length; antenniferous prominences half length of head, divergent, apically bispinose; postocular tubercles bispinose; first antennal segment tumescent, apically transversely sulcate or bifid, second segment shorter, more slender, third as long as first, fourth half length of third, apically tumescent. Rostrum inserted at middle of ventral surface of head in sulcus. Prosternum sulcate; sides of sulcus elevated. Anterior pronotal angles greatly crenulately lobate; lobes two-thirds as long as head and slightly diverging anteriad; posterior angles widely crenulately lobate, these half length of anterior; humeral angles of tegmina crenulately sublobate.

Scutellum subequilaterally triangular, its base obtusely subangular and slightly overlapping posterior margin of pronotum, medially dentately carinate, apex dorsally foveate. Corium nearly twice length of scutellum.

Abdominal margin deeply crenulate; posterior lateral angles of segments obtusely dentate. Connexivum with double and parallel series of semitranslucent annulations, equally conspicuous dorsally and ventrally on all segments except first; second and sixth having but two annulations, all others, to fifth, four. Sixth segment dorsally elevate, crateral. Margin of fifth ventral segment in ♀ semicircularly excavate.

[7] ακανθα=a spine, a thorn; αραδοσ, *nom. gen.*=rattling like armor.

Coxæ nearly one-third length of femora which are strongly incrassate.

Type: *Acantharadus giganteus* Banks, sp. nov.

This genus is nearest related to *Alyattes* Stål, but differs in many essential features, as: pronotal foliations, relative length of scutellum and corium and in the absence of the curved carina on pronotum.

59. **Acantharadus giganteus** sp. nov. (Plate II, fig. 8, *a*.)

Broadly ovate, brown and brown-ochraceous; margins of entire body deeply crenulate; head dark brown, finely rugose-tuberculate, sparsely pilose; apices of juga and of antenniferous processes pale brown. Rostrum sparsely pilose. Antennæ dark brown, with sparse golden pile; apex of fourth segment pale, densely pilose. Anterior and posterior pronotal lobes brown-ochraceous, sparsely pilose; on anterior area two shallow foveæ surrounded by tuberculate annulations, within which a smaller tuberculate ring mediad; posterior margin sinuate before scutellum; the latter with elevated tuberculate margins; the basal angles pale. Corium with tuberculate veins, the apical cross-vein terminating before apex of clavus. Apex of corium acuminate, pale brown. Membrane nearly black, the veins on costal area anastomosing, those on posterior area simple and subparallel, conspicuous. Connexivum dark brown, except on fourth to sixth segments, the apical angles of which are brown-ochraceous. Connexival annulations semitranslucent, a few on each segment having dark spots at their centers. Visible sclerites of seventh abdominal segment of same shape as antenniferous processes of head. Discs of metasternum and abdomen brown-ochraceous, remainder of ventrum and legs dark brown. All femora and tibiæ hispid or coarsely pilose.

Length 15 millimeters; greatest width (connexival) 7.5 millimeters, width of pronotum 6 millimeters.

PALAWAN, Iwahig, P. I., (*C. M. Weber* collector).

Type No. 11699 in Entomological Collection, Bureau of Science, Manila, P. I. The type lacks the left posterior leg.

BRACHYRHYNCHUS Laporte.

Ess. Hém. (1832), 54.
Type: *B. membranaceus* Fabr.

60. BRACHYRHYNCHUS TAGALICUS Stål.
Arictus tagalicus Stål, *Ö. V. A. F.* (1870), 672.
———— Bergr., *Verh. Z.-B. Gesellsch. Wien.* (1886), **36**, 59, pl. 2, figs. 5 and 7.
Brachyryhynchus tagalicus Dist., *Fauna British Ind., Rhyn.* (1904), **2**, 162.

This species is known also from Burma, Java and Nias Island. It is a very distinct form.

PALAWAN, Iwahig, Bacuit and Bintuan, P. I., (11660, 11667, 11693, *C. M. Weber*). A number of specimens from each place.

NEUROCTENUS Fieber.

Eur. Hem. (1861), 34.
Type: *N. caffer* Stål.

61. NEUROCTENUS PAR Bergr.
Crimia rubrescens (part) Walk., *Cat. Het.* (1873), 7, 14.
Neuroctenus par Bergr., *Öfv. Finska Vet. Soc. Förh.* (1887), **29**, 180.
——————— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 164.

Walker described specimens of this and the following species together under the same name in 1873, Bergroth separated this as a distinct species in 1887. The species certainly show a marked difference both in size, color and sculpture.

PALAWAN, Iwahig, P. I., (11733 *C. M. Weber*), 6 specimens.

62. NEUROCTENUS SERRULATUS Stål.
Neuroctenus serrulatus Stål, *Ö. V. A. F.* (1870), 674.
Crimia rubrescens (part) Walk., *Cat. Het.* (1873), 7, 14.
Neuroctenus serrulatus Stål, *Enum. Hem.* (1873), 3, 145.
——————— Bergr., *Öfv. Finska Vet. Soc. Förh.* (1887), **29**, 179.
——————— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 165.

This species, originally described from the Philippines, is known also in Java, Siam, Ceylon and India.

PALAWAN, Iwahig, P. I., (11705 *C. M. Weber*). A single specimen.

63. NEUROCTENUS NITIDULUS Bergr.
Neuroctenus nitidulus Bergr., *Öfv. Finska Vet. Soc. Förh.* (1887), **29**, 177.
——————— id., *Ent. Tidskr.* (1894), **15**, 113.
——————— Dist. *Fauna British Ind., Rhyn.* (1904), 2, 165.

This is a very easily recognized species, owing to its shining surface. This is its first record for the Philippines. It is quite abundant at Iwahig.

PALAWAN, Iwahig, P. I., (11735 *C. M. Weber*), 14 specimens.

64. **Neuroctenus weberi** sp. nov.

Elongate, ovate, dark red-brown to piceous, slightly paler beneath; head with preocular and postocular spinous processes of about equal length, equally acute; postocular just passing eyes, which are scarlet; anterior, cephalic process extending beyond apex of first antennal segment by one-half the length of the latter; its apex distinctly bifid and slightly broader than its base; tylus subprominent, but deflected between juga before bifid apex; mediad to each eye a broad longitudinal opaque sulcus; first, second and fourth antennal joints equal, robust; third slightly longer and more slender; fourth with lutescent pile at apical third; rostral segments equal; pale brown, tip darker. Pronotum with distinct carmine collar.

Granulations on head, pronotum and scutellum minute and uniformly distributed; transverse pronotal impression sinuate; scutellum obtusely sub-angulate at apex.

Corium slightly longer than scutellum; its apical transverse vein nearly straight, curved cephalad at mid longitudinal vein; its costal vein pale, translucent brown, its apical margin broadly albescent; base of membrane transversely albescent; remainder and veins nearly black. Connexivum red-brown; the submarginal parallel area darker. Anterior and intermediate femora strongly incrassate, granulate, posterior less so; all tibiæ denticulate externally.

Length 5.25 millimeters; greatest width 2 millimeters.

PALAWAN, Iwahig, P. I., *C. M. Weber*, collector, to whom the species is dedicated.

Type ♂ No. 11734 in Entomological Collection, Bureau of Science, Manila, P. I.

Another collection of this species from Iwahig (11646 *C. M. Weber*), 25 specimens. Among these the individuals vary in length from the size of the type to 5.75 millimeters, and are somewhat darker in color.

65. **Neuroctenus antennatus** sp. nov.

Elongate, ovate; piceous, nearly black; tuberculate; first segment of antennae just reaching apex of juga, second joint shorter than first, less tumescent, third longest, one-fourth longer than second, very slender in comparison with others; fourth as long as second. Intraocular foveæ obsolescent; collar to pronotum almost obsolete. Granulations on head, prothorax and scutellum, coarse, evenly distributed; scutellum broader and shorter than in *N. weberi*. Corium with apex, acuminate, black; base of membrane albescent as is apical margin of corium. Ventrum piceous; femora tumescent granulate; tibiæ not serrulate along dorsal margins.

Length 5.75 millimeters; width of pronotum 1.75 millimeters, of abdomen 2.25 millimeters.

PALAWAN, Bacuit, P. I., (*C. M. Weber* collector).

Type No. 11732 in Entomological Collection, Bureau of Science, Manila, P. I. Two paratypes bear the same number.

This species differ from *N. weberi* in having the first antennal segment reaching the apex of juga, in the great length and slenderness of third segments, in the shape of the scutellum and in the almost entire absence of the intraocular foveæ and the anterior collar to pronotum.

Fam. HYDROMETRIDÆ

Subf. GERRINÆ.

Div. GERRINARIA.

LIMNOMETRA Mayr.

Reise Novara, Hem. (1866), 174.
Type: *L. femorata* Mayr.

66. LIMNOMETRA FEMORATA Mayr. (Plate II, fig. 3, a.)

Limnometra femorata Mayr, *Reise der Freg. Novara, Hem.* (1866), 174.
———————— Stål, *Ö. V. A. F.* (1870), 705.

This species which very closely resembles *L. cursitans* Fabr., differs from it in having the apical portions of the intermediate and posterior femora and the apical half of the intermediate tibiæ luteous, and the apex of the first and the whole of the fourth antennal segments albescent. Distant places this genus as synonymous with *Gerris*.

PALAWAN, Iwahig, P. I., (11228 *W. Schultze*), 4 specimens.

GERRIS Fabr.

Ent. Syst. (1794), 4, 187.
Type: *G. lacustris* Linn.

67. GERRIS ?ANADYOMENE Kirk. (Plate II, fig. 1.)
Gerris ?anadyomene Kirk., *Entomologist* (1901), 34, 117.
——————— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 177.

The two specimens at hand have been referred doubtfully to this species. One of them is apterous and the other winged. They differ from Kirkaldy's description in having the middle of the second, the subbasal portion of the third antennal segments luteous and the whole of the apical segment except its base, white.

PALAWAN, Iwahig, P. I., (11229 *W. Schultze*), 2 specimens.

Fam. REDUVIIDÆ.

Subf. EMESINÆ.

Div. EMESARIA.

GARDENA Dohrn.

Linn. Ent. (1863), 14, 214.
Type: *G. melinarthrum* Dohrn.

68. GARDENA SEMPERI Dohrn.
Gardena semperi Dohrn, *Linn. Ent.* (1863), 15, 64.
——————— Stål, *Ö. V. A. F.* (1870), 704.
——————— id., *Enum. Hem.* (1874), 4, 96.

PALAWAN, Bacuit, P. I., (11905 *C. M. Weber*), 2 specimens.

Subf. STENOPODINÆ.

ONCOCEPHALUS Klug.

Symb. Phys. (1830), 2.
Type: *O. notatus* Klug.

69. ONCOCEPHALUS IMPUDICUS Reut., *Act. Soc. Sc. Fenn.* (1883), 12, 715, pl. 2, figs. 26 and 27.
Oncocephalus impudicus Dist., *Fauna British Ind., Rhyn.* (1904), 2, 229.

Recorded also from Java, Sumatra, Borneo and the Philippines. This species is very common on the Island of Negros and in Manila.

PALAWAN, Iwahig, P. I., (10867 *W. Schultze*). A single specimen.

Subf. ACANTHASPIDINÆ.

Div. ACANTHASPISARIA.

ACANTHASPIS Amyot and Serville.

Hém. (1843), 336.
Type: *A. flavovaria* Hahn.

70. **Acanthaspis distanti**[8] sp. nov.

Piceous, with sericeous and and ochraceous markings and a dark brown ovate spot at base of membrane between veins II and III.

Head nearly black, sericeous and with erect pile; a distinct, dark brown, median, glabrous carina from before anterior transverse impression to base of tylus which is also elevated above juga. Eyes dark brown; ocelli ochraceous; basal segment and apex of second segment of antennæ piceous (remainder of antennæ broken off). A well-defined transverse sulcus posterior to eyes and anterior to ocelli. Anteocular and postocular regions about equal, the latter slender.

Anterior lobe of pronotum piceous with sericeous sculpture as follows: Collar transversely, posterior to which medially three short longitudinal fasciæ terminated by an oblique fascia on each side from near median line to anterior lateral angles; posterior to oblique fascia on each side three short longitudinal fasciæ, the middle one curving lateral and coalescing with outer before anterior lateral angle. Posterior lobe rugosely sericeous, with a slight median fovea cephalad. Lateral angles acuminate, pale, hirsute. Lateral margins ochraceous. Scutellum medially foveate basally; spine suberect, hirsute, pale apically. Elytra piceous, slightly passing apex of abdomen; corium piceous, sparsely sericeous, with pale subbasal spot, a pale streak on median vein to its apex, then following apical margin of corium and curved anteriad on inner vein, thence to near apex of clavus. A small, pale, transverse streak from beginning of first streak halfway to costal margin. Lying exteriad and posteriad to the first and this, a dark brown spot. Membrane dark fuscous, the veins lighter, but bordered with piceous. A large, dark brown, nearly black, velvety spot at middle of base touching corium. Connexivum alternately piceous and ochraceous. Abdomen beneath uniformly piceous, sericeous except in region of stigmata.

Acetabula ochraceous, remainder of sternum piceous, moderately sericeous. Femora dark ochraceous, anterior and intermediate with basal, medial and apical piceous annulations; posterior with pale bases and two piceous rings beyond and one just before middle.

[8] After this paper was in press I received a MS. from Mr. W. L. Distant in which he also described this species as new. As I could not get his paper published before mine, I have taken the only alternative and am glad to be able to change the name which I had given it to *A. distanti*. A figure of the species will occur in Mr. Distant's paper, to be published shortly in this Journal.

Anterior and mid tibiæ with a spongy fovea on their apical halves; apices of anterior tibiæ rounded and foveate dorsally for reception of tarsi, which, with those of remaining legs, are pale fuscous; their bases and apices piceous, their middle portions ochraceous. Posterior tibiæ with three equal annulations, the apical and basal piceous, the middle ochraceous. All legs with fine erect hairs.

Length 14 millimeters; width of pronotum 3.9 millimeters.

PALAWAN, Iwahig, P. I., (*C. M. Weber*, collector).

Type No. 11904 in Entomological Collection, Bureau of Science, Manila, P. I.

This species appears to be most closely related to *A. signaticollis* Stål, but may be easily differentiated from its close allies by the presence of the large dark spot at base of membrane and the sericeous pattern on the anterior lobe of the pronotum.

Div. LENÆARIA.

VELITRA Stål.

Hem. Afr. (1865), 3, 122.
Type: *V. rubropicta* Amy. & Serv.

71. VELITRA RUBROPICTA Amy. & Serv.
Opinus rubropictus Amy. & Serv., *Hém.* (1843), 339.
Platymerus discolor Herr-Schäff., *Wanz. Ins.* (1848), 8, 31, fig. 805.
Velitra rubro-picta Stål, *Ö. V. A. F.* (1870), 695.
Reduvius rivulosus Walk., *Cat. Het.* (1873), 7, 194.
Velitra rubropicta Stål, *Enum. Hem.* (1874), 4, 69.
——————— Dist., *Ann. Mag. Nat. Hist.* (1902) (7), 10, 189.
——————— id., *Fauna British Ind., Rhyn.* (1904), 2, 276, fig. 182.

This species appears to be rare in the Philippines. No specimen has been brought to this laboratory previous to the one here recorded.

PALAWAN, Mangahan Swamp near Iwahig, P. I., (11681 *C. M. Weber*). A single specimen, slightly mutilated.

SMINTHOCORIS Distant.

Fauna British Ind., Rhyn. (1904), 2, 279.
Type: *S. pictus* Lap.

72. SMINTHOCORIS PICTUS Lap.
Tapeinus pictus Lap., *Ess. Hém.* (1832), 82.
Tapinus ——— Burm., *Handb.* (1835), 2, pt. 1, 236.
Hammatocoris —— Blanch., *Hist. Ins.* (1840), 3, 105.
Opinus ——— A. & S., *Hist. Nat. des Ins.* (1843), 340.
Tapinus ——— Herr-Schäff., *Wanz. Ins.* (1843), 8, 56, fig. 825.
Sminthus —— Stål, *Ö. V. A. F.* (1870), 694.
——————— id., *Enum. Hem.* (1874), 4, 68.
Sminthocoris — Dist., *Fauna British Ind., Rhyn.* (1904), 2, 279 [ref.].

Though not having the original description of this species, I feel certain of the identification because of the statement made by Stål in describing *S. zonatus* in "Enumeratio Hemipterorum" in which he says: "S. picto *simillimus, differt parte anteriore pallida hemelytrorum postice truncata, parte fusca corii ante partem fuscam membranae haud extensa"*, while the rest of the description of *zonatus* agrees perfectly with the insects at hand.

PALAWAN, Mangahan Swamp near Iwahig, P. I., (11683 *C. M. Weber*). Two adult and one young specimen.

Subf. PIRATINÆ.

ECTOMOCORIS Mayr.

Verh. Z.-B. Ges. Wien (1865), **15**, 438.
Type: *E. quadriguttatus* Fabr.

73. ECTOMOCORIS FLAVOMACULATUS Stål (Plate II, fig. 7.)
Ectomocoris flavomaculatus Stål, *Ö. V. A. F.* (1870), 692.
Eumerus ——————— id., *Enum. Hem.* (1874), **4**, 62.

This species was described by Stål from the Philippines and has been collected by me in Manila. I do not think his points of differentiation warrant making a new genus for this species and have therefore retained it in *Ectomocoris*.

PALAWAN, Iwahig, P. I., (10956 *W. Schultze*).

Subf. ECTRICHODIINÆ.

ECTRYCHOTES Burmeister.

Handb. der Ent. (1835), **2**, 237.
Type: *E. pilicornis* Fabr.

74. ECTRYCHOTES HÆMATOGASTRA Burm.
Reduvius (Loricerus) hæmatogaster Burm., *Nov. Act. Ac. Leop.* supp. prim. (1834), 301, Tab. 41, fig. 9.
Larymna hæmatogastra Stål, *Ö. V. A. F.* (1860), **16**, 184.
——————— Mayr, *Reise Novara., Hem.* (1866), 156.
Larymna ——————— Stål, *Ö. V. A. F.* (1870), 891.
Ectrichodia ——————— Walk., *Cat. Het.* (1873), **8**, 55.
Ectrychotes ——————— Stål, *Enum. Hem.* (1874), **4**, 51.

This species was originally described from the Philippines and has been taken by me in various parts of Luzon and Negros.

PALAWAN, Iwahig, P. I., (10862 *W. Schultze*), 3 specimens. Mangahan Swamp near Iwahig (11684 and 11907 *C. M. Weber*), 13 specimens.

Subf. APIOMERINÆ.

ECTINODERUS Westwood.

Proc. Ent. Soc. (1843), 74.
Type: *E. longimanus* Westw.

75. ECTINODERUS BIPUNCTATUS Amy. et Serv.
Pristhevarma bipunctata Amy. et Serv., *Hém.* (1843), 355, pl. 6, fig. 5.
Ectinoderus bipunctatus Stål, *Ö. V. A. F.* (1866), 245.
——————— Dist., *Fauna British Ind., Rhyn.* (1904), **2**, 326, fig. 211.

This is the first record of this species as from the Philippines, though it has been recorded from Java, Sumatra and Borneo, and two closely related species are known from these Islands, viz., *E. philippinensis* Westw., and *E. nitidus* Stål.

The specimens from Palawan are easily recognizable and the pale pronotum and spots on the corium, together with sanguineous bases of the femora, make their identity certain.

PALAWAN, Iwahig, P. I., (10859 *W. Schultze*, 11906 *C. M. Weber*), 3 specimens.

I have recently received five specimens of *E. philippinensis* Westw., from Limay, BATAAN, collected by R. J. Alvarez of the Bureau of Forestry. This species is much larger than *bipunctatus*.

Subf. HARPACTORINÆ.

Div. HARPACTORARIA.

HARPACTOR Laporte.

Ess. Hém. (1832), 8.
Type: *H. iracundus* Poda.

76. HARPACTOR MARGINELLUS Fabr.

Reduvius marginellus Fabr., *Syst. Rhyng.* (1803), 271.
——————— Stål, *Hem. Fabr.* (1868), 1, 111.
Lamphirus ——— id., *Enum. Hem.* (1874), 4, 39.
——————— var. vicinus Stål, *Ö. V. A. F.* (1859), 202.
Harpactor ——— Dist., *Fauna British Ind., Rhyn.* (1904), 2, 334.

The specimen before me is Distant's var. *a*, having the red-ochraceous abdominal margins, spotted with black. The species is known from Burma, Sikhim, Aden, Borneo, Java, Celebes and China. It has not been reported from the Philippines previously.

PALAWAN, Iwahig, P. I., (11701 *C. M. Weber*). A single specimen.

SPHEDANOLESTES Stål.

Ö. V. A. F. (1866), 284, 288.
Type: *S. impressicollis* Stål.

77. **Sphedanolestes xanthopygus** sp. nov. (Plate I, fig. 6,*a*.)

Brown, except legs and ventral surface of abdomen which are piceous; glabrous, sparingly pilose. Head, antennæ and rostrum concolorous, postocular region equal to distance from apex of head to posterior margins of eyes and having, posterior to ocelli, four erect bristles, the tips of which curve forward; ocelli lemon-yellow, on slight tubercles; posterior lobe of pronotum obsoletely granular, tuberculate. Scutellum with **Y**-shaped pale carina on apical half; corium and membrane fuliginous, apical angle of former piceous; dorsum of abdomen sordid yellow, irrorated with piceous, except last segment which is piceous. Pygidium orange-yellow in both sexes.

Legs clothed with fine erect hairs. Tibiæ apically with silver pubescence.

Length to tip of abdomen 10 millimeters; to tip of tegmina 12 millimeters; width 2.5 millimeters.

PALAWAN, Iwahig, P. I., (*W. Schultze,* collector).

Types of ♂ and ♀ No. 10869 in Entomological Collection, Bureau of Science, Manila, P. I.

A single male and a single female, only, were collected. This species differs from every described species in the monotony of its general coloring and in the color of the pygidium.

Div. SYCANARIA.

SYCANUS Amyot and Serville.

Hém. (1843), 360.
Type: *S. collaris* Fabr.

78. SYCANUS COLLARIS Fabr.

Reduvius collaris Fabr., *Spec. Ins.* (1781), **2**, 380.
Cimex carbonarius Gmel., *Syst. Nat.* (1788) (1), **4**, 2199.
Zelus collaris Fabr., *Syst. Rhyng.* (1803), 285.
Reduvius longicollis Lepell. & Serv., *Enc. Méth.* (1825), **10**, 278.
Zelus collaris Amy. & Serv., *Hém.* (1843), 360.
Arilus ——— Herr.-Schäff., *Wanz. Ins.* (1848), **8**, 37, fig. 813.
Sycanus —— Dohrn, *Stett. Ent. Zeit.* (1859), **20**, 98.
——— leucomesus Walk., *Cat. Het.* (1873), **8**, 84.
——— collaris Stål, *Enum. Hem.* (1874), **4**, 28.
——————— Dist., *Ann. Mag. Nat. Hist.* (1903) (7), **11**, 212.
——————— id., *Fauna British Ind., Rhyn.* (1904), **2**, 351, fig. 225.

Known from India, Ceylon and several islands of the Malay Archipelago.

PALAWAN, Iwahig, P. I., (10858 *W. Schultze*), 5 specimens in fair condition; Bacuit, P. I., (11674 and 11913 *C. M. Weber*), 2 specimens.

Div. EUAGORASARIA.

MACRACANTHOPSIS Reuter.

Act. Soc. Sc. Fenn. (1881), **12**, 282.
Type: *M. nodipes* Reut.

79. **Macracanthopsis nigritibialis** sp. nov. (Plate I, fig. 7,*a*.)

Elongate, ovate, ochraceous, pubescent; antennæ, posterior tibiæ, a spot near apical angle of corium and all tarsi black.

Head pale, dull ochraceous; ocelli red; eyes brown; apex of rostrum piceous; first segment of antennæ shining black, second opaque, third and fourth brown; first slightly longer than combined length of second and third; fourth as long as first and third; apices of post-antennal spines fuscous; juga conically, porrectly produced; fuscous; anterior lobe of pronotum with distinct longitudinal fovea; anterior angles sublobately produced; lateral angles of posterior lobe tumescent, subacute, their margins slightly reflexed. Scutellum tumescent basally, medially carinate apically, pubescent. Tegmina extend beyond apex of abdomen for one-third their length. Apical half of clavus translucent, foliate; apical margin of corium concave at juncture with membrane which is fuliginous on basal half; apical angle of corium acuminate; a black spot on its costal area twice its own length from angle.

Entire body beneath pale ochraceous, glabrous, sparsely pubescent; all femora and tibiæ, except posterior, concolorous with body, pubescent; posterior tibiæ shining black, pubescent. All tarsi black.

Length 10 millimeters; to apex of tegmina 13 millimeters; width 3 millimeters; antennæ 15.5 millimeters.

PALAWAN, Bacuit, P. I., (*C. M. Weber*, collector).

Type No. 11666 in Entomological Collection, Bureau of Science, Manila, P. I.

This species is easily distinguished by the black posterior tarsi and the black spots before the apical angle of the corium.

Another specimen of this species was taken by Prof. Dean C. Worcester at Mansalay, MINDORO, on 16 July 1909. This specimen is labeled as the paratype. It is No. 11400 in the collection.

EUAGORAS Burmeister.

Hand. der Ent. (1835), **2**, 226.
Type: *E. stollii* Burm.

80. EUAGORAS PLAGIATUS Burm.
Zelus plagiatus Burm., *Nov. Act. Ac. Leop. Nat. Cur.*, Suppl. 1, (1834), **16**, 303.
Darbanus nigrolineatus (♂) Amy. & Serv., *Hém.* (1843), 371.
—————— Stål, *Ö. V. A. F.* (1859), 194.
Euagoras —————— id., *Stett. Ent. Zeit.* (1861), **22**, 136.
——— plagiatus Stål, *Ö. V. A. F.* (1870), 679.
—————— Distant, *Fauna British Ind., Rhyn.* (1904), **2**, 363, fig. 231.

This species, recorded from India, Assam, Andamans, Java, and by Stål from the Philippines, has been taken by me in Manila.

PALAWAN, Iwahig, P. I., (10864 *W. Schultze*, 11921 *C. M. Weber*), 10 specimens.

EPIDAUS Stål.

Ö. V. A. F. (1859), 192.
Type: *E. transversus* Burm.

81. EPIDAUS MACULIGER Stål, *Ö. V. A. F.* (1859), 192.
Epidaus maculiger Stål, *ibid.*, (1866), 271.
—————— Stål, *ibid.*, (1870), 679.
—————— id., *Enum. Hem.* (1874), **4**, 22.

Originally described from the Philippines.

The principal character by which this species may be separated from its close ally *E. transversus* Burm., is in its having the discoidal lobes of the posterior portion of the pronotum simple instead of bidentate.

PALAWAN, Iwahig, P. I., (10861 *W. Schultze*), 7 specimens; Bacuit, P. I., (11671 *C. M. Weber*).

ASTINUS Stål.

Ö. V. A. F. (1859), 193.
Type: *A. m-album* Amy. & Serv.

82. ASTINUS PUSTULATUS Stål (Pl. I fig. 2, a.)
Astinus pustulatus Stål, *Ann. Soc. Ent. Fr.* (1863) (4), **3**, 30.
——————— id., *Ö. V. A. F.* (1866), **23**, 269.
——————— id., *Enum. Hem.* (1874), **4**, 22.

This beautiful species, originally described from Borneo, is here recorded from the Philippine Islands for the first time.

The double series of ventral white, mouldy spots on the abdomen, separates this species from the closely related *A. modestus* Stål, described from Pulo Penang.

PALAWAN, Iwahig, P. I., (10860 *W. Schultze*), 6 specimens were taken in mangrove swamp; Bacuit, P. I., (11675 & 11915 *C. M. Weber*), 6 specimens.

Div. POLIDIDUSARIA.

SCIPINIA Stål.

Stett. Ent. Zeit. (1861), **22**, 137, 138.
Type: *S. horrida* Stål.

83. SCIPINIA HORRIDA Stål.
Sinea horrida Stål, *Freg. Eug. Resa, Ins.* (1859), 262.
—— peltastes Dohrn, *Stett. Ent. Zeit.* (1860), **21**, 406.
Scipinia horrida Stål, *ibid.* (1861), **22**, 138.
——————— id., *Ö. V. A. F.* (1866), 264.
——————— ibid. (1870), 675.
——————— Stål, *Enum. Hem.* (1874), 4, 15.
——————— Dist., *Fauna, British Ind., Rhyn.* (1904), **2**, 384, fig. 244

This species is extremely common in Manila, it being hardly possible to make a single sweeping in certain places, without securing numerous specimens.

PALAWAN, Iwahig, P. I., (11914 *C. M. Weber*), 1 specimen.

Fam. CAPSIDÆ.

Subf. CAPSINÆ.

Div. CYLLOCORARIA.

STHENARIDEA Reuter.

Ent. Tidskr. (1884), **5**, 197.
Type: *S. pusilla* Reut.

84. STHENARIDEA PUSILLA Reuter.
Sthenaridea pusilla Reut., *Ent. Tidskr.* (1884), **5**, 198.
——— Dist. *Fauna British Ind., Rhyn.* (1904), **2**, 475, fig. 306.

PALAWAN, Tara Island, P. I., (11802 *C. M. Weber*), 1 specimen.

This specimen appears to correspond in every detail with the description and figure given by Distant, except that it is slightly smaller.

Fam. NEPIDÆ.

LACCOTREPHES Stål.

Hem. Afr. (1865), **3**, 186.
Type: *L. fabricii* Stål.

85. LACCOTREPHES ROBUSTUS Stål, *Ö. V. A. F.* (1870), 706.
Nepa robusta Ferrari, *Ann. Hoffm. Wien.* (1888), **3**, 182.
Laccotrephes robustus Montand., *Ann. Mus. Civ. Gen.* (1897), **37**, 376.
Nepa robusta var. pfeiferiæ Ferrari, *op. cit.* p. 187.
Laccotrephes robustus Montand, *op. et pag. cit.*
——— Dist., *Fauna British Ind., Rhyn.* (1906), **3**, 18, fig. 13.

This species, originally described from the Philippines by Stål, has also a rather wide distribution outside the Archipelago. It is found in most parts of the Islands.

PALAWAN, Iwahig, P. I., (11231 *W. Schultze*), 2 adults and 1 nymph.

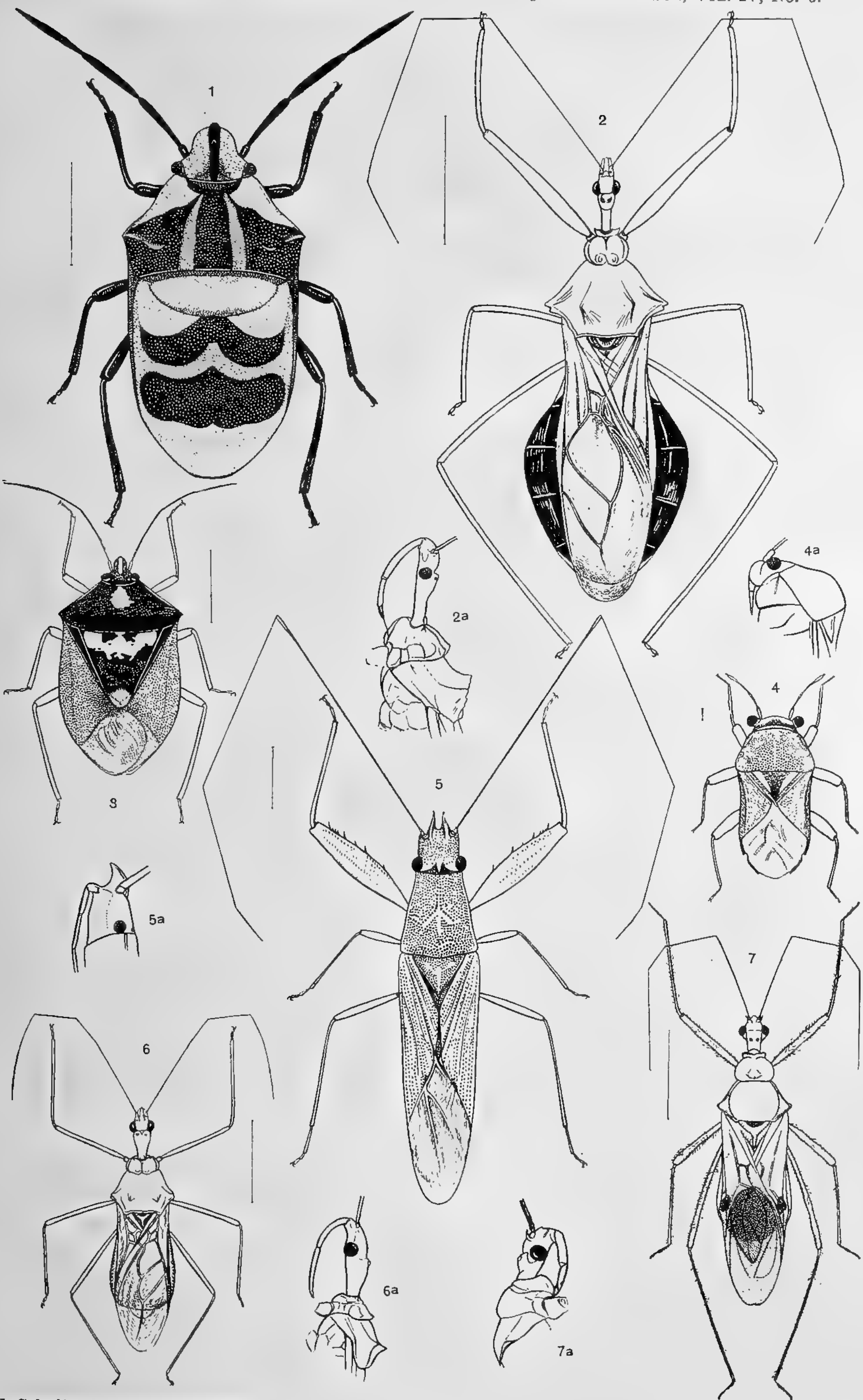
ILLUSTRATIONS.

PLATE I.

FIG. 1. Cosmocoris pulcherrimus Banks, sp. nov.
2, *a*. Astinus pustulatus Stål.
3. Tolumnia longirostris Dallas.
4, *a*. Chauliops bisontula Banks, sp. nov.
5, *a*. Pachygrontha bicornuta Banks, sp. nov.
6, *a*. Sphedanolestes xanthopygus Banks, sp. nov.
7, *a*. Macracanthopsis nigritibialis Banks, sp. nov.

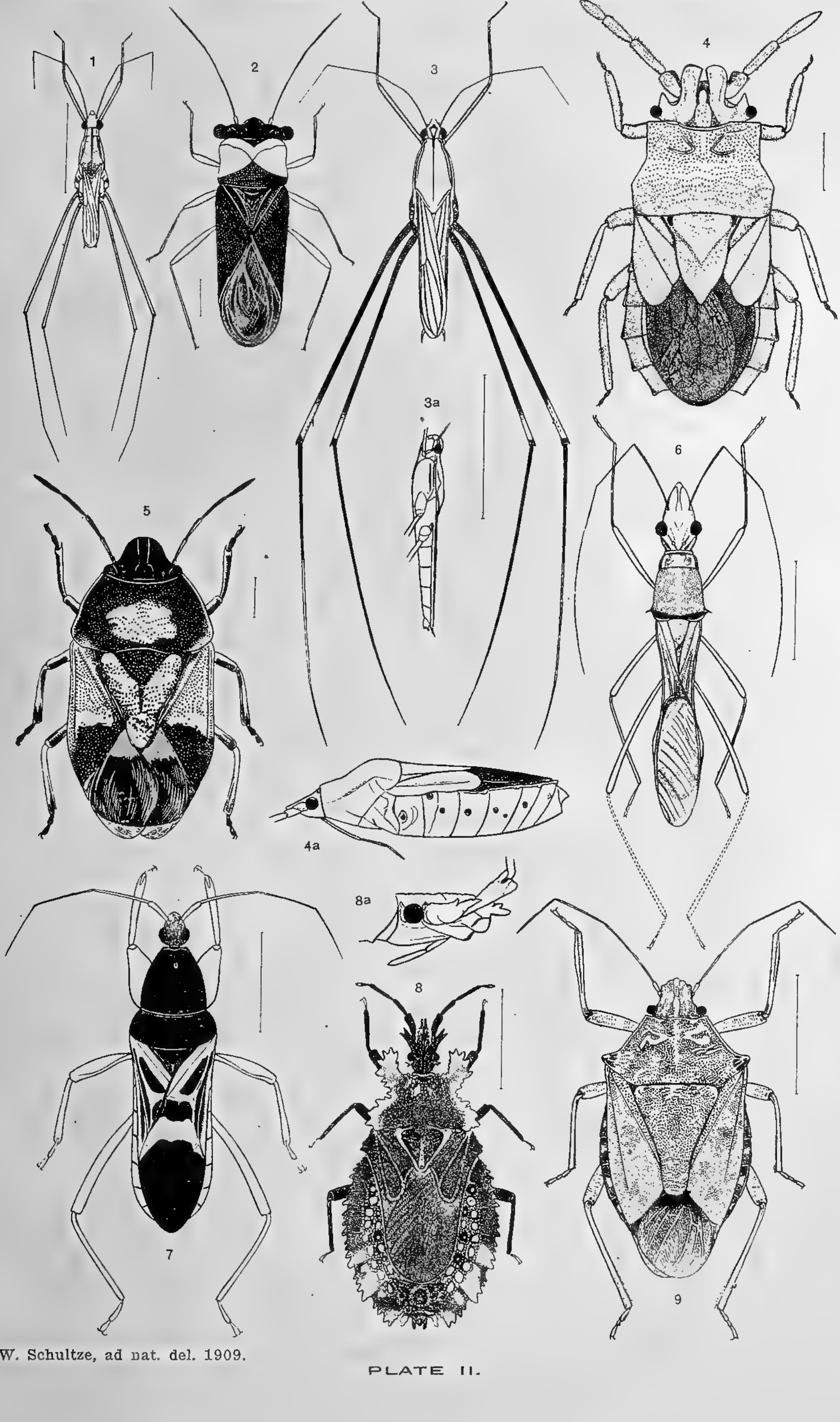
PLATE II.

FIG. 1. Gerris ?anadymone Kirkaldy.
2. Scopiastes ruficollis Banks, sp. nov.
3, *a*. Limnometra femorata Mayr.
4, *a*. Eumenotes obscura Westwood.
5. Apines grisea Banks, sp. nov.
6. Marcius quinquespinus Stål.
7. Ectomocoris flavomaculatus Stål.
8, *a*. Acantharadus giganteus Banks, gen. et sp. nov.
9. Dalpada tagalica Stål.



W. Schultze, ad nat. del. 1909.

PLATE I.



W. Schultze, ad nat. del. 1909.

PLATE II.

A LIST OF SNAKES FOUND IN PALAWAN.

By Lawrence E. Griffin.
(*From the Biological Laboratory, Bureau of Science, Manila, P. I.*)

Two collections of snakes from Iwahig, Palawan, one made by Mr. C. M. Weber of Iwahig and the other by Mr. Schultze of this laboratory, have recently been placed in my hands. As these collections add considerably to the known Ophidian fauna of the island, it seems well to publish a complete list of the snakes now known to be found in Palawan. The only other considerable collection of snakes known to be from this island was made about sixteen years ago by Mr. Everett and described by Boulenger.[1]

In 1881 Peters [2] published the description of a snake from Palawan, *Doliophis bilineatus*, "the first poisonous snake recorded from the Philippines." Aside from these papers I do not know of any which treat of Palawan snakes. Cuming sent a number of snakes from the Philippines to the British Museum,[3] but since the locality is given as "Philippines" only, it is impossible to take them into account while listing the snakes of any particular locality.

Four new species are described in the following list; there is also recorded one genus and three species already known from other localities but now found for the first time in the Philippines. We now know of thirty-one species of snakes which exist in Palawan. Thorough exploration of the island will undoubtedly add many more species to the list, especially of marine forms. Fourteen species are added to Boulenger's list, and all tend to confirm his conclusion as to the close relationship of the Palawan reptiles with those of Borneo.

The species included in Weber's collection are indicated by an asterisk (*) after the name; those in Schultze's collection by a dagger (†); and those in Everett's collection, listed by Boulenger, by a double dagger (‡).

Python reticulatus (Schneider).*

Found throughout the Philippines.

[1] On the Herpetological Fauna of Palawan and Balabac. *Ann. Nat. Hist.* (1894), 14, 81–89.

[2] *Sitzungsber. d. Ges. naturfor. Freunde zu Berlin*, 1881.

[3] Catalogue of the Snakes in the British Museum.

Polyodontophis bivitattus Blgr.‡

Found only in Palawan. The two specimens upon which Boulenger's description is founded are the only ones which have been collected.

Natrix spilogaster (Boie).‡

Found only in the Philippines. This is the most common snake in some parts of the Islands, but Everett's specimen is the only one so far recorded from Palawan.

Natrix chrysaryga (Schleg.)* † ‡.

Found only in Palawan and Balabac of the Philippine Archipelago. This species is found outside the Philippines in Java, Sumatra, Borneo, India and China.

Ophites aulicus (Linn.)*

First collected in Palawan by Weber. Common throughout south-eastern Asia, the Malay Archipelago, and the Philippines.

Ophites subcinctus (Boie).*

Found in Palawan, Mindanao, the Malay Peninsula and Archipelago. This is the first record of its occurrence in Palawan.

Dryocalamus philippinus n. sp.†

Maxillary teeth 8; the last two considerably larger than the others, compressed toward their points, and separated from the first six by a short space. The anterior mandibular teeth are slightly longer than the posterior. There is one distinct tooth-like knob on the basisphenoid. Width of head almost twice that of the neck; head much depressed and flattened. Eye large, pupil vertically elliptic. Body slightly compressed and slender. Scales smooth, no pits. Ventrals and subcaudals strongly keeled, the latter in two rows.

Rostral nearly twice as broad as deep, just visible from above; nasal entire; suture between internasals slightly longer than between præfrontals; frontal longer than its distance from the end of the snout, a little shorter than the parietals; loreal longer than deep, entering the eye; one small prae-ocular above the loreal; two post-oculars; temporals 2+3; seven upper labials, the third and fourth entering the eye; four lower labials in contact with the anterior chin-shields, which are longer than the posterior.

Black above, with three white stripes extending from the head to the tip of the tail, each stripe being one scale wide; the stripes are separated from each other and the white lower surface by two scale-rows; the outer row of scales on each side is white; upper lip, angle of jaw, and lower surface of head white; dark brown stripes pass along each side of the head, through the eyes, meet on the occipital region and join the dark stripes on each side of the neck; central portion of frontal and parietals dark brown, surrounded by a white band which extends onto the præfrontals and internasals.

Total length 241 millimeters; tail 57 millimeters; scales in fifteen rows; anal entire; ventrals 216; subcaudals 99.

Iwahig, Palawan; collected by Mr. W. Schultze.

This seems to be the first specimen of the genus to be found within the Philippines. Members of the genus are found from southern India and Ceylon to Sumatra. In many respects *D. philippinus* is very much like *D. tristrigatus*, but the differences are sufficiently great to clearly differentiate the species. *D. philippinus* differs from all the other species of the genus in the absence of pits on the scales.

Elaphe oxycephala (Boie).*‡

This species is found recorded within the Philippines only from Palawan and Balabac. It is, however, a widely distributed species, found in the eastern Himalayas, Malay Peninsula and Archipelago.

Elaphe erythrura (D. & B.).‡

Widely distributed in the Philippines; also found in Celebes.

Elaphe philippina n. sp.*†

The species *Elaphe* (Coluber) *melanura, E. radiata, E. erythrura,* and *E. philippina,* form a very closely allied group in which *E. philippina* seems to be intermediate between *E. melanura* and *E. erythrura.* The number of scale rows is the same as in *E. erythrura,* as well as the general shape and arrangement of scales. The proportions of the head and body are, however, constantly different, and with the markings seem to present sufficient differences for constituting a separate species.

Scales feebly keeled, the outer row of scales on the body and tail smooth; rostral slightly broader than deep, broader at the top and more oval in its general outline than in *E. erythrura;* inter-nasals as broad as long, much shorter than the præfrontals; frontal very little longer than broad, as long as or a little shorter than its distance from the end of the snout, shorter than the parietals; loreal as deep as long; one large præocular extending upon the dorsal surface of the head; two small postoculars; temporals 2+2; nine upper labials, fourth, fifth and sixth entering the eye; five or six lower labials in contact with the anterior chin shields, which are a little shorter than the posterior.

Scales in 21 rows on the body and 23 on the neck. Lateral keel of ventrals very obtuse.

Light brown above; upper lip and ventral surface yellowish; the lateral ends of the ventral scales brown; a black streak on the lip below the eye, a black line extending from the eye to the angle of the mouth, and a longer black line extending from the temporals diagonally over the side of the neck; in a young specimen the anterior half of the body is crossed by fourteen dark bars, each enclosing a white spot in its ventral ends, and sometimes other spots in the dorsal portion. Older specimens show only the lateral parts of the anterior three to six bands; in these the white centers are faint, while the black color extends well down on the sides of the ventral scales. The head of *E. philippina* is slightly narrower than that of *E. erythruras*, and the end of the snout a little more oblique.

Measurements of two adults of each species are as follows:

From tip of the snout to the posterior end of the parietal suture, *E. erythruras*, 26 millimeters, 24 millimeters; *E. philippina*, 26 millimeters, 23 millimeters.

Across the widest part of the head, *E. erythrurus*, 20 millimeters, 17½ millimeters; *E. philippina*, 17 millimeters, 15 millimeters.

This shows the head of *E. erythrura* to be a little more than one-sixth wider than that of *E. philippina*.

No.	Sex.	Locality.	Collector.	When collected.	Scale rows.	Anals.	Ventrals.	Subcaudals.	Total length.	Length of tail.
									mm.	*mm.*
14	♀	Iwahig, Palawan	C. M. Weber	Feb., 1909	21	1	233	106	1,420	320
15	♀	do	do	do	21	1	238	105	1,340	304
16	♂	do	do	do	21	1	219	110	460	85
17	♀	do	do	do	21	1	236	94	1,420	307
18	♀	do	W. Schultze	Mar., 1909	21	1	227	111	465	107

Boulenger [4] gives the number of ventrals of *E. erythruras* as 211–233, of subcaudals as 86–100. It will be noticed that both the ventrals and subcaudals are more numerous in *E. philippina*.

Dendrophis pictus Gmel.*†‡

Found throughout the Philippines, and also in India, Indo-China, the Malay Peninsula and Archipelago.

Dendrelaphis caudolineatus Gray.*†‡

Found in Palawan, Balabac, southern India, the Malay Peninsula and Archipelago.

Oligodon iwahigensis n. sp.†

Maxillary teeth six; two teeth on each palatine. Nasal divided; portion of rostral seen from above much shorter than its distance from the frontal; suture between the internasals slightly shorter than that between the præfrontals; frontal longer than its distance from the end of the snout, a little shorter than the parietals; loreal very small, longer than deep; one prae- and two post-oculars; temporals 1+2; seven upper labials, third and fourth entering the eye; labials in contact with the

[4] *Loc. cit.*

anterior chin-shields, which are longer than the posterior. Scales in 15 rows; ventrals 139; anal entire; subcaudals 36.

Dark purplish brown above, with eleven light brown rhomboidal spots along the back. Lateral scales finely flecked with white dots; here and there a larger white spot. Upper surface of head gray-brown, with a transverse brown band passing through the eye, and a chevron shaped band back of this, having its point confluent with the middle of the anterior band. Lower surface of head and throat whitish, with numerous irregular dark brown splotches. Remainder of ventral surface uniform coral-red.

Total length, 324 millimeters; tail, 57 millimeters.

Iwahig, Palawan; collected by Mr. W. Schultze.

Very much like *O. everetti*, except for color and markings. The portion of the rostral seen from above is much shorter, and the shape of other head scales is slightly different.

It differs from *O. notospilus* in having fewer and smaller dorsal spots, two postoculars in place of one, broader bands on the head, and a different coloration.

Ablabes tricolor (Schleg.).†

Iwahig, Palawan. I believe that this is the first record of this snake being found in the Philippines. It also occurs in Java, Sumatra, and Borneo.

Calamaria everetti Blgr.*‡

Known to occur in Palawan and Borneo. The specimen collected by Weber differs markedly in its coloration from those described by Boulenger. This specimen is black above without spots or markings of any kind except on the neck, where the color is very dark brown, and there is a narrow, incomplete yellowish collar. The upper surface of the head is very dark brown, without darker spots. Each scale of the outer row is yellowish in the center, black on the borders. Lower parts dull yellow, tinged with red. No median dark stripe along the lower surface of the tail.

Total length 315 millimeters; tail 26 millimeters. Scale rows 13; ventrals 174; anal entire; subcaudals 25.

Hurria rhynchops (Schneid.).*‡

Found along rocky coasts throughout the Philippines, and from India to New Guinea and Australia.

Boiga cynodon (Boie).†‡

Found in Palawan, Mindanao, Borneo, the Malay Peninsula and Archipelago.

Boiga dendrophila (Schleg.).*†‡

Found in Palawan, Mindanao, Luzon, Malay Peninsula, Borneo, Sumatra, Java, and Celebes.

Psammodynastes pulverulentus Boie.‡

Recorded in the Philippines from Palawan, Balabac, Mindanao and Luzon. Found throughout southeastern Asia and the Malay Archipelago.

Dryophis prasinus Boie.*†

Found throughout the Philippines, eastern Himalayas, Burma, Indo-China, the Malay Peninsula and Archipelago.

Chrysopelea ornata (Shaw).*†

This is the first record of this snake in Palawan. It is widely distributed throughout the Philippines and all southeastern Asia.

Distira ornata (Gray).*

Iwahig, Palawan. Widely distributed on the coasts of the Indian and western Pacific oceans.

Laticauda colubrina (Schneider).*

Iwahig, Palawan. Very common and of large size among the Visayan Islands. Widely distributed on the coasts of the Indian and Pacific oceans.

Naja naja (Linnæus) var. **miolepis** Blgr.*‡

This variety has not yet been found outside of Palawan and Borneo. In Palawan this cobra is quite common.

Naja naja (Linnæus) var. **cæca** Gmel.*

This variety does not seem to have been captured before in Palawan, or in the southern islands of the Philippines. It is widely distributed in the northern islands, and in India, and has also been found in Java.

The species, with its several varieties, is found throughout southern Asia and the Malay Archipelago.

Naja bungarus Schleg.*

A single specimen, 239 centimeters long, has been collected in Palawan. The species is also found in Luzon. Outside the Philippines it is found throughout India, Burma, southern China, the Malay Peninsula and Archipelago.

Doliophis bilineatus (Peters).*†‡

Found only in Palawan and Balabac. It seems to be very common in Palawan.

Haplopeltura boa (Boie).*‡

To this date this snake has been recorded only from Palawan and Balabac, within the Philippine Archipelago. It is found in Pinang, Borneo, Java, and the Moluccas.

Trimeresurus gramineus (Shaw).*

This is, I believe, the first record of *T. gramineus* occurring in the Philippines. This specimen is dark purplish-blue above, faintly marked by ill-defined black bars; the upper surface of the head shows a network of faint black lines; belly bluish-green; tail coral-red, the yellow lateral streak being here spotted with purple.

Trimeresurus wagleri (Boie).*†‡

This species has been collected in the Philippines in Palawan, Mindanao, and Albay. Its range includes the entire Malay Archipelago. Two of Schultze's specimens are of a new color variety in which the usual blue or purple lines are replaced by red.

Trimeresurus sumatranus (Raffles).‡

A single specimen was found in Palawan by Everett. Found outside the Philippines in Singapore, Sumatra, and Borneo.

Trimeresurus schultzei n. sp.*

Scales between eyes and gular and occipital scales smooth; scales on body faintly keeled. First lower labial in contact with its fellow behind the symphysial. Tail prehensile; scales in 23 rows; ventrals 203; anal entire; subcaudals 70.

Canthus of snout rounded; diameter of the eye more than half its distance from the tip of the snout. Rostral one-fourth broader than deep; nasal entire; upper head-scales small, smooth, sub-imbricate, rounded behind instead of pointed, irregular in shape and size; 8 between the anterior ends of the supra-oculars; supra-oculars narrow, as long as the diameter of the eye; internasals small, separated by two scales of the same size; a sub-ocular and two or three post-oculars; sub-ocular in contact with the third labial; temporal scales smooth; ten upper labials, the second forming the anterior border of the loreal pit, the third largest.

Olive-green above, with black cross-bars united on the back by zig-zag lines; the dorsal surface of the head marked by a reticulate pattern of distinct black lines; outer row of scales canary-yellow; belly yellowish-green; tail bright red.

Total length, 330 millimeters; tail, 46 millimeters.

Iwahig, Palawan; collected by Mr. W. Schultze.

T. schultzei differs from *T. gramineus* in the following characters: the snout is shorter; the occipital scales are smooth; the inter-nasals are much smaller; the head scales are less pointed and more irregular, imbricating less; the scales of the body are less keeled, the scales are in 23 rows (although *T. gramineus* rarely has 23), ventrals 203; the body is longer in proportion to the tail.

ERRATA.

Page 143, line 26, **Regner** should read **Regener.**

Page 144, lines 5 and 9, **Fisher** should read **Fischer.**

Page 145, line 9, **Fisher** should read **Fischer.**

Page 221, line 13, "**One such schist has been described**" should read, "**One highly siliceous rock has been described.**"

Pages 239–259, in title at top of pages, **Quingan** should read **Quiangan.** In table of Contents, **Quingan** should read **Quiangan.**

Page 415, line 12, **nasal** should read **cephalic,** and **cephalic** should read **nasal.**

INDEX.

(New generic and specific names are printed in **heavy-faced** type.)

○

CONTENTS.

The "Philippine Journal of Science" is issued as follows:

Section A. General Science, $2, United States currency, per year.
Section B. Medical Sciences, $3, United States currency, per year.
Section C. Botany, $2, United States currency, per year.

The entire "Journal" $5, United States currency, per year.
Single numbers, 50 cents, United States currency.

Authors receive 100 copies of their papers free.

FOREIGN AGENTS.

THE MACMILLAN COMPANY, 64-66 Fifth Avenue, New York.
WM. WESLEY & SON, 28 Essex Street, Strand, London, W. C.
MARTINUS NIJHOFF, Nobelstraat 18, 's Gravenhage, Holland.
MAYER & MÜLLER, Prinz Louis Ferdinandstrasse 2, Berlin, N. W.
KELLY & WALSH, LIMITED, 32 Raffles Place, Singapore, S. S.
A. M. & J. FERGUSON, 19 Baillie Street, Colombo, Ceylon.

(Entered at the post-office at Manila, P. I., as second-class matter.)

A limited number of unbound copies of previous volumes are available which may be secured from the Business Manager, Philippine Journal of Science, Manila, P. I., or from any of the above-named agents at the following rates: Volume I, 1906 (not divided into sections), $10 United States currency; Supplement to Volume I, $4 United States currency; Volume I (without Supplement) $6 United States currency; all later volumes at current subscription prices.