SMITHSONIAN

MISCELLANEOUS COLLECTIONS

VOL. 60

"EVERY MAN IS A VALUABLE MEMBER OF SOCIETY WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES KNOWLEDGE FOR MEN"—SMITHSON

(PUBLICATION 2235)

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The present series, entitled "Smithsonian Miscellaneous Collections," is intended to embrace all the octavo publications of the Institution, except the Annual Report. Its scope is not limited, and the volumes thus far issued relate to nearly every branch of science. Among these various subjects zoölogy, bibliography, mineralogy, and anthropology have predominated.

The Institution also publishes a quarto series entitled "Smithsonian Contributions to Knowledge." It consists of memoirs based on extended original investigations, which have resulted in important additions to knowledge.

CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

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SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 1

THREE NEW SPECIES OF PIPUNCULIDÆ (DIPTERA) FROM PANAMA

BY

J. R. MALLOCH

Bureau of Entomology, U. S. Department of Agriculture

(PUBLICATION 2141)

CITY OF WASHINGTON

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SEPTEMBER 6, 1912

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THREE NEW SPECIES OF PIPUNCULIDÆ (DIPTERA) FROM PANAMA[1]

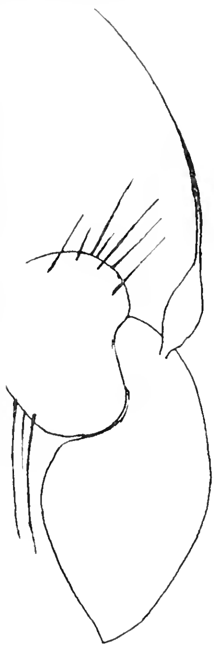
By J. R. MALLOCH

BUREAU OF ENTOMOLOGY, U. S. DEPARTMENT OF AGRICULTURE

The new species herein described were collected by Mr. August Busck, while a member of the Smithsonian Biological Survey of the Panama Canal Zone.

PIPUNCULUS INTERRUPTUS, new species

Male.—Eyes confluent for a longer distance than length of frons; frons gray dusted; face slightly narrowing from upper part to end of upper fourth, then parallel-sided to mouth margin, gray dusted; occiput gray dusted, not much swollen, rather broader above than below; antennæ black, third joint brownish, second with numerous hairs on dorsal surface and 2-3 on ventral, third joint not acuminate, obtusely pointed, arista brown, elongate dilated at base; proboscis brown; palpi yellow, brown at tip and somewhat spatulate. Mesonotum black, subopaque, brown-gray dusted, especially anteriorly and laterally; humeri black; pleuræ black, subopaque, gray dusted; scutellum sub-opaque, marginal hairs weak. Abdomen velvety opaque black, all segments with narrow, interrupted, white pollinose hind-marginal fasciæ; basal fringe black, all segments with distinct, black, lateral, rather long hairs; fifth segment one-third longer than fourth; hypopygium viewed from above one-half as long as fifth segment, left side slightly the longer, depression central, large and distinct, ventral processes yellowish with short pale hairs. Legs black, apices of fore coxæ, extreme apices of femora and bases of tibiæ yellow; all femora with ventral, short, black thorns, mid



P. INTERRUPTUS, ♂.

[1] This paper is the fourteenth dealing with the results of the Smithsonian Biological Survey of the Panama Canal Zone.

pair with long black hairs posteriorly, posterior femora not shining ventrally but glossy posteriorly; all tibiæ with two dorsal rows of short black bristles, antero-ventral surface of fore pair with short golden pilosity, hind tibiæ thickened on apical half, the two dorsal rows of short bristles widening for a short distance and then closing together, leaving an oval flat surface at middle of tibiæ, the hairs on anterior surface of dilated portion are noticeably longer than is usual in this genus being as long as diameter of tibiæ; three or four long hairs are present on last joint of tarsi, the claws are yellow with fuscous apices. Wings as in *acuticornis*. Halteres brownish yellow, knob black.

Female.—Eyes separated by an almost parallel-sided stripe, which is opaque brown on upper two-thirds and silvered on lower third; face silvered, becoming gradually slightly broader as it descends; antennæ slightly more rounded than in male and third joint brown. Ovipositor of moderate length, reaching to slightly beyond apex of third dorsal segment, viewed laterally, the attenuated apical portion longer than the black globose base. Legs rather darker than in male and armed in somewhat similar manner, though the long hairs on the hind tibiæ are not so conspicuous and the terminal tarsal hairs are much shorter. Otherwise as male. Length 2½ mm.

Locality.—Two males and one female. Taboga Island, Panama, Feb. 22-23, 1912 (August Busck).

Type.—Cat. No. 15119, U. S. Nat. Mus.

Very distinct from any described American species in color and armature of legs as well as in abdominal markings.

PIPUNCULUS ACUTICORNIS, new species

Male.—Eyes confluent for at most as long as length of frons; frons silvered, most distinctly on lower portion, slightly raised in center; face silvered, parallel-sided, as broad as frons at above antennæ; occiput silvered, as broad at ocelli as at lower margin of eyes; antennæ black, third joint yellow, elongate acuminate, arista yellow at base of swollen portion, the remainder brown; proboscis and palpi yellow. Mesonotum black, shining, gray-brown dusted, especially anteriorly; humeri yellow; a few extremely short hairs represent the normal discal rows and the humeral hairs are also weak; pleuræ black, shining, grayish dusted, anterior spiracle yellow; scutellum shining black, slightly brown dusted. Abdomen sub-opaque brown, all segments with distinct hind-marginal grayish fasciæ, the one on basal segment complete, those on other segments indistinctly interrupted centrally; fifth segment half as long again as fourth; basal fringe black, strong but not numerous; only the fifth segment with very weak dorsal hairs, the others bare; hypopygium shorter than fifth segment viewed from above, black, shining, slightly brown dusted, longest on right side, depression on left, shallow, a slight apical tuberculate production on right side, ventral processes not protruding, yellow. Legs yellow, only coxæ, except apices of fore pair and terminal joints of tarsi brown; posterior femora glossy ventrally, all femora with distinct but short ventral thorns; all tibiæ with two dorsal and two or three anterior and posterior longitudinal rows of short black bristles; last tarsal joint on all legs with several long black apical hairs; claws yellow, brown at apices. Wings slightly infuscated, stigma brown, reaching to end of auxiliary vein; second costal division one and one-half times as long as third, both together slightly longer than fourth; small cross vein at just beyond end of auxiliary vein and at three-sevenths from base of discal cell; outer cross vein slightly bent, as far as its own length from end of fifth vein; last portion of sixth vein one-third as long as last portion of fifth. Halteres yellow. Length, 2½ mm.

P. ACUTICORNIS, ♂.

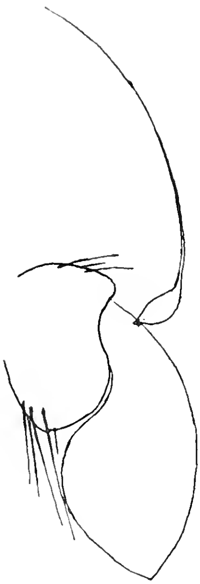
Locality.—One male Taboga Island, Panama, Feb. 22, 1912 (August Busck).

Type.—Cat. No. 15120, U. S. Nat. Mus.

Recognizable from any described American species by the color and shape of the antennæ, as well as the color of the legs and the peculiar hypopygium.

PIPUNCULUS BUSCKI, new species

Male.—Eyes confluent for a considerably longer distance than the length of frons; frons hardly silvered, only slightly so in center; face grayish-brown, as broad below antennæ as frons at above antennæ, then narrowing slightly and continuing almost parallel-sided to mouth margin; occiput silvered below, opaque and very narrow above; antennæ black, second joint with 2-3 distinct hairs on under surface, third rounded at apex and not much larger than second joint, arista black, swollen at base, not reaching as high as upper angle of frons; palpi pale. Mesonotum opaque brown; humeri brown; pleuræ slightly shining especially on lower portion; scutellum sub-opaque, bare. Abdomen opaque black-brown, only the posterior margins of segments narrowly paler, and low down on lateral margins each segment broadly pale brown; ventral surface opaque black-brown; basal fringe short, sparse, black; hypopygium brown, viewed from above as long as last segment of abdomen, a distinct depression on right side, ventral processes slightly shining and with a group of short pale hairs on the center. Legs dull brown, apices of coxæ, basis of tibiæ and middle three joints of tarsi paler; femoral bristles very weak. Wings distinctly fuscous except at base and along hind margin; stigma darker than general body of wing; veins dark brown; second costal division one and one-half times as long as third; second and third together longer than fourth; small cross vein slightly beyond end of auxiliary vein and at middle of discal cell; outer cross vein at nearly its own length from end of fifth vein; last portion of sixth vein slightly shorter than last portion of fifth. Halteres black-brown. Length, 1½ mm.



P. BUSCKI, ♂.

Locality.—One male. Taboga Island, Panama, Feb. 20, 1912 (August Busck).

Type.—Cat. No. 15121, U. S. Nat. Mus.

The exceptionally dark color of the wings and legs of this species separates it from any described American species.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 2

NEW MAMMALS FROM EASTERN PANAMA

BY

E. A. GOLDMAN

(Publication 2142)

CITY OF WASHINGTON
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NEW MAMMALS FROM EASTERN PANAMA[1]

By E. A. GOLDMAN

During the early part of the present year I was again detailed from the Biological Survey, U. S. Department of Agriculture to field work in connection with the Smithsonian Biological Survey of the Panama Canal Zone. Additional collections of mammals and birds were made in January and February in the Canal Zone. From the latter part of February to near the end of June work was carried on in eastern Panama to determine the faunal relation of the region to the Canal Zone and the better known areas to the westward and northward. The work was centered in the Pirri range of mountains which rises to a height of over 5,000 feet near the Colombian boundary southeast of San Miguel Bay. This range, one of the highest of eastern Panama, is an isolated spur jutting out into the broad, low valleys of the Rio Tuyra and its tributaries from the mountains, forming the continental divide to the southeastward. The region is covered with an unbroken forest and has a heavy annual rainfall, but at the lower levels the months from January to April are usually quite dry. At this season the prevailing winds are from the north and moisture laden air reaches the upper slopes of the Pirri Range after passing over the lower mountains along the continental divide and across the broad, dry Tuyra Valley. Clouds form almost continuously and the summits are shrouded in heavy fogs in which it is often impossible to see more than a few feet, twilight effects being produced in the forest even at midday. Although little real rain usually falls at this season the condensation of moisture on the foliage and constant dripping amount to light showers. The forest is of rather lower, denser growth than at the lower levels, many beautiful palms being conspicuous and epiphytic vegetation abundant.

The region was entered from the Pacific side. Leaving Panama by steamer, February 21, I landed at Marraganti, between one and two miles above Real de Santa Maria, near the head of tide-water on the Rio Tuyra, February 22. On the following day the river was ascended by dugout canoe as far as Boca de Cupe, a small settle-

[1] This paper is the fifteenth dealing with the results of the Smithsonian Biological Survey of the Panama Canal Zone.

ment at the mouth of the Rio Cupe. From this point I proceeded overland by the tramroad of the Darien Gold Mining Company, Ltd., to the mines 30 miles southwestward at Cana. The mines are situated at 2,000 feet altitude on the southeastern slope of the mountains and afforded a convenient base for work in the general region. The time from April 12 to May 6 was spent in the vicinity of a temporary camp at about 5,000 feet altitude on the headwaters of the Rio Limon near the summit of Mount Pirri.

The collections of natural history specimens, consisting mainly of about 800 birds and 595 mammals, show that eastern Panama is South American in general faunal character. Representatives of numerous groups of both classes not previously known from Panama are found to occur, and along with them a few recognized as North or Middle American, such as the mammalian genera *Peromyscus* and *Macrogeomys*, are extended from their known ranges in extreme western Panama. A number of the birds and mammals obtained proved to be undescribed. The new birds are being published by Mr. E. W. Nelson. Fourteen new species and subspecies of mammals are described below.

In the prosecution of the work the officials charged with the administration of the Canal Zone and Panama Railroad have rendered the same courteous and active assistance as last year. Special acknowledgments for aid are due to the Darien Gold Mining Company, Ltd., which, through the kindness of its managers and directors, Messrs. M. Masse, M. Degontin and G. Michel at Cana, and agents at various stations—Mr. Pablo Pinel at Panama, Mr. P. Campagnani at Marraganti and others facilitated the field operations in eastern Panama. To Mr. Samuel Henshaw I am indebted for the loan of topotype material, for comparison, from the Bangs Collection in the Museum of Comparative Zoölogy.

PERAMYS MELANOPS, sp. nov.

Type from Cana (altitude 2,000 feet), in the mountains of eastern Panama. No. 179609, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 23, 1912. Original number 21737.

General characters.—Size medium; form robust; pelage short and velvety; color very dark; ears large.

Color.—Upper parts in general very dark brown, suffused with cinnamon on cheeks and sides of neck, becoming blackish on face, shoulders and lower part of back; throat and sides of belly mouse gray; under side of neck, except median stripe, grayish tinged with buffy; general color of under parts interrupted along median stripe which is buffy on neck, becoming pure white and broadening on chest, and narrowing gradually along a line extending posteriorly to near base of tail; chin with a small central white spot; ears dusky; limbs, feet and tail black all round.

Skull.—Rather broad across anterior roots of zygomata; sides of rostrum tapering rapidly to rather high and narrow anterior nares; nasals moderately expanded posteriorly, the expansion beginning near middle; premolars closely crowded; third upper molar deeply emarginate on outer side; posterior lower premolar smaller than middle premolar, the crown broad and extended antero-posteriorly.

Measurements.—Type: Total length, 168 mm.; tail vertebræ, 60; hind foot, 16.5. *Skull* (type): Condylobasal length, 28; nasals, 13.7 x 4.3; palatal length, 15; upper molariform teeth row, 9.5; upper molar series, 5.8.

Remarks.—The type and only specimen obtained of this very dark colored species seems to differ considerably from all of the previously known members of the genus. It may be similar to *adustus*, but the latter is described as lighter in color and apparently differs in other characters.

MARMOSA INVICTA, sp. nov.

Type from Cana (altitude 2,000 feet), in the mountains of eastern Panama. No. 178708, male adult, U. S. National Museum (Biological Survey Collection), collected March 14, 1912. Original number 21517.

General characters.—Size rather small; form slender; color very dark; skull smoothly rounded, without supraorbital or temporal ridges, and scarcely a trace of postorbital processes.

Color.—General color of upper parts in fresh pelage blackish slate with a faint silvery sheen, darkening to pure glossy black on lower part of back and rump (becoming dull, very dark brown in worn pelage); middle of face mouse gray; under parts, including inner sides of limbs lightly washed with silvery white, the under color of the fur slaty black; scrotum clothed with short silky hairs which are silvery white to roots, in marked contrast with the dark body color; mammæ in adult female enclosed in a cinnamon brownish area; chin, lips and lower part of cheeks whitish; anterbital spots black; wrists, ankles and feet to toes dusky, the toes white; tail dark brownish above, somewhat lighter below.

Skull.—Smoothly rounded, flattened above, very broad across anterior roots of zygomata; supraorbital and temporal ridges absent; postorbital processes faintly indicated in male only; frontal region broad, slightly constricted near point where postorbital processes usually develop; audital processes of alisphenoids and enclosed bullæ small; incisive foramina reaching to posterior plane of canines.

Measurements.—Type: Total length, 248 mm.; tail vertebræ, 137; hind foot, 19. An adult topotype: 240; 136; 17.5. *Skull* (average of two adults): Greatest length, 31.1 (31-31.2); condylobasal length, 30.5 (30.2-30.8); zygomatic breadth, 16.1 (16-16.3); nasals, 14.1 x 3.4 (14.1 x 3.3-14.1 x 3.5); frontal constriction, 6.1 (6-6.2); palatal length, 16.7 (16.5-17); upper molariform tooth row, 11 (10.8-11.3); upper premolar series, 4.7 + (4.7-4.8).

Remarks.—This pigmy opossum is very different from the other Middle American species and I am unable to associate it with any of those described from South America. It is characterized externally by darker color than usual in the genus. The frontal constriction is further back than in *elegans* which has similarly rounded supraorbital borders. The type and topotype are at the molting stage. In the type a patch of worn pelage remains on the anterior part of the back, while in the topotype collected about a week later the molt has progressed only as far as the head.

Specimens examined.—Two, from the type locality.

MICROSCIURUS ISTHMIUS VIVATUS, subsp. nov.

Type from near Cana (altitude 3,500 feet), in the Pirri range of mountains, eastern Panama. No. 179565, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, June 5, 1912. Original number 21771.

General characters.—Similar to *isthmius*, but upper parts paler; under parts more orange buffy, less ferruginous.

Color.—Upper parts, including outer sides of limbs, rather coarsely grizzled black and pale orange buff or buffy yellow, the yellowish element palest and clearest on head, and especially on cheeks; under parts orange buffy, clearest and strongest on under side of neck, chest and inner sides of fore legs, becoming a lighter wash on belly and inner sides of hind legs where the darker under color of the fur shows through; throat and ears buffy yellow, like cheeks; feet tawny ochraceous; upper side of tail coarsely grizzled black and pale buff, under side tawny ochraceous, with a black submarginal stripe and grayish buffy edging, becoming pure black at tip.

Skull.—Closely resembling that of *isthmius*, but rostrum slenderer and premaxillæ narrower posteriorly than in the type; interpterygoid fossa broad, and interparietal convex anteriorly as in *isthmius*.

Measurements.—Type: Total length, 260 mm.; tail vertebræ, 113; hind foot, 38. Average of two adult topotypes: 239 (236-243); 110 (110-110); 36 (35-37). *Skull* (type): Greatest length, 38.2; condylobasal length, 33.5; zygomatic breadth, 22.5; nasals, 10.7; interorbital breadth, 13.4; palatal length, 17.5; maxillary tooth row, 6.5.

Remarks.—This pigmy squirrel is allied to the darker, richer colored *M. isthmius*, which is based on specimens from the Truandó River, Colombia, and it requires no close comparison with *venustulus* which occurs at 1,500 feet lower elevation on the same mountain slope. It is readily distinguished from *venustulus* by much paler, more coarsely grizzled color of upper parts. Comparing the skull with that of *venustulus*, the interpterygoid fossa and basioccipital are broader, the maxillæ encroach further on the frontals between the lachrymals and premaxillæ, and the interparietal is subtriangular instead of rectangular. The occurrence of these widely differing pigmy squirrels in close proximity on the slope of the Pirri range of mountains seems to show that the forms typified by *alfari* and *isthmius* belong to two very distinct groups.

Specimens examined.—Three, from the type locality.

PEROMYSCUS PIRRENSIS, sp. nov.

Type from near head of Rio Limon (altitude 4,500 feet), Mount Pirri, eastern Panama. No. 178997, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 3, 1912. Original number 21675.

General characters.—A large species of the subgenus *Megadontomys;* similar to *flavidus*, but hind foot longer; color decidedly darker, less ochraceous; skull larger, with longer, slenderer rostrum; anterior lobe of first upper molar very narrow and entire, or slightly notched.

Color.—General color of upper parts varying from dark brownish cinnamon to cinnamon rufous lined with black, becoming grayish brown on head and more rusty on rump; sides brighter, more rufescent; under parts dull buffy white, the plumbeous basal color of fur showing through everywhere; nose and upper sides of forearms to near base of toes dusky; toes of fore feet whitish; hind feet whitish more or less clouded with dusky over proximal half of metatarsus;

tail brownish and nearly unicolor, clothed with very short inconspicuous hairs leaving the annulations showing distinctly. *Young* (about one-third grown): Decidedly darker than in *flavidus* of corresponding age.

Skull.—Larger than that of *flavidus*, with rostrum less swollen laterally; nasals more attenuate posteriorly; anterior lobe of first upper molar decidedly narrower, the longitudinal notch shown in *flavidus* faint or absent.

Measurements.—Type: Total length, 348 mm.; tail vertebræ, 185; hind foot, 35.5. Average of six adult topotypes: 356 (342-376); 197 (185-204); 36 (35-36.5). *Skull* (average of six adults): Greatest length, 42.3 (40.8-44.2); condylobasal length, 38.1 (37-40); zygomatic breadth, 20.6 (20.2-21.5); nasals, 17.5 (16.5-19.2); interorbital breadth, 6.1 (5.8-6.5); interparietal, 11 x 5.2 (9.8 x 4.8-12.1 x 6); incisive foramina, 7.9 (7.3-8.2); length of palatal bridge, 7.1 (7-7.8); maxillary tooth row, 6.1 (5.9-6.3).

Remarks.—This species is evidently more closely allied to *flavidus* than to any other known form, but differs notably in dentition. The anterior lobe of the first upper molar is narrower, less extended internally, and the longitudinal notch is faint or absent. The supplementary cusps are rather weakly developed for a *Megadontomys*, and the general form of the tooth suggests the 5-tuberculate condition of typical *Peromyscus*. In *flavidus*, on the contrary, the division of the anterior lobe being more complete the dentition is not very unlike that of the 6-tuberculate genus *Rhipidomys*.

Specimens examined.—Twenty, all from 3,500 to 5,200 feet altitude in the vicinity of Mount Pirri.

NEACOMYS PICTUS, sp. nov.

Type from Cana (altitude 1,800 feet), in the mountains of eastern Panama. No. 178717, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, March 13, 1912. Original number 21512.

General characters.—Similar in color to *N. pusillus* from the coast region of western Colombia, but decidedly larger; feet white instead of yellowish; pelage of upper parts composed of grooved black-tipped spines and slender orange rufous hairs.

Color.—Upper parts orange rufous mixed with black, resulting in a grizzled effect, the black predominant on head, middle of face, and lower part of back; sides, shoulders and cheeks paler, more ochraceous buff, this color clearest along a sharp line of demarcation between upper and under parts; under parts, including lips and under sides of forearms, white, the fur pure white to roots on throat, becoming somewhat duller and faintly plumbeous basally on belly; forearms brownish above near wrists, and ochraceous buffy along outer sides; inner sides of hind legs pale buffy; nose and orbital rings dusky; feet white; tail dark brown above, lighter below to near tip which is dark all round. *Young* (half-grown): Similar to adults, but darker, less rufescent.

Skull.—Larger than that of *pusillus;* brain-case bulging posteriorly well behind plane of occipital condyles; temporal ridges extending posteriorly along lateral margins of parietals to supraoccipital; nasals reaching posteriorly beyond premaxillæ.

Measurements.—Type: Total length, 159 mm.; tail vertebræ, 83; hind foot, 21.5. Average of three adult topotypes: 160 (158-163); 84 (83-87); 20.8 (20.5-21). *Skull* (average of four adults, including type): Greatest length, 21.4 (21.3-21.5); condylobasal length, 18.6 (18.2-19); zygomatic breadth, 11.2 (11.2-11.3); nasals, 8.6 (8.3-9); interorbital breadth, 4.4 (4.3-4.7); interparietal, 8.3 x 2.2 (8.2 x 2.3-8.5 x 2.2); incisive foramina, 3 (3-3.2); length of palatal bridge, 3.8 (3.7 x 4); maxillary tooth row, 2.7 (2.7-2.8).

Remarks.—This handsome little spiny mouse seems to require comparison only with *pusillus.* The adults present remarkably slight variation in size or color. A half-grown young individual is in a comparatively soft pelage corresponding to the immature coat seen in *Heteromys* and other genera.

Specimens examined.—Five, four adults and one young, all from 1,800-2,000 feet altitude at the type locality.

RHEOMYS RAPTOR, sp. nov.

Type from near head of Rio Limon (altitude 4,500 feet), Mount Pirri, eastern Panama. No. 179028, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 28, 1912. Original number 21658.

General characters.—Size small; color dark; fur short and glossy, the longer hairs of back about 9 mm. in length; probably most like *trichotis,* but still smaller, with darker upper parts, and without white markings on under parts or tip of tail.

Color.—Upper parts from nose to base of tail mixed black and cinnamon, producing a finely grizzled effect, the black predominating especially on head and rump; sides paler and somewhat grayer; entire under parts varying from pale smoky gray to pale mouse gray, passing without a sharp line of demarcation into darker color of sides, the fur everywhere darker and more plumbeous basally; ears well clothed with dark hairs, whiskers grayish; sides of rump with a few projecting white hairs as in *Ichthyomys hydrobates;* upper surface of metacarpus blackish; metatarsus, including fringing bristles, brownish; toes of fore and hind feet dull white; tail well haired, black all round. *Young* (nearly full-grown): Upper parts nearly uniform mouse gray, lacking the cinnamon element of the adult pelage.

Skull.—Small and smoothly rounded, the frontal region not depressed as in *Ichthyomys hydrobates;* audital bullæ short and rounded; incisors of the ordinary murine type; molars about as in *Ichthyomys hydrobates.*

Measurements.—Type: Total length, 201 mm.; tail vertebræ, 94; hind foot 23.5; ear from meatus (in dry skin), 7.7. An old adult topotype: 214; 102; 26.5. *Skull* (type): Greatest length, 25.7; condylobasal length, 24.8; zygomatic breadth, 13.8; nasals, 10.5; interorbital breadth, 5; interparietal, 7.3 x 2.7; incisive foramina, 4.9; length of palatal bridge, 5.5; maxillary tooth row, 4.2.

Remarks.—*Rheomys raptor* appears to be the smallest known member of the *Ichthyomys* group. It may be not very unlike *trichotis* which is still imperfectly known, but differs considerably from the color description of the latter species. The upper incisors are clearly of the *Rheomys* type, the anterior surface not heavily beveled internally as in *Ichthyomys,* in which the beveled internal border results in the deep emargination of the cutting edge. The whiskers are reduced to slender hairs, quite different from the stiff bristles of *Ichthyomys.*

Specimens examined.—Three, all from 4,500 to about 5,000 feet altitude on the upper slopes of the mountains in the vicinity of Mount Pirri.

MACROGEOMYS DARIENSIS, sp. nov.

Type from Cana (altitude 2,000 feet), in the mountains of eastern Panama. No. 179587, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 31, 1912. Original number 21760.

General characters.—Similar in general size to *cavator,* but tail longer, color a duller brown or black, lacking the rich seal brown shade of *cavator;* pelage shorter; whiskers and vibrissæ over orbits and in front of ears brown instead of silvery gray; skull more elongated, much narrower posteriorly and differing widely in detail.

Color.—Upper parts dull chocolate brown, becoming nearly pure black in fresh pelage; under parts and inner sides of limbs nearly naked, the scattered hairs a lighter brown, becoming grayish on lips and near base of tail; whiskers brown; feet and tail brownish, or dark flesh color.

Skull.—Size large, rather elongated, with anteriorly spreading zygomata, narrow brain-case and narrow rostrum; similar to that of *cavator*, but less massive, more elongated, narrower posteriorly, with lower lambdoid crest and narrower rostrum; premaxillæ less extended posteriorly, leaving a wider space for the union of frontals and maxillæ between premaxillæ and lachrymals; upper surface of premaxillæ more constricted near zygomata, the sides of rostrum bulging below; lambdoid crest low, nearly straight or slightly convex posteriorly (not high and sinuous as in *cavator* and *pansa*); squamosals less expanded laterally as postglenoid shelves, the margin deeply notched and exposing much of tubular portion of bulla when viewed from above; parietals and squamosals less upturned posteriorly; mastoid process of squamosal and lateral wing of supraoccipital less expanded vertically; maxillary and squamosal arms of zygoma more widely separated by jugal (meeting or nearly meeting along upper border of zygoma in *cavator*), third upper molar shorter, the posterior heel less produced; incisors narrower.

Measurements.—Type: Total length, 401 mm.; tail vertebræ, 132; hind foot, 53.5. Average of three adult male topotypes: 367 (358-376); 129 (122-135); 51.5 (51-53). Average of four adult female topotypes: 364 (348-388); 121 (118-128); 49.9 (48-52.5). *Skull* (type): Condylobasal length, 70.7; zygomatic breadth, 44.7; nasals, 27.8 x 8.9; breadth of premaxillary constriction in front of zygoma, 13; interorbital breadth, 10.9; breadth across postorbital processes, 16.2; breadth across mastoid processes of squamosals, 39.3; breadth between postglenoid constrictions of squamosals, 28.1; basion to summit of lambdoid crest, 18.2; alveolar length of maxillary tooth row, 14.2.

Remarks.—The pocket gopher of eastern Panama seems to be most like *cavator* of western Panama, but differs in numerous characters from all its congeners. In the general elongation of the skull and low, nearly straight lambdoid crest it is somewhat like *dolichocephalus,* but the zygomata are divergent anteriorly, and the skull is unlike all the Costa Rican species in the postglenoid contraction of the squamosal platform, and the greater anterior development of the basioccipital below the plane of the audital bullæ.

Specimens examined.—Total number, 15, from localities in eastern Panama as follows: Cana (type locality), 11; Boca de Cupe, 4.

HETEROMYS CRASSIROSTRIS, sp. nov.

Type from near head of Rio Limon (altitude 5,000 feet), Mount Pirri, eastern Panama. No. 179016, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 26, 1912. Original number 21649.

General characters.—A small species of the *desmarestianus* group allied to *panamensis*, but decidedly smaller, color paler; skull with much broader, more massive rostrum.

Color.—Ground color of upper parts dark mouse gray, shaded with black on median dorsal area and in a line down rump to base of tail; slender hairs ochraceous buffy, somewhat altering the general color and producing a grizzled effect; under parts, including inner sides of limbs, lips and borders of pouches, white; outer sides of forearms and hind legs dark mouse gray; fore feet usually white, but sometimes clouded with dusky to near toes, the toes white; hind feet dull white, changing to dusky on proximal third of metatarsus; ankles dusky all round; tail brownish above, whitish below, in some specimens becoming white all round on a subterminal band or at tip. *Young* (in first pelage): Upper parts varying from nearly uniform blackish slate to slate black; under parts pure white.

Skull.—Similar in general to that of *panamensis*, but smaller with rostrum much broader and heavier; brain-case rather smoothly rounded, the temporal and supraorbital ridges only moderately developed.

Measurements.—Type: Total length, 267 mm.; tail vertebræ, 132; hind foot, 32.5. Average of eight adult topotypes: 266 (255-277): 140 (132-149): 32.9 (31.5-34). *Skull* (average of five adults): Greatest length, 34.5 (33.7-35.5); zygomatic breadth, 16.3 (15.8-17); interorbital breadth, 9.3 (9-9.5); nasals, 14 (13.8-14.3); width of brain-case in front of projection of auditory meatus, 14.6 (14.5-14.8); interparietal, 9.4 x 5 (8.2 x 4.8-10 x 5.3); maxillary tooth row, 5.2 (5-5.5).

Remarks.—*H. crassirostris* is one of the smallest of the known species of the genus. It requires close comparison only with *panamensis*, from which it is quite distinct. The supraorbital shelves are rather weakly developed for a member of the *desmarestianus* group and suggest the condition usual in South American species of the genus. In the adult pelage a few inconspicuous pure white hairs are irregularly intermingled with the bristles on the back.

Specimens examined.—Twenty-three, all from 4,500 to about 5,000 feet altitude on the upper slopes of the mountains in the vicinity of the type locality.

HYDROCHŒRUS ISTHMIUS, sp. nov.

Type from Marraganti, near the head of tide-water on the Rio Tuyra, eastern Panama. No. 179703, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 4, 1912. Original number 21591.

General characters.—Similar to *Hydrochœrus hydrochœris* in color, but size decidedly smaller; skull differing in important details, especially the peculiar, short, thickened condition of pterygoids.

Color.—Upper and under parts in general varying from very dark rusty reddish to dull pale clay color, usually somewhat darker above than below, becoming more or less blackish in some specimens on middle of face, cheeks, lower part of rump, and outer sides of hind legs; orbital rings, sides of muzzle and spots near base of ears paler, more buffy; ears and feet brownish, thinly haired. *Young* (about one-fourth grown): Upper parts more tawny ochraceous than in adults.

Skull.—Smaller than that of *hydrochœris;* nasals with inner border more extended forward over anterior nares, approaching median projection of premaxillæ; maxillary portion of outer wall of antorbital vacuity broader; maxillo-premaxillary suture passing further forward along upper surface of rostrum, and turning thence more abruptly downward; incisive foramina relatively narrower; premaxillæ with posteriorly extended portions reaching to near posterior plane of incisive foramina (ending well in front of this plane in *hydrochœris*); pterygoid processes shorter, thicker, more rounded, less produced posteriorly; dentition about as in *hydrochœris,* but relatively lighter.

Measurements.—Type: Total length, 1,025 mm., hind foot, 200. Average of two adult females: 998 (972-1,025); 197 (195-200). *Skull* (type): Greatest length, 200; zygomatic breadth, 116.5; interorbital breadth, 52.5; length of nasals along inner side, 79.8; width of nasals posteriorly, 47.7; palatal length, 122; length of palatal bridge, 70.8; alveolar length of maxillary tooth row, 64.2.

Remarks.—The capybara is among the more interesting mammals whose known ranges are found to extend into Panama. The

Isthmian representative of the genus seems to be a distinct species as shown by comparison with specimens of *hydrochœris* from Surinam, Brazil and Paraguay. In Panama it is apparently restricted to a limited area near the head of tide-water in the delta region of the Tuyra and Chucunaque rivers.

Specimens examined.—Six, all from the type locality.

ISOTHRIX DARLINGI,[1] sp. nov.

Type from Marraganti (near Real de Santa Maria), on the Rio Tuyra, eastern Panama. No. 179577, female young, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 11, 1912. Original number 21739.

General characters.—Size rather small; color pale; head grayish brown; ears tufted; hind feet short and broad, armed with short, sharp, strongly curved claws; tail unicolor, evenly tapering, thinly clothed with short hairs, becoming a trifle longer but not thicker or forming a distinct brush near tip. Somewhat similar to *labilis,* but smaller and much paler in color; differing also in cranial characters.

Color.—Upper parts ochraceous buff, somewhat darkened by admixture of black-tipped hairs along back, becoming grayish brown on middle of face and cheeks; nose, lips and muzzle mouse gray, this color abruptly interrupted at posterior base of whiskers by a white vertical streak; orbital rings black; a small white supraorbital spot; ears brownish or blackish, with a marginal fringe of longer hairs, and tufts of the same length and color near anterior and posterior base; inner base of ears clothed with a partially concealed patch of whitish fur; whiskers and a postorbital tuft of long vibrissæ black; under parts ochraceous buff, becoming grayish on wrists, ankles and chin; feet silvery white; tail brownish.

Skull.—Similar to that of *labilis,* but smaller and relatively broader; zygomata more spreading anteriorly; audital bullæ larger, more inflated; dentition about as in *labilis.* In general form and dentition much as in *Isothrix caniceps* as figured by Günther, but palate narrower and premaxillæ reaching posteriorly beyond nasals.

Measurements.—Type: Total length, 472 mm.; tail vertebræ, 240; hind foot, 44. *Skull* (type): Greatest length, 53.5; condylobasal length, 49.5; zygomatic breadth, 25.2; nasals, 14.4; interorbital breadth, 12.3; palatal length, 23.1; length of palatal bridge, 12.8; maxillary tooth row, 12.9.

[1] Named for Dr. S. T. Darling, of the Sanitary Department, Isthmian Canal Commission, who first collected the species, at Ancon, Canal Zone.

Remarks.—Close comparison of this form with the insular species, *labilis*, is unnecessary, the latter being distinguishable at once by intense rusty reddish coloration. It may be similar to *Isothrix caniceps* (Günther), from Medellin, Colombia, but the latter seems to be somewhat different in color, with a bushy tail, and the skull as figured differs in detail. Unfortunately no fully adult examples of the new form are available. In the skull of the type the posterior molars are not yet fully in place.

Specimens examined.—Two, from localities as follows:

Panama: Marraganti (type locality), 1.

Canal Zone: Ancon, 1.

SYLVILAGUS GABBI MESSORIUS, subsp. nov.

Type from Cana (altitude 1,800 feet), in the mountains of eastern Panama. No. 179569, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 23, 1912. Original number 21736.

General characters.—Closely allied to *gabbi;* general color less rufescent, more grayish or paler buffy, and more heavily overlaid with black.

Color.—Top of head rusty reddish mixed with black; nape ochraceous buff; dorsal area varying from buff to pale ochraceous buff of Ridgway, heavily overlaid with black; sides paler, more creamy buff, the hairs less broadly tipped with black; nose blackish; cheeks buffy, more or less washed with black; ears brownish, becoming blackish along outer side of anterior border; under side of neck dull buff, this color encroaching on under parts along sides of belly; rest of under parts, including inner sides of limbs, white, the under color of fur more or less plumbeous across belly; outer sides of forearms and feet ochraceous buffy; tail ochraceous buffy, with a partially concealed dark spot near tip. *Young* (in first pelage): Less rufescent than *gabbi* or *truei* of similar age.

Skull.—Closely resembling that of *gabbi;* audital bullæ slightly larger, with a correspondingly deeper constriction of basioccipital between them. Compared with that of *truei* the skull is less massive, with smaller audital bullæ and decidedly longer palatal bridge.

Measurements.—Type: Total length, 370 mm.; tail vertebræ, 17; hind foot, 80. Average of two adult topotypes: 363 (343-384); 17 (16-18); 76 (75-78). *Skull* (type): Greatest length, 73; condylobasal length, 65.5; zygomatic breadth, 36.7; nasals, 29.2 x 12.5; interorbital breadth, 15; palatal length, 31.2; length of palatal bridge, 7.6; maxillary tooth row, 14.7.

Remarks.—The forest rabbits of the *gabbi* group doubtless inhabit nearly the whole of Panama, and range from sea level well up on the slopes of the higher mountains. Eight specimens from localities on both the Atlantic and Pacific sides in the Canal Zone agree with the types of *gabbi* and have been used for comparison. The new form lacks the strongly rufescent suffusion shown in *gabbi*, and the upper parts are more obscured by the long black tips of the longer hairs.

Specimens examined.—Ten, from the type locality.

ICTICYON PANAMENSIS, sp. nov.

Type from near head of Rio Limon (altitude 5,000 feet), Mount Pirri, eastern Panama. No. 179046, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 28, 1912. Original number 21655.

General characters.—Similar in general to *venaticus*, but color of head and shoulders paler, less rusty reddish; skull differing in detail.

Color.—Type: Top and sides of head, neck, shoulders, and anterior half of back pinkish buff, varying to buffy white between shoulders and middle of neck; flanks and posterior half of back similar, but somewhat darkened by a sparse admixture of dusky hairs; under side of neck, chest, and belly pale ochraceous buff thinly mixed with black, becoming clearer ochraceous buff on inguinal region; interorbital space, muzzle and anterior cheeks pale ochraceous buffy, varied by a few black hairs under eye; chin dusky; fore limbs blackish except toes and a narrow line along under side which are pale buffy; hind limbs blackish, becoming buffy on inner sides of thighs, and brownish toward toes; buttocks covered with mixed dusky and buffy hairs; tail black with a few brownish hairs along basal half of under side. *Young* (nearly full-grown, but very immature): Top of head, ears, and neck pale ochraceous buff, this color darkening by intermixture with black hairs on a V-shaped area narrowing from between shoulders to a point near center of back; posterior half of back, sides, shoulders, entire under parts and tail black; limbs and feet brownish black; interorbital space, cheeks, and eyebrows mixed black and pale buff; muzzle and upper lip dusky.

Skull.—In general form closely resembling that of *venaticus*, but rostrum apparently more depressed; nasals tapering more gradually and reaching further posteriorly (lateral margins turned more abruptly inward in *venaticus*); frontals and premaxillæ not meeting along lateral border of nasals (meeting in Winge's photograph of *venaticus*); third upper premolar shorter and more obliquely placed; fourth upper premolar narrower in proportion to its length; molars $\frac{2}{2}$.

Measurements.—Type: Total length, 740 mm.; tail vertebræ, 125; hind foot, 118. Average of two nearly full grown young females: 689 (680-698); 130 (130-130); 114 (113-115). *Skull* (type): Occipitonasal length, 122; condylobasal length, 129.2; zygomatic breadth, 78; nasals, 36.2 x 14; interorbital breadth, 30.8; palatal length, 65; upper molariform tooth row, 43; alveolar length of second upper premolar, 6.2; length of third upper premolar, 6.8; length of fourth upper premolar, 11.8; breadth of fourth upper premolar, 5.8; length of first upper molar, 9; breadth of first upper molar, 6.3.

Remarks.—The discovery of a bush dog in Panama materially extends the known range of the genus. I am unable to make direct comparison of the Panaman species with museum material of the Brazilian *I. venaticus*, but it differs in apparently important respects and in view of its isolation will doubtless be found to possess additional characters when specimens of the two forms are brought together. The lighter areas of the body are of a paler, less rusty red color than represented in the descriptions and illustrations of Lund,[1] Burmeister,[2] Flower[3] and Mivart.[4] The skull figured by Lund seems to be of a young individual and the figures untrustworthy. Those figured by Burmeister, Huxley[5] and Mivart are better, but each differs considerably in detail and they may not all represent typical *venaticus.* Better still, for comparative purposes, is a photograph by Winge[6] of the upper surface of a skull apparently representing the typical animal from Lagoa Santa, Brazil. It is worthy of note that in the Panaman form the second upper molars are present in all of the three skulls examined. One skull of an old female shows that these teeth are at least not always early deciduous as Flower suggested may be the case in *venaticus.*

Specimens examined.—Three, an old female and her offspring, two nearly full-grown young, from the type locality.

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[1] Kongel. Danske Videnskab. Selskabs. natur. og. math. Afhandlinger, 11 Deel. Kjöbenhavn, 1845, "Blik paa Brasiliens Dyreverden, for sidste Jordenævaltning, 5te Afhandling," p. 62, pls. 41 and 43.

[2] Erlauterungen zur Fauna Brasiliens, 1856, pp. 1-18, pls. 17-20.

[3] Proc. Zool. Soc., 1880, pp. 70-76, pl. 10.

[4] Monograph of Canidae, 1890, pp. 189-194, pl. 43, text figs. 52-54.

[5] Proc. Zool. Soc., 1880, pp. 268-269.

[6] E. Museo Lundii, "Jordfundne og nulevende Rovdyr (Carnivora) fra Lagoa Santa, Minas Geraes, Brasilien," pp. 29-31, pl. 5.

BASSARISCYON GABBI ORINOMUS, subsp. nov.

Type from Cana (altitude 1,800 feet), in the mountains of eastern Panama. No. 179157, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, March 10, 1912. Original number 21474.

General characters.—Similar to *gabbi* in size, but color more tawny or paler fulvous, less brownish; skull with very long postorbital processes, broad basioccipital and small audital bullæ; differing from the other species mainly in cranial details.

Color.—Upper parts in general pale fulvous darkened along median line of dorsum by black-tipped hairs, becoming grizzled grayish on top of head and face; under parts varying from pale orange buff to very pale buffy yellow; upper base of ears distinctly blackish in some specimens, fulvous in others; feet varying from grayish fulvous to grayish brown; tail varying shades of pale fulvous, darker above than below, becoming brownish or blackish toward tip and more or less distinctly annulated along median portion.

Skull.—In general outline about as in *gabbi* (frontal profile convex, not flattened as in *alleni*); basioccipital broader; postorbital processes longer, more projecting; audital bullæ decidedly smaller; dentition as in *gabbi*. Similar to that of *richardsoni* in development of postorbital processes, but basioccipital broader and audital bullæ smaller.

Measurements.—Type: Total length, 820 mm.; tail vertebræ, 419; hind foot, 86. An adult female topotype: 840; 450; 84. An old adult male from Mount Pirri: 865; 457; 88. *Skull* (type): Greatest length, 85; condylobasal length, 85; zygomatic breadth, 56.2; interorbital breadth, 18; breadth across postorbital processes, 35.8; palatal length, 46.5; upper molariform tooth row, 23.7.

Remarks.—The known forms of *Bassariscyon* seem to agree closely in essential characters and may prove to be geographic races all assignable to a single widely ranging species. As in many other groups cranial modifications are more reliable than color as distinguishing characteristics. No material showing the color of *gabbi* at the type locality is available, but a specimen from near Gatun, Canal Zone, agrees very closely in cranial details with the type and coming, as it does, from within the same general faunal area may be regarded as typical. In this specimen the face is gray as usual in the genus, and not at all like Huet's[1] figure of the animal from "Caimito, dans la province de Correo, un peu au nord de Panama"

[1] Nouv. Arch. du Mus. d'Hist. Nat. de Paris, 2e ser., V, 1883, pp. 1-12, pls. I-III.

(= the vicinity of Chorrera, about 17 miles southwest of Panama) and only about 30 miles from Gatun. Huet's figures of the skull, on the other hand, agree very well with the type of *gabbi* and on geographic grounds might be expected to represent that species. The skulls from Gatun and Chorrera agree with the type of *gabbi*, and differ from the new form here described in the shorter postorbital processes, larger audital bullæ and correspondingly narrower basioccipital. *B. richardsoni* has long postorbital processes, but the audital bullæ are large and the basioccipital narrow as in *gabbi*. The new form may be not very unlike *medius*, but the latter is described as having a smaller, lighter muzzle and rather smaller molars than *gabbi* (therefore differing from *orinomus*). In addition the long postorbital processes, broad basioccipital and small bullæ of *orinomus* could scarcely have been overlooked and left unmentioned by Thomas if present in his specimens of *medius*. Another apparent peculiarity of the new form is a perforation, or transverse median notch, in the fold of the basioccipital close to the foramen magnum. This perforation is present in all the skulls examined, ranging in age from that of a young individual in which the deciduous teeth are being replaced by the permanent series to those of adults with worn molars. In *Bassariscyon* the principal bones of the skull become fused early in life; with advancing age the temporal ridges become prominent in the male, but apparently do not unite to form a sagittal crest.

Specimens examined.—Total number, 4, from the following localities in Panama: Cana (type locality), 3; Mount Pirri, 1.

CRYPTOTIS MERUS, sp. nov.

Type from near head of Rio Limon (altitude 4,500 feet), Mount Pirri, eastern Panama. No. 178976, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 2, 1912. Original number 21669.

General characters.—Member of the *mexicana* group similar to *C. orophila*, but somewhat smaller; claws decidedly smaller; color darker; skull high and narrow.

Color.—Entire upper and under parts uniform glossy black; feet dusky; tail black all round.

Skull.—Slightly smaller than that of *orophila*, with much narrower brain-case; interorbital region more depressed; large upper premolar with antero-internal cusp less prominent; first and second upper molars relatively broader and shorter; third upper molar smaller, the internal lobe weakly developed and unpigmented.

Measurements.—Type: Total length, 98 mm.; tail vertebræ, 31; hind foot, 12.5. Average of two adult topotypes: 96 (91-101); 26.5 (25-28); 12.2 (12-12.5). *Skull* (type): Condylobasal length, 18.8; zygomatic breadth, 6.5; lachrymal breadth, 5; breadth of brain-case, 9.3; depth of brain-case, 5.1; upper tooth row, 8.8.

Remarks.—By the discovery of this small species so close to the Colombian frontier, the known range of the *mexicana* group is materially extended eastward from Costa Rica. It seems to require close comparison only with *orophila.* The skull differs conspicuously from that of typical *mexicana* in narrower brain-case, and in the weaker development of the inner cusps of most of the upper teeth; the postero-internal lobes of the first and second upper molars are lower and unpigmented much as in *tropicalis.* The claws of both fore and hind feet are unusually small for a shrew of the *mexicana* group.

Specimens examined.—Three, all from 4,500 to 5,000 feet altitude along the headwaters of the Rio Limon in the vicinity of Mount Pirri.

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DESCRIPTIONS OF NEW GENERA, SPECIES AND SUB-SPECIES OF BIRDS FROM PANAMA, COLOMBIA AND ECUADOR

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DESCRIPTIONS OF NEW GENERA, SPECIES AND SUBSPECIES OF BIRDS FROM PANAMA, COLOMBIA AND ECUADOR[1]

By E. W. NELSON

The first of January, 1912, E. A. Goldman, of the Biological Survey, Department of Agriculture, was again detailed on the Smithsonian Biological Survey of the Canal Zone. He returned to Panama in January and remained there until the last of June passing most of this period in collecting birds and mammals on the slopes of Mount Pirri on the Pacific side of eastern Panama, near the Colombian border. Mount Pirri is the highest point (with an altitude of over 5,200 feet) of a rather narrow and isolated mountain ridge lying southeast of San Miguel Bay and on the southwest side of the Tuyra Valley. The extreme headwaters of the Tuyra River rise on its slopes. The ridge is connected southerly with the mountain divide between the valleys of the Tuyra in Panama and of the Truando River in Colombia. Mount Pirri is heavily forested and although on the southern, or Pacific, side of Panama it receives the benefit of moist air currents from the Carribean so its summit is shrouded in fog most of the year while it has an extremely heavy rainfall.

Previous to Goldman's work no zoölogical collector appears to have visited this interesting mountain. Work was done from its basal lowlands to the summit and many birds and mammals not before known from Panama were taken, a number of which are new to science. Many species from the South American fauna appear to here reach their northern limit and are unknown in the Canal Zone or its adjacent mountains, only about 150 miles away in a direct line by land. In the present paper three apparently new genera and twenty-four new species and subspecies of birds are described from the slopes of Mount Pirri and its bordering lowlands. In addition two new birds from Colombia and Ecuador and one from western Panama are included. The new mammals have been described by Goldman,[2] and later a faunal paper will probably be published covering the total results obtained in this district.

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[1] This paper is the sixteenth dealing with the results of the Smithsonian Biological Survey of the Panama Canal Zone.

[2] Smithsonian Misc. Coll., Vol. 60, No. 2, 1912, p. 18.

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GEOTRYGON GOLDMANI, sp. nov.

Goldman's Wood Dove

Type.—No. 232545, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,000 feet altitude), head of Rio Limon, eastern Panama; collected March 5, 1912, by E. A. Goldman (collector's number 15293).

Distribution.—Known from type locality only.

General characters.—Apparently most closely related to *G. bourcieri* but entire top of head and nape rich rufous.

Description of type.—Forehead cinnamon rufous shading into rich chestnut between eyes and thence into rich reddish chestnut over entire crown and nape; upper side of neck dark olivaceous gray strongly washed with dark vinaceous; interscapular area dark, slightly metallic Indian purple; upper side of rump wings and tail brownish chestnut darker and browner on scapulars; rump and tail, with a slight vinaceous tinge over all; exposed part of primaries and alula dusky gray; sides of head below eyes from base of lower mandible to include ear coverts pinkish buff and bordered from bill back along lower side of cheeks by a strongly marked black line; chin and throat white shading posteriorly into vinaceous gray which covers under part and sides of neck and anterior two-thirds of breast; posterior part of breast pale dingy gray finely maculated with pale buffy; middle of abdomen dingy white; sides of breast, flanks and axillaries dark grayish grown; under tail coverts like posterior part of breast but a little darker; bill black; feet and tarsus (in dried skin) dark red.

Measurements of type.—Wing, 144; tail, 87; culmen, 16; tarsus, 44.

Remarks.—This species is based on a series of five specimens all of which agree in the rufous crown and nape. It appears to be a forest species of the higher slopes of the Mount Pirri range where it was plentiful.

CHLORONERPES CHRYSOCHLORUS AUROSUS, subsp. nov.

Golden Green Woodpecker

Type.—No. 232926, adult male, U. S. National Museum, Biological Survey Collection, from Marraganti, in the lowlands 150 miles east of Canal Zone, Panama; collected April 4, 1912, by E. A. Goldman.

Distribution.—Known from type locality only.

General characters.—In colors and color pattern extremely close to *chrysochlorus* from Brazil but red on head a lighter shade; ear coverts paler olive; stripe from nostrils back along side of head and neck much richer golden, nearly orange yellow; under parts of body barred with deeper and richer ochraceous yellow between dusky bars; rectrices olive green, dusky only along shafts and at tips instead of almost entirely dusky as in *chrysochlorus;* size larger.

Description.—Entire top of head and nape bright poppy red, less crimson than in *chrysochlorus;* rest of upper parts including top of wings and upper side of tail, except the dusky brown shafts and tips of feathers, bright olive green; a narrow line on lores, broadening to include eyes, upper half of cheeks and auriculars light olive brown, this area limited posteriorly by downward extension of red of nape which touches upper border of a rich bright golden yellow stripe extending from nares back below cheeks and lower border of auriculars and along sides of neck; malar patch red like crown and continued posteriorly by a broad stripe of olive along sides of head and neck below the golden yellow stripe; chin and throat duller golden buffy than in *chrysochlorus;* rest of under parts narrowly but strongly barred transversely with ochraceous yellow and olive, bars narrowest immediately below yellow throat patch becoming broadest and palest yellow on abdomen and under tail coverts; bend of wing plain buffy yellow, narrowly barred at base of primaries on top with olive and buffy yellow; axillaries deep orange buff; inner webs of secondaries and primaries entirely deep cinnamon buff basally but this color gradually narrowing to a point on inner margin of inner webs, reaching half way to tips of two first primaries and gradually increasing to near tips of inner webs of secondaries (in *chrysochlorus* outside of bend of wing plain yellow; cinnamon of inner webs of primaries and secondaries paler and extending three-fourths or more of length toward tip of primaries); tail in present form olive green like back with dusky shafts and tips to feathers, in *chrysochlorus* tail almost all dusky.

Measurements of type.—Wing, 123.5; tail, 69; culmen, 23; tarsus, 20. Measurements of adult male from Chapada, Matto Grosso, Brazil (American Mus. Nat. Hist.): Wing, 117; tail, 71; culmen, 21; tarsus, 20.

Remarks.—The present form bears a surprisingly close resemblance to *chrysochlorus* of Brazil but there is a wide gap in the known range of the species southeast of the present type locality. Only a single individual, the type, was seen at Marraganti during Goldman's brief stay there.

AULACORHAMPHUS CÆRULEIGULARIS COGNATUS, subsp. nov.

Mount Pirri Toucan

Type.—No. 232544, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,000 feet altitude) head of Rio Limon, eastern Panama; collected March 5, 1912, by E. A. Goldman (collector's number 15292).

Distribution.—Known from type locality only.

Subspecific characters.—Similar to *A. cæruleigularis* but top of bill at base entirely black with no trace of chestnut colored area about nasal openings characteristic of that bird.

Description.—Like *cæruleigularis* but black on base of bill extends entirely across in front of nostrils completely replacing the chestnut area in front of nostrils of that form; forehead greenish almost like middle of back; crown and top of neck slightly more olive than forehead but much less olive than in *cæruleigularis* and less strongly contrasted with green of back; blue band from eye to throat along base of mandibles distinctly narrower in present form; size same as in *cæruleigularis.*

Remarks.—The present bird is evidently also a close relative of *A. cyanolæmus* from which it differs mainly in the restriction of the black on the upper mandible. These toucans, including *cæruleigularis,* are probably all subspecies of the same bird ranging from Costa Rica to Ecuador. The present subspecies is based on a series of seven specimens.

MOMOTUS CONEXUS RECONDITUS, subsp. nov.

Chestnut-bellied Motmot

Type.—No. 238084, adult male (?), U. S. National Museum, Biological Survey Collection, from Marraganti, eastern Panama; collected April 5, 1912, by E. A. Goldman (collector's number 15943).

Distribution.—Known from Marraganti and Boca de Cupe, eastern Panama.

Subspecific characters.—Most like *M. conexus* from the Canal Zone but much darker; back dark olive green with a darker and more chestnut-rufous suffusion; outside of wings darker green; under parts also much darker and more chestnut, especially on abdomen.

Measurements of type.—Wing, 123; tail, 230; culmen, 37; tarsus, 28.5.

Remarks.—*M. conexus* and the present subspecies are much nearer to *M. subrufescens* than to *lessoni.* In fact it is almost certain that when specimens from intermediate localities are collected they will show that *conexus* and *reconditus* are subspecies of *subrufescens.* The fact that *conexus* from the Canal Zone retains certain distinctions of color pattern characteristic of *subrufescens* with no sign of intergradation toward *lessoni* is a strong indication of the specific distinction of these birds. In *M. lessoni* the black ear patch is narrowly edged above and below by the same color as that on the forehead while in *subrufescens, conexus* and *reconditus* this ear patch is bordered above by the same color as that of the forehead and below by a much deeper and richer blue like that of the nape; these three forms also agree in having the abdomen clearer rufous than the neck and breast which are distinctly greenish; in *lessoni* the reverse of this distribution of color exists and the breast is more rufous and less greenish than the abdomen. *M. c. reconditus* is based on two specimens, the type and one other from Boca de Cupe in the same district.

ELECTRON PLATYRHYNCHUS SUBOLES, subsp. nov.

Darien Motmot

Type.—No. 232536, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 2,000 feet altitude), eastern Panama; collected March 9, 1912, by E. A. Goldman (collector's number 15336).

Distribution.—Known from type locality only.

Subspecific characters.—Size of *E. p. minor* but bill longer and narrower; rufous on head, neck and breast lighter and more buffy; green on back clearer and brighter than in either *platyrhynchus* or *minor* and upper side of tail bluish; abdomen blue.

Description of type.—Top of head and neck rusty cinnamon-rufous paler than in *minor;* under side of neck and fore breast a paler and duller shade of same with an overlying tinge of green;

a thin patch of bluish green on chin; the usual black breast spot; lores and area under and behind eyes black; back nearly grass green; upper tail coverts bluish green; top of wings mainly bluish green but outer borders of primaries distinctly bluish; upper side of tail bright bluish green, varying to cyanine blue on ends of tail in certain lights, the blue on tail much stronger and clearer than in *minor;* a poorly defined margin of bluish grass green about posterior border of rufous on breast changing to cærulean blue with a greenish tinge on abdomen and a greener shade of same on under tail coverts. Bill narrower and longer than in *minor* and black to tip, thus lacking the pale horn colored tip of latter.

Measurements of type.—Wing, 116; tail, 177; culmen, 45; tarsus, 17.

Remarks.—This subspecies differs strongly from *E. p. minor,* the most striking differences being in its long slender bill, paler colors and the distinctly bluish cast of the top of the wings and tail and the blue abdomen. The present bird agrees with *minor* in size and is thus much smaller than typical *platyrhynchus.* Hartert gives the measurements of a typical specimen of the latter from Paramba, Ecuador, as follows: Wing, 130; tail, 223; culmen, 49; tarsus, 20. The bill of *suboles* is actually as well as proportionately narrower than in either of the forms named above. This form is based on a single specimen.

GOETHALSIA,[1] gen. nov.

Apparently nearest *Goldmania,* the three or four middle under tail coverts being shorter than usual and specialized as in that genus, silky white in color and forming a tuft of overlapping or "nested" and strongly decurved stiff plumes about twice as long as in *Goldmania* and more plume-like nearly to base of feathers; other under tail coverts normal and differently colored from middle ones but proportionately smaller than usual; this strong character present in both sexes and in the young as in *Goldmania;* primaries medium width, broader than in *Goldmania,* normal in all conditions (?) and outer primary distinctly longer than next one; tail emarginate, nearly three-fifths the length of wing; bill slightly broadened and ridged at base, terete elsewhere and same length as head; nostrils operculate, feathering of forehead extending out about two-thirds of length of

[1] Named in honor of Colonel George W. Goethals, head of the Panama Canal Commission, to whom the scientific workers of the Biological Survey of the Canal Zone are deeply indebted for prompt and courteous assistance in prosecuting their work.

nostrils; tarsus bare except near upper end in front. *Color:* Males on head and body mainly plain metallic green above and below except buffy-rufous mask on chin and lores and buffy whitish on posterior abdomen; primaries purplish black; secondaries rufous, dark-tipped as in *Eupherusa;* tail feathers pale rufous buffy with exposed parts of middle feathers dark bronze green and same color on tips of other feathers decreasing proportionately in width to a fine narrow margin on outer feather on each side.

Type of genus *Goethalsia bella*, sp. nov. (monotypic).

GOETHALSIA BELLA, sp. nov.

Goethals' Humming-bird

Type.—No. 238672, nearly adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 2,000 feet altitude), eastern Panama; collected March 16, 1912, by E. A. Goldman (collector's number 15371).

Distribution.—Known from extreme eastern Panama only, Cana (2,000 feet) and Mount Pirri (to 5,000 feet).

Description of type.—Top of head dull dark bronze green shading into a brighter bronze green on neck and back and into golden bronze on rump; longer upper tail coverts dark coppery bronze; lores and malar area dark reddish rufous shading into reddish buffy on chin; lower parts, from chin to include front of abdomen, clear bright metallic green; crissum buffy and buffy whitish, except three or four middle under tail coverts which are much longer than other coverts and specialized into satiny white overlapping, rigidly decurved plumes as in *Goldmania* but much longer and broader, or more developed basally; sides of neck and body greenish bronze; posterior flanks reddish buffy; primaries purplish black; secondaries rusty rufous tipped with dark bronzy purplish (similar to pattern of *Eupherusa*); tail mainly rusty buffy but exposed parts of two middle feathers dark bronze green and lateral feathers tipped with proportionately decreasing amounts of same to a narrow edging on tip of outer feather on each side.

Adult female.—Similar to male but smaller and under parts of neck and body nearly uniform ochraceous buffy with metallic green feathers confined to sides of breast; less dark bronze green on tail feathers, two outer pairs entirely reddish buffy.

Measurements of type.—Wing, 52; tail, 29; culmen, 17.

Remarks.—Although the wing characters are different in the present bird from those of *Goldmania* the similarity of the curious modification of the middle under tail coverts in the two genera, present in both sexes and in the immature plumage appears to indicate a close relationship. Unfortunately the only specimens of the present species are two slightly immature males and an adult female, so it is impossible to determine whether the outer primary of the fully adult male is or is not modified near the tip. Goldman collected the type of this new genus and species at Cana at an altitude of 2,000 feet in March, and during the same month and in May collected two others on Mount Pirri at 4,500 and 5,000 feet altitude.

ERIOCNEMIS FLOCCUS, sp. nov.

Wool-tufted Humming-bird

Type.—No. 238295, adult male, U. S. National Museum, Biological Survey Collection, from east slope of Mount Pirri (at 5,000 feet altitude), near head of Rio Limon, eastern Panama; collected April 12, 1912, by E. A. Goldman (collector's number 15488).

Distribution.—Known from type locality only.

Specific characters.—A plainly colored species resembling *E. aureliæ* in size and general color of upper parts; lower parts much greener with gray borders to feathers, whitish abdomen and dingy pinkish buffy leg-tufts, latter with a stringy, woolly appearance.

Description of type.—Top of head dark green, clear and dull on forehead and changing on crown, nape and sides of head, and to a less extent on neck, to greenish coppery bronze; wing coverts a little richer bronze than sides of neck; all of back to tail coverts clear bright metallic grass green with a slight trace of bronze; upper tail coverts bright rich golden bronze; under parts, from chin to abdomen, clearer and more brilliantly iridescent green than back but with a slight wash of bronzy and feathers along under side of chin, neck and breast, except on sides, narrowly bordered with dull grayish white, giving a scaled appearance in certain lights; white edging to feathers increases posteriorly and leaves middle of abdomen dull whitish; under tail coverts green like feathers of breast and similarly edged with grayish white; leg patches more stringy and less puffed than usual and dingy pinkish-buffy white in front, and more of a dingy smoky buffy posteriorly; wings purplish black, with a narrow rufous-buffy margin at bend; tail dark steel blue-black, with a slight bronzing on middle feathers; tail deeply emarginate.

Description of adult female.—Similar to male but much more and clearer white on under parts, including broader edgings to feathers of neck and breast and larger abdominal area; outer tail feathers with small apical whitish tips.

Measurements of type.—Wing, 61; tail, 38.5; culmen, 21.

Remarks.—This species is based on eleven specimens from the type locality. It appears to be quite distinct from the known members of the genus but has a close superficial resemblance on the upper parts to *E. aureliæ* but the colors are brighter than in that species. Its entirely buffy, and not very fluffy, leg puffs are a strong character.

PHÆTHORNIS ADOLPHEI FRATERCULUS, subsp. nov.

Brown Pigmy Humming-bird

Type.—No. 232530, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 2,000 feet altitude) eastern Panama; collected Feb. 28, 1912, by E. A. Goldman (collector's number 15230).

Distribution.—Known from type locality only.

General characters.—Close to *P. a. saturatus* of western Panama and Costa Rica but distinctly darker above and below, crown more sooty brownish, upper tail coverts darker and more chestnut and light tips of tail feathers narrower. Although this form is based on a single specimen it differs so strongly from the series representing neighboring forms there is little doubt of its being distinct.

THAMNISTES ANABATINUS CORONATUS, subsp. nov.

Rufous-crowned Antshrike

Type.—No. 238537, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 3,500 feet altitude), eastern Panama; collected June 6, 1912, by E. A. Goldman (collector's number 15845).

Distribution.—Panama, from Veragua to the Colombian border.

Subspecific characters.—More richly colored than *T. a. saturatus* with crown dull rufous contrasting with olivaceous brown of back, and under side of neck and upper breast dull ochraceous buffy, contrasting with the olivaceous buffy of rest of under parts.

Description of type.—Crown and nape dull chestnut rufous; entire back brownish olive; top of wings, upper tail coverts and tail rusty chestnut becoming browner on terminal half of wings from primaries to tertials; concealed spot of bright orange rufous on back narrowly margined posteriorly with black; chin, under side of neck and fore part of breast deep ochraceous buffy plainly contrasting with the olivaceous buffy of rest of under parts which become paler along median line and darker and more olive on sides; sexes alike except absence of concealed orange rufous spot on back of female; size about as in *saturatus*.

Remarks.—A series of sixteen *T. a. saturatus* from various Costa Rican localities, including the type, agree in having the crown and back of practically the same color and in having the under parts of neck and body nearly uniform. Five specimens from Calobre (Veragua), the Canal Zone, and Cana near the Colombian border, agree in having the crown distinctly more rufous than back and the under side of neck and fore breast ochraceous buffy contrasting with remainder of lower parts. The specimen from Calobre, Veragua, western Panama, in the U. S. National Museum is evidently the basis for the statement by Mr. Ridgway that in *T. a. saturatus* the pileum is sometimes deep russet. As stated above this specimen belongs to the present subspecies and is even darker and more strongly marked than any of the other examples, including the type.

DYSITHAMNUS MENTALIS SUFFUSUS, subsp. nov.

Olive-sided Antvireo

Type.—No. 238043, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 4,000 feet altitude), eastern Panama; collected May 6, 1912, by E. A. Goldman (collector's number 15676.)

Distribution.—Known from upper slopes of Mount Pirri only.

Subspecific characters.—Males most like typical *mentalis* but much less yellow below, more as in *septentrionalis,* pale grayish white of under side of neck extending farther back (over front of breast); sides, breast and body much more extensively olive green, limiting the yellow mainly to abdomen; flanks dull olive green; under tail coverts dull yellow or yellowish buffy; the female most like that of *semicinereus* from Bogota but top of head rather duller rusty and rest of upper parts more greenish olive (less tinged with brownish); breast and sides of body dingy brownish olive-greenish, becoming browner on flanks and buffy on under tail coverts; abdomen light yellow washed with brownish olive from sides; size large.

Measurements of type.—Wing, 62; tail, 40; culmen, 16; tarsus, 19.5.

Remarks.—The type of *D. m. septentrionalis* from Vera Paz, Guatemala, is a much paler and grayer bird than the large series from Costa Rica and western Panama which have been referred to it. Should more material from Guatemala show that this difference holds between the birds of the two areas the southern bird may require separation as a distinct subspecies. The present form is based on a series of ten specimens.

HERPSILOCHMUS RUFIMARGINATUS EXIGUUS, subsp. nov.

Rufous-winged Antvireo

Type.—No. 238539, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 3,500 feet), eastern Panama; collected June 6, 1912, by E. A. Goldman (collector's number 15844).

Distribution.—Known from type locality and from Boca de Cupe at 250 feet above sea level on the adjoining lowlands.

Subspecific characters.—Smaller than *H. rufimarginatus* with larger bill; the male differs in having a broad black band extending as a continuation from black crown and nape down middle of back and rump, this black on back varied with a slight mixture of the bordering gray; cheeks, chin and throat white without trace of yellow suffusion; female browner above and deeper yellow below.

Description of male (type).—Top of head, back of neck and extension of same in a broad band down middle of back and rump black, this black band varied by slight mixture of gray especially on the front of shoulders; sides of neck as well as sides of both back and rump gray; broad superciliary stripe of dull white with fine black edges to feathers; blackish loral spot and black postocular stripe; sides of head below eyes, chin and throat, dull white, feathers slightly margined with blackish and no yellow suffusion; median part of breast and abdomen dull pale lemon yellow; sides of breast and flanks much paler and grayer; wings black with bright white terminal spots on coverts forming two wing bands, that on lesser coverts broken, on greater coverts larger and more uniform; two innermost tertials strongly edged with white, other tertials, secondaries and primaries edged with rufous chestnut; middle pair of tail feathers dark gray with narrow black shaft line broadening subterminally and tipped with white; outer pair of feathers black with terminal half of outer web and fifth of inner web white, other tail feathers black with small white tips; female with top of head and postocular stripe chestnut; back and rump brownish olive gray; tail with more white on tips and outer webs of all but inner two pairs of feathers than in male; wings and entire under parts similar to male but deeper yellowish with a wash of pale buffy on sides of breast.

Measurements of male (type).—Wing, 48; tail, 37.5; culmen, 15; tarsus, 18.5.

Remarks.—I have seen no specimens of *H. r. frater*, which was described from Sarayacu, Ecuador, but so far as the characters of this form are given in descriptions it appears to differ from the present form, although von Berlepsch and Hartert state that adult specimens from the Caura River have the interscapular region black, apparently as in the present form (Nov. Zoöl. 1902, p. 75). Goldman collected only two specimens of this bird, a fine adult male and female.

GRALLARICULA FLAVIROSTRIS BREVIS, subsp. nov.

Darien Grallaricula

Type.—No. 238069, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 4,500 feet altitude), near head of Rio Limon, eastern Panama; collected May 1, 1912, by E. A. Goldman (collector's number 15630).

Distribution.—Known from upper slopes of Mount Pirri only.

Subspecific characters.—Generally similar to typical *flavirostris* but smaller with much larger bill; upper parts with less brownish suffusion, the crown more olive grayish; back nearly plain olive and outside of wings darker and more olive brown; tawny ochraceous of under side of neck, breast and sides of body about the same, but with black edgings to feathers usually well marked but narrower and less numerous on both throat and breast than in typical *flavirostris*.

Measurements of type.—Wing, 64; tail, 26; culmen, 16.5; tarsus, 24.

Remarks.—This subspecies is based on four specimens, three of which are much alike but the other lacks the dark edges to feathers of neck and breast as in *costaricensis*, but the ochraceous of these parts is lighter and yellower, the upper parts greener and less brownish olive, and the size smaller with larger bill.

MARGARORNIS BELLULUS, sp. nov.

Beautiful Margarornis

Type.—No. 238070, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 4,500 feet altitude) near head of Rio Limon, eastern Panama; collected May 1, 1912, by E. A. Goldman (collector's number 15636).

Distribution.—Known from upper slopes of Mount Pirri only.

Specific characters.—Top of head and neck bistre brown; back burnt umber; tail bright rufous chestnut; chin and throat white;

rest of under parts olive brown with numerous black bordered guttate white spots.

Description.—Top of head and neck dull olive brown each feather narrowly bordered with dusky; back and lesser wing coverts burnt umber with broad blackish shaft lines on wing coverts, and obscurely marked narrow dark shaft lines on back; greater wing coverts and exposed parts of scapulars, secondaries, upper tail coverts and top of tail bright rufous chestnut, dullest on wings; greater coverts with blackish shaft lines; primaries edged externally with rusty brown, shaded with olive; sides of head and neck, including malar region, brown like top of head and marked with a supraocular stripe extending back to nape; ring around eyes and streaks along sides of head and neck pale yellowish white; chin and throat white; rest of under parts nearly uniform olive brown (with a slight tinge of reddish on flanks, becoming stronger on under tail coverts) with numerous bright yellowish white guttate spots sharply edged with black, the spots largest along median line, smaller on sides and becoming shaft streaks on under tail coverts; posterior white marks of abdomen smaller and with slight or no dark margins; inner webs of secondaries and all but two or three outer primaries mainly rich orange buff; inner side of wing at bend and axillaries pale buffy with black borders to feathers except on some axillaries, and under secondary and primary coverts.

Measurements of type.—Wing, 76; tail, 71; culmen, 14.5; tarsus, 20.

Remarks.—This well-marked species is nearest *perlata* but appears to be distinct from any heretofore described. The spots on the under parts resemble those of *perlata* but are much smaller and fewer and the general color of the under parts is browner and less washed with rufous. On the back the two are very distinct. This species is based on six specimens, all from Mount Pirri. In some specimens the dusky shaft streaks on the back are much more prominent than in others and one specimen has a few small scattered yellowish white shaft streaks on the posterior part of the neck or extreme front of the back.

MITREPHANES EMINULUS, sp. nov.

Green-backed Flycatcher

Type.—No. 238135, adult male, U. S. National Museum, Biological Survey Collection, from Cana, eastern Panama; collected February 26, 1912, by E. A. Goldman (collector's number 15200).

Distribution.—Known from type locality only.

Specific characters.—Above dark olive greenish, darkest on top of head and on upper tail coverts; wings and tail blackish slate color narrowly margined with dull olive green; lores and narrow ring around eyes dingy yellowish; sides of head olive green like back, under side of neck and breast dingy fulvous—almost olive—buffy shading into olive greenish on sides of breast and changing abruptly into canary yellow on abdomen and under tail coverts, yellow palest on tail coverts and darkest next breast; bend of wing dark olive green; axillaries pale dull yellowish; bill dusky above yellow below; feet and tarsi dusky horn color.

Measurements of type.—Wing, 62; tail, 49; culmen, 10; tarsus, 12.3.

Remarks.—The present species, represented in the collection by five specimens, differs strongly from other known members of the genus in the green back, light olive-fulvous breast and bright yellow abdomen, thus reproducing a style of coloration found in *Empidonax*. An immature specimen taken at the type locality, March 13, has conspicuous dark buffy edgings to the wing coverts, forming two wing bars; narrow grayish white edgings to outer borders of tertials and small buffy gray tips to points of tail feathers. In the adult the wings and tail are plain, or with scarcely a trace of edgings to the feathers. This species appears to be most closely related to *M. olivaceus* Berl. & Stolz. of Central Peru but is distinguished by the clearer yellow of the abdomen and other characters.

PRÆDO,[1] gen. nov.

Generic characters.—Small flycatchers closely related to *Aphanotriccus* Ridgway, but with a strong resemblance in coloration to *Empidonax;* bill proportionately broader and much thinner or more flattened than in *Empidonax*, broad and depressed at base with well-marked ridge along top; outline of sides slightly convex subbasally; compressed and hooked at tip with a well-marked notch; rictal bristles fine and weak extending along top of upper mandible three-fourths its length; nostrils open, rounded and set well forward on mandible (about one-third of distance from feathering of forehead to tip); under mandible slightly keeled with broad rounded interramal area extending forward as far as anterior border of nostrils; point of wings short, longest primaries only a little more than half the length of culmen longer than secondaries; tenth or outer primary equals third and also equals the longest secondaries; ninth pri-

[1] Prædo = a robber.

mary nearly equals sixth; seventh and eighth primaries equal and longest; length of tail equals distance from bend of wing to tips of secondaries; tarsus a little more than one-fourth the length of wings; tail emarginate with two outermost pairs of feathers slightly graduated.

Color.—Above plain olive green with two dull slightly greenish yellow wing bands; narrow supraloral streak and ring about eye white; chin pale grayish; rest of under parts rich primrose yellow except sides of body and a broad band across breast of dull olive greenish; bill, above and below, black.

Type of genus *Prædo audax* (monotypic).

PRÆDO AUDAX, sp. nov.

Black-billed Flycatcher

Type.—No. 238681, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 2,000 feet altitude), eastern Panama; collected March 19, 1912, by E. A. Goldman (collector's number 15403).

Distribution.—Known from type locality only.

Specific characters.—Resembles *Empidonax* in general coloration (upper parts olive green, two pale wing bands, under parts yellow except olive breast), but at once distinguished by its black bill and short extension of primaries beyond tips of secondaries.

Description of type.—Upper parts olive green distinctly darkest on top of head and neck and palest on upper tail coverts and borders of tail feathers; lores dusky; ear coverts and below eyes dark olive; a narrow supraloral streak and ring about eyes white; wings dusky slaty gray, darker than tail, with two wing bands and edges of secondaries and tertials dull greenish yellow; edges of primaries dull olive; chin and upper throat pale gray tinged with yellow; rest of throat, under side of neck, abdomen and under tail coverts rich primrose yellow, dullest on coverts; sides of neck and breast and a narrow band of same across front of breast dull olive green; flanks olive green above and yellow below; upper and lower mandibles black with lower mandible becoming dark horn color at base; feet and tarsus dusky horn color.

Measurements of type.—Wing, 58; tail, 52.3; culmen, 13; width of bill at angle of gape 10; tarsus, 15.

Remarks.—This interesting little flycatcher at first glance appears to be a small species of *Empidonax*, but the entirely black bill, situation of nostrils and other characters show that it is generically distinct. It appears, however, to be closely related to that genus, and to *Aphanotriccus*. Goldman secured two specimens both from the type locality, one in March and the other the last of May.

CARYOTHRAUSTES CANADENSIS SIMULANS, subsp. nov.

Black-masked Finch

Type.—No. 238535, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 3,000 feet altitude), eastern Panama; collected June 10, 1912, by E. A. Goldman (collector's number 15876).

Distribution.—Known from type locality only.

Subspecific characters.—Much like typical *canadensis* from Cayenne but black area on chin and throat larger and upper parts paler; more golden yellow on forehead and crown shading back into lighter more yellowish olive green on back; front of head including band across forehead, lores, sides of head back to include eyes, and down over chin and throat black; auricular region and under parts of body bright golden yellow as in *brasiliensis;* size of *canadensis* but bill larger and heavier.

Measurements of type.—Wing, 86; tail, 66; culmen, 18; tarsus, 22.

Remarks.—In the black frontal band this form resembles *P. c. frontalis* Hellmayr (Nov. Zoöl. 1895, p. 277) from N. E. Brazil but differs otherwise. Two specimens examined.

TANAGRA XANTHOGASTRA QUITENSIS, subsp. nov.

Quito Manakin

Type.—No. 30929, adult male, U. S. National Museum, from Quito, Ecuador, collected by C. R. Buckalew.

Distribution.—Peru (except southeastern part) and Ecuador.

General characters.—Largest of the known subspecies with distinctly paler yellow crown and less orange yellow on under parts; entire upper parts black suffused with violet iridescence strongest on back of neck and gradually lessening to top of tail; black of chin and throat faintly tinged with violet; under parts of body and under tail coverts chrome yellow becoming more orange along median line.

Measurments of type.—Wing, 66; tail, 40; culmen, 10; tarsus, 17.

Remarks.—This form is distinguished from typical *xanthogastra* as well as from *brevirostris* and *brunneifrons* by its large size and pale yellow crown; from *chocoensis* by its larger size and much stronger violet iridescence on upper parts and richer and more orange yellow under parts.

The subspecies of *T. xanthogastra* stand as follows:

T. xanthogastra xanthogastra Sundevall. Brazil.

T. xanthogastra brevirostris Bp. Middle and eastern Colombia.

T. xanthogastra chocoensis Hellmayr. Western Colombia and eastern Panama.

T. xanthogastra brunneifrons Chapman. Southeastern Peru.

T. xanthogastra quitensis subsp. nov. Peru (except southeastern part) and Ecuador.

Four specimens of this subspecies examined.

TANGARA FUCOSUS, sp. nov.

Green-naped Tanager

Type.—No. 232996, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,000 feet altitude) near head of Rio Limon, eastern Panama; collected May 1, 1912, by E. A. Goldman (collector's number 15640).

Distribution.—Known from type locality only.

Specific characters.—In size and general appearance closely resembles *T. dowii*, but at once distinguishable by the green instead of brown patch on middle of occiput, by a well-marked green patch covering part of cheeks and auriculars and the imperfect nuchal collar; ends of black feathers on neck below black throat-patch broadly tipped with blue; under parts of body ochraceous buffy much paler than in *dowii;* feathers along sides of breast and flanks with dark centers similar to those on breast.

Description.—Head, neck, back and upper sides of wings and tail black, duller than in *dowii*, and the back lightly washed with greenish; a patch across back of crown, an imperfect nuchal collar, the lower part of cheeks and part of ear coverts beryl green varying in different lights and glossed with metallic ochraceous buffy, the latter strongest on cheeks and ear coverts; rump glaucous green varying in different lights; chin and throat plain black; feathers on remainder of under side of neck broadly tipped with ultramarine blue, forming a thin blue patch over the black feathers; lesser wing coverts bordered with same blue color; greater coverts paler blue, and tertials, secondaries and primaries lightly edged with a more greenish blue; tail feathers bordered with latter color; feathers of breast and sides of body, including flanks, with black or dusky centers edged with light green on fore part of breast and with paler greenish and buffy on lower breast and sides of body; the dark centers less strongly marked posteriorly and buffy edgings distinctly washed with pale greenish; middle of breast, abdomen and under tail coverts dull buffy, palest anteriorly and dark ochraceous buffy on under tail coverts; dark centers of feathers on breast less sharply defined than in *dowii*.

Measurements of type.—Wing, 72; tail, 50; culmen, 12; tarsus, 19.

Remarks.—Described from three specimens collected near the summit of Mount Pirri, where they were not common.

HYLOSPINGUS,[1] gen. nov.

Generic characters.—Most closely related to *Chlorospingus* but larger, with proportionately heavier bill, tarsus and feet; more pointed wing and outer tail feathers broader and more graduated giving a more rounded end to tail.

Bill, feet and tarsus rather short and heavy; bill compressed laterally, about two-thirds as wide as deep at nostrils; upper and lower outlines slightly curved, tip of upper mandible slightly overhanging and notched; cutting edge of upper mandible slightly sinuate; wing formula nearly as in *Chlorospingus,* 9th primary slightly longer than longest secondary; 8th a little shorter than 6th and 7th which are subequal and longest; longest primaries about length of culmen longer than secondaries; three outer pairs of tail feathers graduated enough to produce a distinctly but not strongly rounded tail; tarsus unusually thick with short strong toes and claws; middle toe with claw about three-fourths length of tarsus; tarsus less than one-third length of wing and less than half the length of tail.

Color.—Top of head dark slate color; rest of upper parts plain olive green; under parts greenish yellow becoming more orange from chin to breast. Sexes alike.

Based on *Hylospingus inornatus* sp. nov. (monotypic).

HYLOSPINGUS INORNATUS, sp. nov.

Mount Pirri Tanager

Type.—No. 238680, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,200 feet altitude) eastern Panama; collected April 14, 1912, by E. A. Goldman (collector's number 15497).

Distribution.—Known from higher slopes of Mount Pirri only.

Specific characters.—Much like a large dark colored species of *Chlorospingus;* top of head dark slate color, rest of upper parts olive green; below mainly greenish yellow, palest along median parts.

Description.—Top and sides of head to include lores and suborbital area to angle of gape blackish slate color, darkest on fore-

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[1] *ὕλη* = forest, *σπίγγος* = a small bird.

head, lores and below eyes; posterior part of crown becoming greenish and shading into the nearly uniform olive green covering rest of upper parts, but becoming a little brighter greenish on edgings to wings and on rump; chin, throat and breast dull gamboge yellow, a little paler on throat and darker and more greenish on breast; feathers of chin and throat marked with inconspicuous small arrow-shaped black spots on tips as in some species of *Chlorospingus;* sides of breast and flanks yellowish olive green shading into dull lemon yellow on abdomen; under tail coverts dull gamboge yellow; primaries dark slate except for greenish edges; tail olive green; bill blackish; feet dusky horn color.

Measurements of type.—Wing, 82; tail, 66; culmen, 15; tarsus, 27.

Remarks.—Goldman found this to be a common bird in the tree tops on the summit of Mount Pirri. He informs me that the skin on the top of the head is much thickened and oily although these birds have no crest or other development of the feathers which would account for this character.

CHRYSOTHLYPIS CHRYSOMELAS OCULARIS, subsp. nov.

Black and Gold Tanager

Type.—No. 238544, adult male, U. S. National Museum, Biological Survey Collection, from Cana (at 3,500 feet altitude), eastern Panama; collected June 6, 1912, by E. A. Goldman (collector's number 15848).

Distribution.—Eastern Panama.

Subspecific characters.—Similar to typical *chrysomelas* but males differ in having a broader black ring around eyes, the black extending forward anteriorly to form a well-marked loral spot; females more strongly distinguished from those of the typical form by having entire under parts, from chin to under tail coverts, nearly uniform greenish yellow; typical *chrysomelas* has chin, throat and under tail coverts duller yellow, middle of breast and abdomen whitish and sides of breast and flanks dull grayish with a faint wash of yellow.

Remarks.—A series of five specimens including both sexes was collected at the type locality.

HEMITHRAUPIS ORNATUS, sp. nov.

Orange-throated Tanager

Type.—No. 17880, adult male, U. S. National Museum, from Truando, Colombia; collected by A. Schott.

Distribution.—From Cana, eastern Panama, to Truando, northwestern Colombia.

Specific characters.—Close to *H. flavicollis* but smaller with yellow areas a rich dark cadmium yellow.

Description of type.—Top and sides of head, including ear coverts, top and sides of neck, anterior half of back, top of wings and upper tail coverts dull black, of a more intense or less sooty shade than in typical *flavicollis;* chin, sides of head up to lower border of eyes, fore neck, under tail coverts and posterior half of back, including rump, rich dark cadmium yellow; under side of body white, nearly pure along middle and grayer on sides; indistinct and partly hidden black bars on whitish feathers immediately back of yellow area on upper breast; axillars and basal part of inner webs of primaries and secondaries pure white.

Measurements of type.—Wing, 66; tail, 48; culmen about 11.5 (broken); tarsus, 16.5.

Remarks.—A nearly mature male collected by Goldman at Cana, eastern Panama, May 22, 1912, agrees with the type in the intense cadmium color of the yellow areas except the under tail coverts which are mainly lemon yellow but contain new cadmium colored feathers showing the paler color to be a mark of immaturity. Two specimens of this subspecies examined.

VIREOLANIUS EXIMIUS MUTABILIS, subsp. nov.

Panama Shrike Vireo

Type.—No. 238507, adult female, U. S. National Museum, Biological Survey Collection, from Cana (at 3,000 feet altitude), eastern Panama; collected June 11, 1912, by E. A. Goldman (collector's number 15893).

Distribution.—Known from type locality only.

Subspecific characters.—Similar to typical *eximius* but supraloral part of superciliary yellow stripe broader and a tinge of yellowish green suffuses and nearly replaces the blue on forehead back to about middle of orbits, the posterior part of crown and nape being clearest blue, whereas the forehead and front of crown are most clearly blue in the type of *eximius;* ear coverts bordered posteriorly with blue like that of crown; chin and throat clear bright canary yellow changing rather abruptly into, and contrasting with, the yellowish green of lower neck and breast (in *eximius* the chin is more greenish yellow and shades thence gradually over throat to green of breast); green of under parts paler and more yellowish becoming pale olive yellow on middle of abdomen; under tail coverts canary yellow about like chin and throat; in type of *eximius* the under parts are a nearly uniformly darker greenish than in the present form.

Measurements of type of eximius (sex?).—Wing, 75; tail, 48.5; culmen, 19; tarsus, 21.

Measurements of type of mutabilis (ad. ♀)—Wing, 70; tail, 44; culmen, 17.5; tarsus, 21.5. Owing to the sex of the type of *eximius* being unknown it is impossible to decide whether the differences in size shown in these measurements are due to sex or not.

Remarks.—Through the courtesy of Mr. Witmer Stone, Curator of Birds in the Philadelphia Academy of Natural Sciences, I have been able to make direct comparison with the type of *eximius.* It was formerly mounted and shows some signs of fading, but the retention of the yellow practically unchanged on the superciliary stripe and chin and its absence on the abdomen and under tail coverts indicate that it never existed on these last named parts, and thus differs strongly from the present form in this character as well as in the restricted area of yellow on the chin and throat. The back of the type of *mutabilis* is more bluish green than in the type of *eximius* but this may be due to fading in the latter. From the foregoing it appears that notwithstanding any fading that may have occurred in the type of *eximius* the present form differs from it sufficiently to be recognized as a geographic race. The type is the only specimen seen by Goldman and these birds are apparently scarce in eastern Panama.

BASILEUTERUS MELANOGENYS IGNOTUS, subsp. nov.

Mount Pirri Warbler

Type.—No. 232972, adult female, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,200 feet elevation), near head of Rio Limon, eastern Panama; collected April 18, 1912, by E. A. Goldman (collector's number 15539).

Distribution.—Known from type locality only.

Subspecific characters.—In general similar to typical *melanogenys,* but superciliary line pale greenish yellow and broader in front where occupying most of forehead; lores black but remainder of sides of head and chin pale greenish yellow (like under side of body) finely flecked and mottled with black, the black heaviest on malar region and immediately below eyes; back distinctly greener and under parts with a stronger greenish yellow suffusion; size smaller with proportionately larger bill.

Measurements of type.—Wing, 56; tail, 56.5; culmen, 12; tarsus, 20.

Remarks.—This form is based on a single specimen which is so strongly characterized by the yellow superciliary line, restriction of black on the sides of the head, and much more greenish back and yellower under parts that it evidently represents a well-marked subspecies.

BASILEUTERUS MELANOGENYS EXIMIUS, subsp. nov.

Boquete Warbler

Type.—No. 188465, adult female, U. S. National Museum, from Boquete (at 5,000 feet altitude), western Panama; collected March 23, 1901, by W. W. Brown (Bangs collection).

Distribution.—Known from type locality only.

Subspecific characters.—Paler and grayer than true *melanogenys;* back of neck and back dull gray, becoming more greenish on rump and borders of wings and tail; under side of neck and body much paler and more whitish lacking nearly all the yellowish suffusion of *melanogenys* and *ignotus;* sides of breast and flanks grayer and less olive greenish; size about the same.

Measurements of type.—Wing, 60; tail, 58; culmen, 12; tarsus, 23. Measurements of type of *B. melanogenys* (male adult No. 30497 U. S. National Museum): Wing, 61; tail, 60; culmen, 12; tarsus, 22.

Remarks.—Two specimens in the National Museum collection from Boquete, western Panama agree in the characters named above and are so easily recognizable from the large series in the National Museum of true *melanogenys* from Costa Rica, including the type, it is evident they represent a distinct subspecies. The gray backs and pale under parts at once distinguish the Boquete form from the greenish backs and yellowish tinged under parts of true *melanogenys.*

TROGLODYTES FESTINUS, sp. nov.

Mount Pirri House Wren

Type.—No. 238012, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,200 feet altitude), near head of Rio Limon, eastern Panama; collected April 18, 1912, by E. A. Goldman (collector's number 15538).

Distribution.—Known from type locality only.

Specific characters.—Most like *T. ochraceous* but smaller with longer bill; lighter under parts (abdomen white) and shorter superciliary stripe.

Description of type.—Entire upper parts, including a broad postocular streak, tops of wings and tail tawny brown; wings indistinctly barred with dusky brown; top of tail feathers with transverse series of small dusky spots and imperfect bars more regularly placed than in *ochraceus;* lores, chin and sides of head below eyes from malar region back to include lower two-thirds of ear coverts and lower part of sides of neck bright ochraceous but not so rich as in *ligea;* supra- and postocular streak, ending abruptly at posterior border of ear coverts, ochraceous buffy; middle of throat, under side of neck and breast dull ochraceous buffy; abdomen dull white; sides of breast and flanks ochraceous brown; under tail coverts dull ochraceous indistinctly and irregularly barred with dusky.

Measurements of type.—Wing, 44; tail, 27.5; culmen, 14.5; tarsus, 17.5.

Remarks.—Although the present species is much like *ochraceus* yet owing to the two species belonging to high mountain areas widely separated by lowlands it is probable that intergradation does not occur. Goldman only secured a single specimen and saw one other during his stay of nearly a month on Mount Pirri so they appear to be uncommon. The present bird is much less reddish fulvous than *T. ochraceus ligea* from Chiriqui and differs from it more than from typical *ochraceus*. Compared with *T. solstitialis pallidipectus* of western Colombia *festinus* is smaller, with longer bill and brighter more reddish ochraceous on sides of head and neck and upper parts of head and body, and less strongly marked bars on wings and tail.

MYADESTES COLORATUS, sp. nov.

Varied Solitaire

Type.—No. 232601, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,000 feet altitude), near head of Rio Limon, eastern Panama; collected March 6, 1912, by E. A Goldman (collector's number 15309).

Distribution.—Known from type locality only.

Specific characters.—Head, neck and under parts of body gray with a jet black mask about base of bill, extending back to eyes as in *M. melanops*, with top of back and wings rufous nearly as in *ralloides*.

Description.—Front of head covered by a black mask surrounding base of bill, covering forehead and sides of head to middle of eyes, malar region and chin; rest of head, neck and under parts of body clear dark ashy gray a little paler than in *melanops*, sometimes washed with rusty olive on back of crown and nape and a more or less strong wash of same on flanks; middle of abdomen paler, sometimes almost whitish posteriorly; under tail coverts pale gray slightly tipped with whitish; top of back and wings tawny rusty rufous shaded with olivaceous anteriorly and becoming more rufous posteriorly to the dark rusty rufous rump and upper tail coverts; secondary wing coverts like back but shading into deep ochraceous buffy on borders; primaries, primary coverts and secondaries blackish, bordered on outer web of terminal half of secondaries with color of back and slight edging of same on terminal half of primaries; tertials mainly rufous a little lighter (more buffy) than back; top of tail slaty black slightly washed with olive gray on middle feathers; outer pair of tail feathers pale dull gray on terminal two-thirds, edged at tip of inner web with white; second pair of feathers with a short gray spot near tip narrowly edged with whitish and a small whitish tip to third pair; exact amount of white on tail feathers varying a little individually; bill varying from orange yellow to orange red; feet and tarsus waxy yellow, sometimes tinged with orange.

Measurements of type.—Wing, 87; tail, 81; culmen, 14; tarsus, 21.

Remarks.—This handsome species is based on a series of sixteen specimens all from at or near the type locality.

CATHARUS FUSCATER MIRABILIS, subsp. nov.

Darien Nightingale Thrush

Type.—No. 232933, adult male, U. S. National Museum, Biological Survey Collection, from Mount Pirri (at 5,200 feet altitude), near head of Rio Limon, eastern Panama; collected April 18, 1912, by E. A. Goldman (collector's number 15534).

Distribution.—Known from higher parts of Mount Pirri only.

Subspecific characters.—Most like *C. f. hellmayri* but upper parts clearer slaty blackish, distinctly black on top and sides of head and more slaty on back, and lacking the brownish shade suffusing *hellmayri;* most of under parts of head and body dull white suffused with pale buffy yellowish; size slightly larger.

Description of type.—Top and sides of head including malar region black with only slight traces of dark slaty but shading into clear dark slaty on top of neck, back and tail; wings a little more brownish slaty than back; a fine line of black extends forward from malar region along lower borders of rami to chin; remainder of chin and throat under side of breast and abdomen dull white suffused with pale buffy yellowish and faintly clouded with slaty gray; an indistinct band of same slate gray across breast in front, where commonly almost divided in middle by extension of whitish area along median line; sides of neck, breast and flanks slate gray, paler and slightly browner than back; under tail coverts dull buffy gray (sometimes tinged with more brownish than flanks or with pale buffy yellow); bill bright orange red; feet and legs orange yellow; sexes alike except for smaller size of females.

Measurements of type.—Wing, 83; tail, 72; culmen, 17; tarsus, 34.

Remarks.—This handsome subspecies is at once distinguishable from *hellmayri* by its blacker head, grayer, or less brownish, upper parts and the distinctly yellowish of the light area on the under parts of the head, neck and body. It is based on a series of twelve specimens.

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RUBELZUL COTTON: A NEW SPECIES OF GOSSYPIUM FROM GUATEMALA

With Two Plates

BY

FREDERICK L. LEWTON

(Publication 2144)

CITY OF WASHINGTON
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RUBELZUL COTTON: A NEW SPECIES OF GOSSYPIUM FROM GUATEMALA

By FREDERICK L. LEWTON

(With Two Plates)

The Kekchi Indians at Rubelzul, a part of the Finca Trece Aguas, a few miles from Senahú in Alta Verapaz, Guatemala, cultivate about their door yards the distinct type of cotton described below. An examination of the region and questioning of the natives failed to throw any light upon the origin of this cotton. It is undoubtedly a distinct, local species and has probably been cultivated by these Indians for several hundred years.

Its most prominent feature is the remarkable development of the calyx which reaches proportions not known in any other species. Seeds from the plants at Rubelzul when grown in richer soil at a considerable higher altitude in Guatemala or when planted in Florida or Texas show this very large calyx in an even more exaggerated degree. Next to the calyx the most distinguishing feature is the three deep, cuneate nectaries at the end of the pedicle, instead of the usual circular or reniform shape of the nectaries found in that position. The shape of these nectaries was retained by the plants cultivated in Texas and was recognizable in hybrid plants having the Rubelzul cotton as one parent. The plants grown in Texas from the Guatemalan seed were so affected by the new conditions as to be otherwise almost unrecognizable. All the vegetative characters were much exaggerated, the plants becoming large, spreading bushes with leaves ten inches across.

The fiber being longer and of finer quality than the species commonly planted by the Kekchi Indians this cotton was favored for their door-yard cultures.

The size and form of the calyx indicate at once the specific distinctness of the plant which may be technically described as follows:

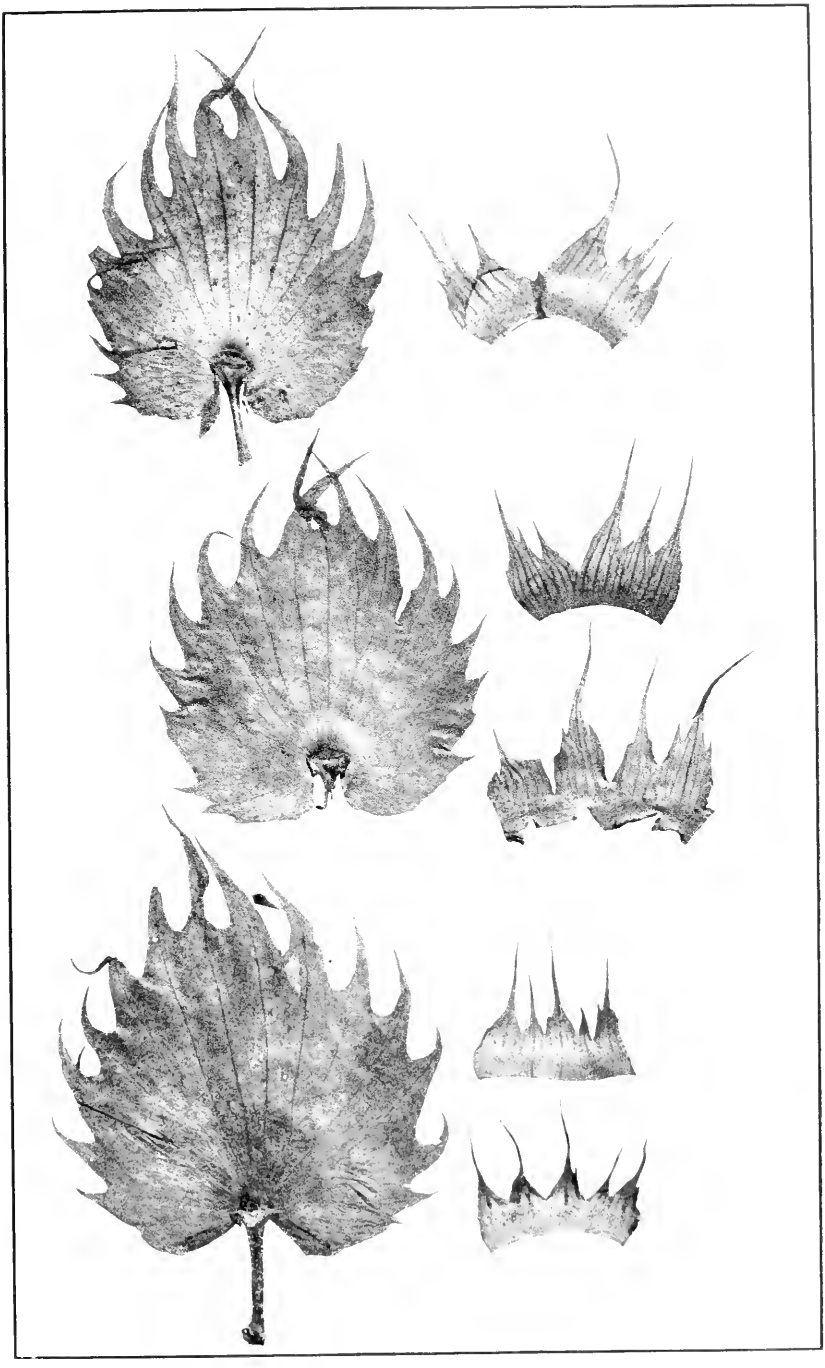
GOSSYPIUM IRENAEUM Lewton, new species

Plant a large, lax, spreading bush, 6-10 feet high, broadly pyramidal in outline; main stem erect but weak, becoming woody. Vegetative branches very long, beginning close to ground, horizontal, the ends curving upwards; axillary limbs few and small; fruiting branches beginning below middle of the plant, lowest ones very long, becoming successively shorter, not clustered; ends of branches very hairy, hairs retained on under side of old branches. Leaves 3- to 5-lobed like Upland cotton; lobes ovate acute; hairy on the main veins above; leaf nectaries variable, rhomboidal or cuneate. Stipules not prominent, broad, persistent. Involucral bracts, large for the genus, nearly orbicular in outline; laciniæ 12-17, the longest 2-2.5 cm., very hairy on the margins; nectaries at end of pedicle 3, large, deep, cuneate, very active at anthesis. Bractlets not present. Calyx adpressed to corolla, deeply 5-lobed, the lobes often trifid, the divisions subulate, the middle one nearly twice as long as the calyx tube; external nectaries usually 3, broadly triangular, smooth; floral nectary narrow, the hairy band not conspicuous. Flower buds well protected by calyx until anthesis, and young bolls protected for several days. Petals medium sized, like those of Upland cotton, very pale yellowish white, no red spots on the claws. Bolls 5 cm. long, conical, long and sharply pointed, usually 3-locked, not opening well; valves thin, but tough and woody, when old recurving with strong hooked points; black glands on bolls numerous, but well below the surface and obscure. Seeds 7-9 per lock, free, black, without fuzz except for tuft of white hairs at pointed end. Lint abundant, white, strong, fine, soft, 3 cm. long.

Perennial; growth and fruiting continuous except in wet, cold weather and late, cold spring. Crop mostly borne on extra-axillary fruiting branches.

Type in U. S. National Herbarium, No. 691080; grown in Miami, Fla. (Lewton, No. 1007), July 24, 1908, from seed obtained at Rubelzul, Finca Trece Aguas, Alta Verapaz, Guatemala, by F. L. Lewton in May, 1906.

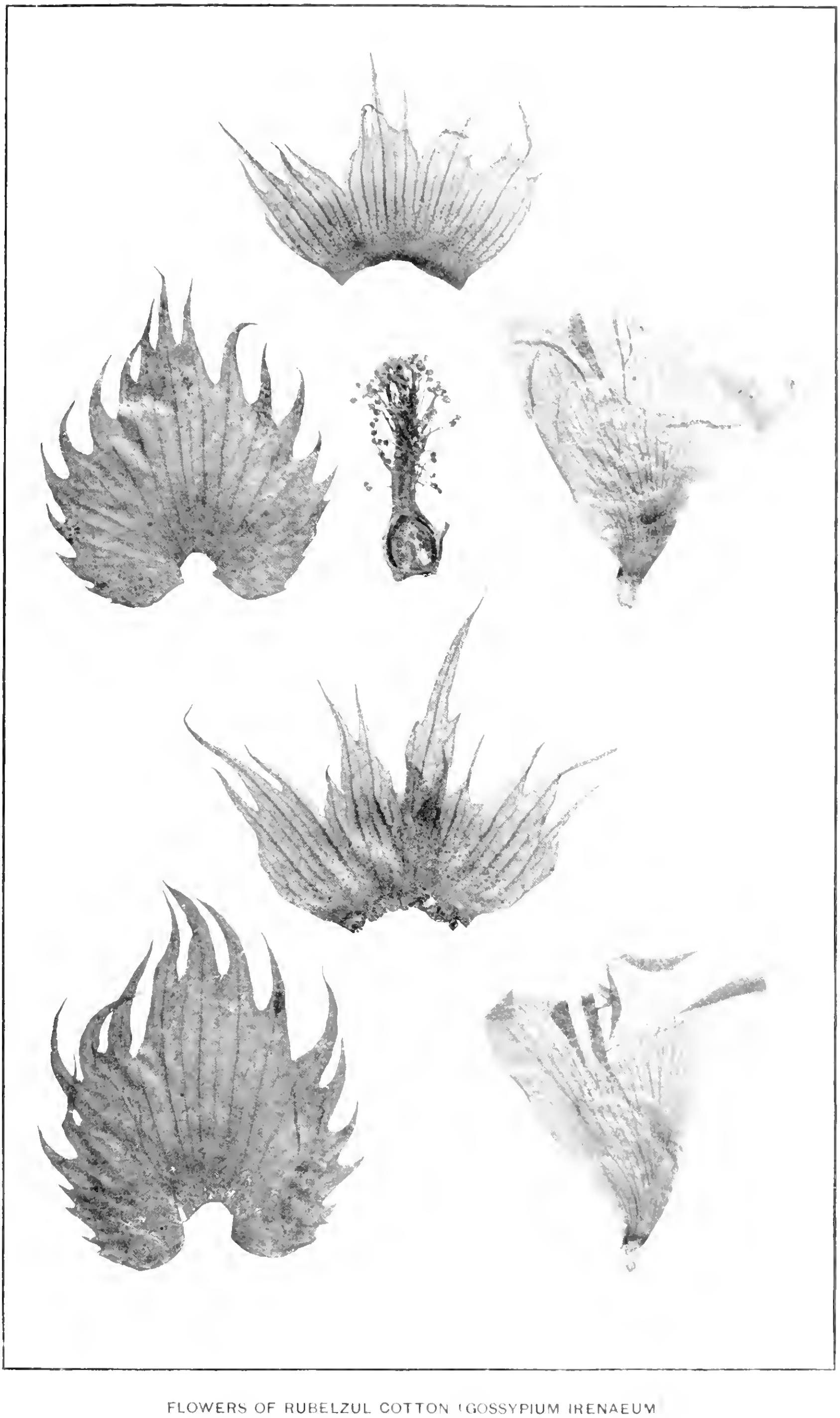
Specific name from εἰρηναῖος, as the species appears to be confined to the province of Alta Verapaz.



FLOWERS OF RUBELZUL COTTON (GOSSYPIUM IRENAEUM)

Dissected to show involucral bracts and calyx. From the original plants at Rubelzul, Guatemala

(Natural size)



FLOWERS OF RUBELZUL COTTON (GOSSYPIUM IRENAEUM)

Dissected to show involucral bracts, outer and inner surfaces of calyx, trifid calyx lobes, staminal column and petals. From offspring of the original plants, grown at Finca Trece Aguas, Alta Verapaz, Guatemala

(Natural size)

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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KOKIA: A NEW GENUS OF HAWAIIAN TREES

WITH FIVE PLATES

BY

FREDERICK L. LEWTON

(PUBLICATION 2145)

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KOKIA: A NEW GENUS OF HAWAIIAN TREES

By FREDERICK L. LEWTON

(WITH FIVE PLATES)

A few beautiful malvaceous trees, known to the natives under the name of "kokio,"[1] are at present to be found at North Kona, Island of Hawaii, in the driest part of the island at an elevation of 2,000 feet in the rough lava fields on the slopes of the Volcano of Hualalai. They were discovered, in 1909, by Mr. Joseph F. Rock, of Honolulu, and represent the surviving members of a hitherto unrecognized species of a genus here to be described as new. Within a year two of the six original trees have been destroyed, and unless immediate steps are taken by the territorial authorities for their protection, the four remaining trees will be exterminated. Mr. Rock has very kindly furnished the writer with notes on the living trees as well as herbarium material collected by him, which have mainly afforded the data necessary for the description of the new genus and species.

Formerly there were to be found on some of the other Hawaiian islands a number of trees known as *Gossypium drynarioides*, and a "variety β," which we must regard as representing two distinct species, in addition to the one already mentioned. These trees were generally found standing singly or in small groups on rough lava-covered ridges. Probably much more abundant in former times, they were exterminated from all but the driest and most inaccessible portions of the islands, and so destructive have been men and cattle that within the past few years the few remaining trees have all been destroyed. The natives stripped the trees of their bark, which contained a red sap, a preservative of their fish nets, while cattle fed upon the large, succulent leaves.

The botanical history of *Gossypium drynarioides* and the "variety β" may be briefly stated as follows: In 1865 Berthold Seemann[2] described as *Gossypium drynarioides* a specimen in the herbarium of the

[1] Anderson's Hawaiian Dictionary defines the noun *ko-ki* as follows: "The extremity; the end of a tree; a very high place." The native name of these trees, *kokio,* possibly relates to the habitat.

[2] Seemann, B.: Flora Vitiensis, 1865, p. 22.

British Museum, collected on the Island of Molokai by Nelson, the companion of Captain Cook. The description was based upon incomplete material and the author was in doubt as to the genus to which the plant should be referred, no fruit having been seen by him. The species was later collected in 1851, again on Molokai, by E. Jules Remy, a member of the Société Botanique de France, and collaborator of Gay's Flora Chilena, while on a mission to Hawaii for the Paris Museum. Dr. Wm. Hillebrand,[1] in 1888, gave a very full description of the species and also briefly described the narrow-bracted variety β from the Island of Oahu. He mentions R. Meyer as having discovered three trees of the typical form on the western end of Molokai, which could not be found on a subsequent visit. Two years ago Mr. J. F. Rock discovered[2] a single, nearly dead tree, belonging to Seemann's species, in the type locality, which tree has since died.

To summarize briefly: We have (1) a new species on the Island of Hawaii, represented by the four trees now growing on the slopes of Hualalai; (2) the species described by Seemann from the Island of Molokai, and not seen since 1910; (3) Hillebrand's "variety β" from the Island of Oahu, which has not been re-discovered, so far as known, since the publication of Hillebrand's Flora in 1888. It is believed by the writer that these three species comprise a new genus, most nearly related to *Gossypium*. It may be described as follows:

KOKIA Lewton, new genus

Generic characters.—Trees 12 to 25 feet; woody throughout. Flowers single in the axils of the uppermost leaves; peduncle bearing below the middle a broadly sessile, obliquely clasping, caducous, ovate bract. Bracteoles 3, persistent, accrescent, ovate, entire, sinuate or slightly lobed, narrowed at the base, not in the least auriculate, coriaceous, glabrous, strongly reticulated, 7-13 nerved. Calyx urceolate, thin, scarious, punctate with black warts; lobes 5, shallow, rounded, the scarious almost hyaline margins overlapping and completely enclosing the bud. Calyx tube often with a median transverse vein, the upper half of the calyx usually soon breaking off at this point, giving the calyx the appearance of being truncate. At the base of the calyx tube at the point of insertion of the petals there is a ring of stiff, brownish hairs. Floral nectary naked, extra-floral nectaries not evident. Corolla two to three times the length of the bracteoles,

[1] Hillebrand, W.: Flora of the Hawaiian Islands, 1888, p. 51.

[2] Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii, Dec., 1910, p. 72.

red. Ovary five-celled, with one ascending ovum in each cell. Capsule ovoid, ligneous, opening tardily. Seeds obovoid, sharply angled on the ventral side, rounded on the dorsal, covered with short, brick-red tomentum. Cotyledons punctate with black dots. Bark containing a reddish brown sap. Species, 3. Hawaiian Islands.

Type.—*Kokia rockii* Lewton.

KOKIA ROCKII Lewton, new species

Tree 25 feet high, averaging 10 to 12 inches in diameter. Bracts broadly obovate 6.5 cm. long, 6.5 to 8 cm. broad, with three to five blunt and shallow lobes, very strongly reticulated and veined below. Leaves glabrous below except for a dense patch of rusty hairs, 2 to 2.5 cm. in diameter at point of attachment of the petiole, the pulvinus of which is also hairy. Staminal tube 9 to 10 cm. long, curved. Seeds 2 cm. long by 1 cm. wide; lint 3 mm. long. Type in U. S. National Herbarum, no. 691082, collected at Huehue-Puu-waawaa, Hualalai, North Kona, Hawaii, altitude 2,000 feet, by J. F. Rock (no. 3549), June, 1909. Known to the writer only from the type specimen.

KOKIA DRYNARIOIDES (Seemann) Lewton, nov. comb.

Gossypium drynarioides Seemann, Fl. Vit., 1865, p. 22.

Hibiscus drynarioides Kuntze, Rev. Gen. Pl., 1891, vol. 1, p. 68.

With the exception of the calyx, this species is adequately described in Hillebrand's Flora of the Hawaiian Islands. A fragmentary specimen in the Gray Herbarium of Harvard University, collected by Dr. Hillebrand, and identified as *G. drynarioides*, has the narrow bracts of his "variety" here described as *Kokia lanceolata*; while an immature capsule in a pocket attached to the sheet has the broad, almost cordate bracts of the typical form which the writer considers as representing *Kokia drynarioides*. The same herbarium contains a sheet representing Remy's No. 568 from Molokai, evidently from a diseased tree. The involucral bracts are smaller than in Hillebrand's specimen, but are as broad as long.

The U. S. National Herbarium, contains two sheets of this species. The first, consisting of two scraps, represents Hillebrand's No. 1921, no locality being given. The second specimen, consisting of a branch and two mature capsules, was collected at Mahana, Island of Molokai, by J. F. Rock (No. 7076) April, 1910. The latter specimen has leaves which are glabrous below except for a few brownish hairs at the base of the veins.

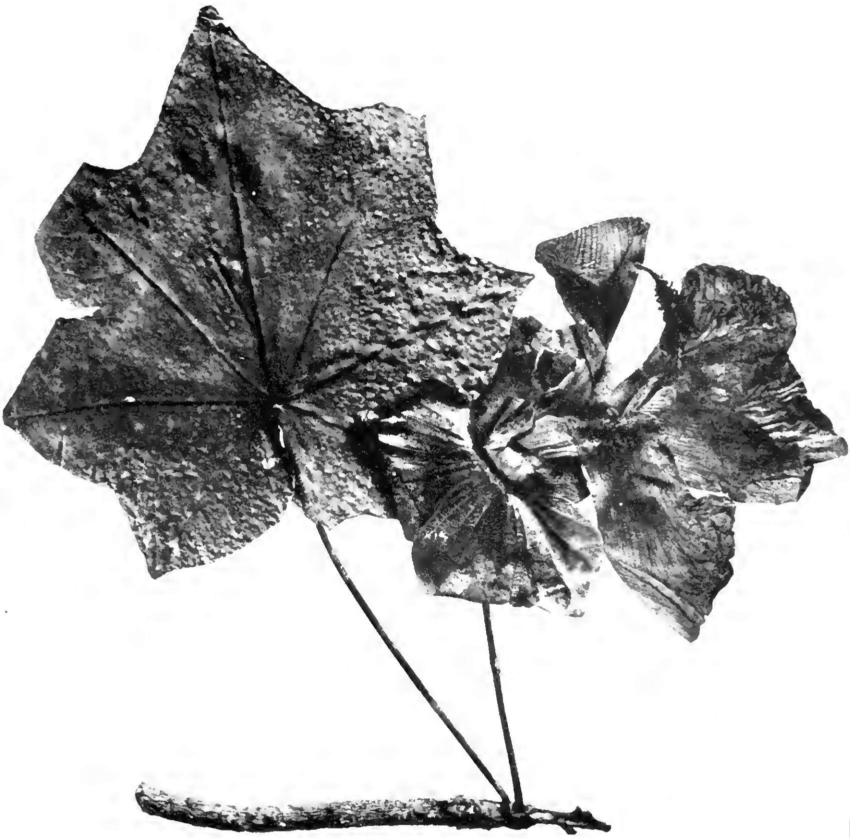
KOKIA LANCEOLATA Lewton, new species

Gossypium drynarioides var. β Hilleb. Fl. H. I., 1888, p. 51.

Under *G. drynarioides* variety β, Hillebrand mentions two trees having lanceolate involucral bracts which are only one-half as wide as long. These were found on the hills of Makaku and Koko Head, at the eastern end of Oahu. Mr. J. F. Rock, after a careful search, failed to discover a single tree now growing on the Island of Oahu.

No specimen, known definitely to have been collected in Oahu, has been seen by the writer, but a study of Hillebrand's narrow-bracted specimen in the Gray Herbarium, referred to under *K. drynarioides*, which was without locality, has convinced the writer that Hillebrand's variety β should be considered as a distinct species.

This view is taken (1) because in the variety as described by Hillebrand, and in the narrow-bracted specimen collected by him, the involucral bracts are but one-half as wide as long, or less, whereas, in the four specimens of *K. drynarioides* examined these parts are as wide as long, or wider; and (2) on account of the restriction of the variety to another island of the Hawaiian group, in keeping with the very limited distribution on certain islands of many Hawaiian plants and animals.



KOKIA ROCKII Lewton

Part of the type specimen

(Two-fifths natural size)

INVOLUCRE (LOWER SIDE) OF "KOKIO" (KOKIA ROCKII)

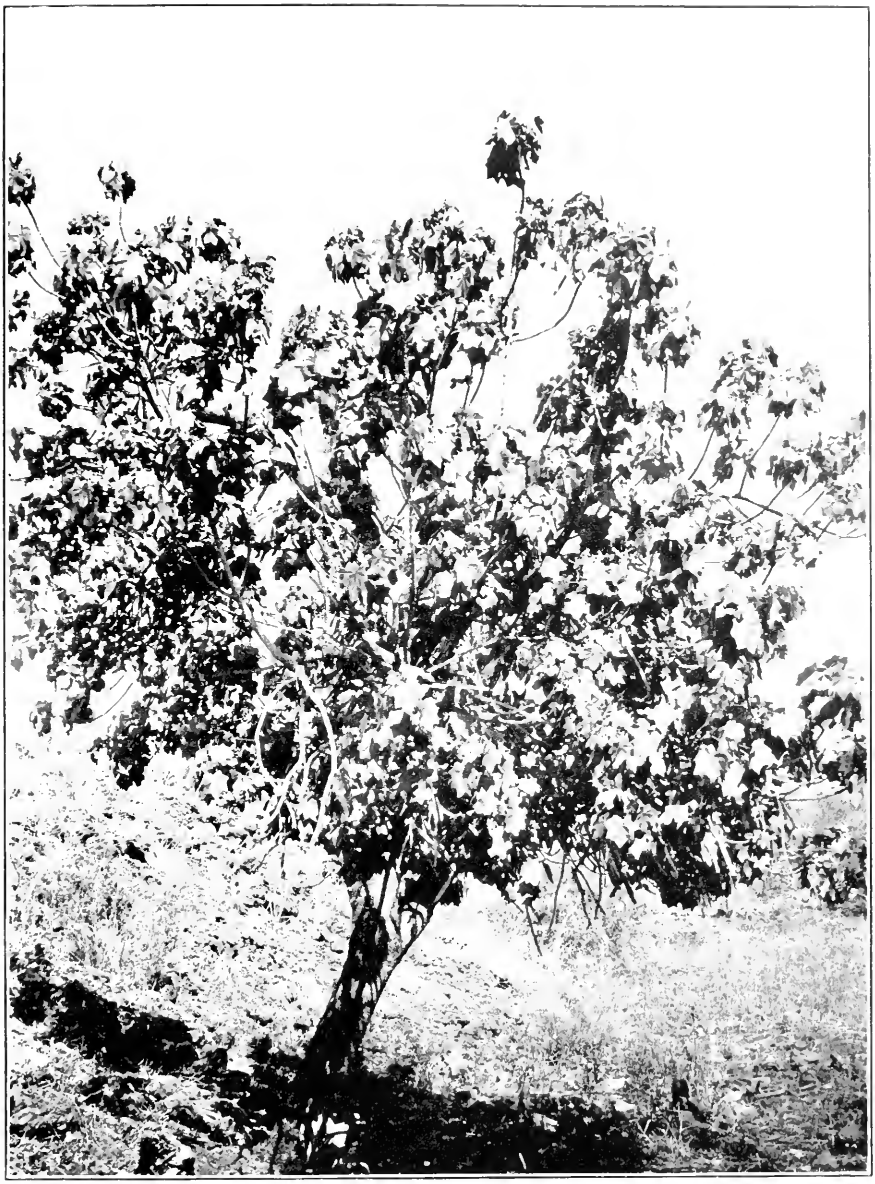
Showing reticulation of veins and scar left by the sheathing bract on the pedicle

(From type specimen; natural size)

FLOWERING BRANCH OF "KOKIO" (KOKIA ROCKII)

From tree in the type locality: Puu-waawaa, North Kona, Hawaii

(Photograph by J. F. Rock; about one-third natural size)



"KOKIO" TREE (KOKIA ROCKII)

Growing on lava fields at Puu-anahulu, Hawaii, H. T.
(Photograph by J. F. Rock)

KOKIA DRYNARIOIDES (SEEM.) LEWTON

Herbarium specimen from the last surviving tree in the type locality: Mahaua, West end of Molokai, H. T.
(Two-fifths natural size)

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THE COTTON OF THE HOPI INDIANS: A NEW SPECIES OF GOSSYPIUM

WITH FIVE PLATES

BY

FREDERICK L. LEWTON

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THE COTTON OF THE HOPI INDIANS: A NEW SPECIES OF GOSSYPIUM

By FREDERICK L. LEWTON

(With Five Plates)

INTRODUCTION

The origin and growth of cotton cultivation in the United States has received the careful attention of historians, ethnologists, statisticians and others, and much has been written concerning the development of this great industry of our country.[1] The identity and description of those varieties which laid the foundation of the American Upland cotton are questions which have received the attention of several writers, notably Watt,[2] Fletcher,[3] and de Lasteyrie.[4] The types of plants which compose the field crop as it is grown to-day have been systematically studied only within the last few years.[5]

To what extent the cotton cultivated at the present time in the United States has been influenced by the types introduced by the colonists of several European nations, by the tropical species imported from Mexico, Central America and the West Indies, or by the types of cotton native within the present boundaries of the United States when the white man came, it would be difficult to say. It is believed, however, that the last-named factor has had, if any, the least effect upon the present-day field crop. The following notes on a type of cotton long in cultivation by the Pueblo Indians of the Southwest are offered as a contribution to the study of American cottons:

ANTIQUITY OF COTTON CULTURE IN THE SOUTHWEST

That cotton was used and cultivated in the southwestern part of the United States in prehistoric times has been shown by several explorers

[1] Payne, E. J.: History of the New World Called America, 1892, pp. 406, 408-411, 416.

Handy, R. B.: Office of Experiment Stations, U. S. Dept. Agriculture, Bulletin 33, 1896, pp. 17-43.

Donnell, E. J.: Chronological and Statistical History of Cotton, 1872.

[2] Watt, Geo.: Wild and Cultivated Cotton Plants of the World, 1909, pp. 17-22.

[3] Fletcher, F.: Cairo Sci. Journ., 1909, vol. 3, pp. 263-268.

[4] de Lasteyrie, C. P.: Du Cotonnier et de sa Culture, 1808.

[5] Tyler, F. J.: Bur. Plant Industry, U. S. Dept. Agric., Bull. 163, 1910.

Duggar, J. F.: Alabama Agric. Exp. Sta., Bull. 140, 1907.

of the villages of the cliff-dwellers, those wonderful relics in the Mesa Verde National Park which were in ruins when first seen by the white man.

The Swedish explorer, G. Nordenskiöld,[1] and Dr. J. Walter Fewkes,[2] of the Bureau of American Ethnology, both report finding fragments of cotton cloth as fairly common in most of the cliff-dwellings. Nordenskiöld says:

> Cotton was used by the cliff-dwellers as the raw material of superior textile fabrics. Numerous fragments of cotton cloth have been found. The cotton shrub was probably cultivated by the cliff people, at least in some localities, for in the cliff-dwellings of southern Utah, the seeds of this shrub have been observed. On the Mesa Verde no such find has been made.

Dr. Fewkes reports finding cotton cloth in the ruins at Casa Grande in southern Arizona[3] and in the cliff villages of the Red Rock country in the Rio Verde Valley of Arizona.[4] The ruins of the latter region closely resemble those of Tusayan, the limited area now inhabited by the Hopi Indians, and seem to support the claim of the Hopi that some of their ancestors formerly lived in that region. Dr. Fewkes says of these finds:

> Fabrics made of cotton are common in the ruins of the Red-rocks, and at times this fiber was combined with yucca. Some of the specimens of cotton cloth were finely woven and are still quite strong, although stained dark or almost black. Specimens of netting are also common, and an open-mesh legging, similar to the kind manufactured in ancient times by the Hopi and still worn by certain personators in their sacred dances, were taken from the western room of Honanki. There were also many fragments of rope, string, cord, and loosely twisted bands, resembling head bands for carrying burdens. A reed in which was inserted a fragment of cotton fiber was unlike anything yet reported from cliff houses, and as the end of the cotton which projected beyond the cavity of the reed was charred, it possibly was used as a slow-match or tinder box.[4]

REFERENCES TO COTTON BY THE FIRST SPANISH EXPLORERS

Francisco Vasquez de Coronado was appointed governor of the province of New Galicia in April, 1539, by the good viceroy of Mexico, Antonio de Mendoza. A few months later he was sent on an expedition to explore the country north of Mexico and verify the reports of the great riches of the region which had been brought back by

[1] Nordenskiöld, G.: The Cliff-Dwellers of the Mesa Verde, 1893, pp. 94, 104.

[2] Fewkes, J. Walter: Bur. Amer. Ethnol., Bull. 41, 1909, pp. 43, 45, fig. 17; Bull. 51, 1911, p. 76.

[3] 28th Ann. Rep. Bur. Amer. Ethnol. (in press, 1912).

[4] 17th Ann. Rep. Bur. Amer. Ethnol., 1898, p. 573.

Padre Marcos de Niza and Melchior Diaz. Coronado's expedition resulted in the discovery of the Pueblo Indians of New Mexico and Arizona, the Grand Canyon of the Colorado and the bison of the plains. Pedro Casteñada de Najera, the historian of the Coronado expedition, mentions the Pueblo Indians as wearing cotton blankets and giving them presents of cotton cloth.[1]

In Coronado's letter to Mendoza, dated August 3, 1540, and in other papers of the Coronado expedition there is mention of cotton raising by the natives of the region[2] extending from the present southern to the northern boundaries of Arizona and eastward to the Rio Grande.

EVIDENCES OF FORMER CULTIVATION BY THE HOPI INDIANS

In 1895 Dr. J. Walter Fewkes made explorations in Awatobi, an historic Hopi ruin which was destroyed in 1700, and reports finding evidence of the use of cotton by the inhabitants.

> In the very earliest accounts which we have of Tusayan, the Hopi are said to raise cotton and to weave it into mantles. These mantles, or "towels" as they were styled by Espejo, were, according to Casteñada, ornamented with embroidery, and had tassels at the corners. . . . .
>
> The historical references which can be mentioned to prove that the Tusayan people, when they were first visited, knew how to spin and weave are numerous, and need not be quoted here. That the people of Awatobi made cotton fabrics there is no doubt, for it is distinctly stated by early visitors that they were acquainted with the art of weaving, and some of the presents made to the first Spanish explorers were of native cotton. Archeological evidence supports the historical in this particular, and several fragments of cloth were found in our excavations in the western mounds of the village. These fragments were of cotton and agave fiber, of cotton alone, and in one instance of the hair of some unknown animal.[3]

Later, Dr. Walter Hough, of the U. S. National Museum, in making excavations in the large ruin of Kawaiokuh, near the Keam's Canyon road, found offerings of cotton and other seeds accompanying burials. The cotton seed resembled that still raised by the Hopi Indians of Oraibi village at Moenkopi.[4]

Lieut. Joseph C. Ives explored in 1858 the Colorado River and the country occupied by the Hopi (Moqui) Indians. At the Pueblo of Tegua, east of Oraibi, May 17, 1858, he wrote as follows:

> The unpassable cañons west of the territory of these Indians have thrown them out of the line of travel and exploration, and there has been no record

[1] 14th Ann. Rep. Bur. Amer. Ethnol., 1896, pp. 480, 517.

[2] 14th Ann. Rep. Bur. Amer. Ethnol., 1896, pp. 550, 560, 569, 574, 575

[3] 17th Ann. Rep. Bur. Amer. Ethnol., 1898, p. 620.

[4] Ann. Rep. U. S. Nat. Mus., 1901, pp. 341, 345.

concerning them since the accounts of the early Spanish missionaries, who visited the country, and described the "seven cities" which they found there. . . . . The men wear loose cotton trousers, and frequently a kind of blouse for an upper garment, over which they throw a blanket. The dress of the women is invariably a loose black woolen gown with a gold-colored stripe around the waist and bottom of the skirt. The stripe is of cotton which they grow in small quantities.[1]

EVIDENCES OF FORMER CULTIVATION BY THE PIMA INDIANS

The Spanish missionary, Padre Pedro Font, who accompanied Padre Francisco Garcés in his fifth journey from the San Xavier Mission to the Pima Indians on the Gila River, kept an extended diary of the journey. On November 1, 1775, he wrote:

I also saw how they wove cloaks of cotton, a product which they sew and spin; and the greater number of them know how to weave.[2]

Mr. John R. Bartlett, U. S. Commissioner of the United States and Mexican Boundary Commission during the years 1850 to 1853, also records the Pimas on the Gila as raising cotton:

Cotton is raised by them (the Pimas), which they spin and weave. Their only manufactures consist of blankets of various textures and sizes; a heavy cloth of the same material used by the women to put around their loins; and an article from 3 to 4 inches wide, used as a band for the head, or a girdle for the waist. The blankets are woven with large threads, slightly twisted and without any nap. They are made of white cotton, and are without ornament of colors or figures, save a narrow selvage of buff. . . . . The weaving is generally done by the old men.[3]

Lieut. A. W. Whipple, U. S. A., also of the Mexican Boundary Commission, in an official report of the survey of the Gila River, dated January 10, 1852, describes finding an Indian garden in the Cascade Grotto, where were melons, maize, beans, and to his great surprise, a field of cotton. He also states that the banks of the Gila from the Pima settlement to the junction of the Salt River, were fertile, producing crops of cotton of the first quality.[4]

The suitability of this region for growing cotton and the familiarity

[1] Ives, Jos. C.: Report upon the Colorado River of the West, 1861, pp. 116, 127.

[2] 26th Ann. Rep. Bur. Amer. Ethnol., 1908, p. 29.

See also Coues, E.: On the Trail of a Spanish Pioneer, 1900, vol. 2, p. 386.

[3] Bartlett, John R.: Personal Narrative of Explorations and Incidents in Texas, New Mexico, California, Sonora and Chihuahua, 1854, vol. 2, p. 224.

[4] Bartlett, John R.: Personal Narrative of Explorations and Incidents in Texas, New Mexico, California, Sonora and Chihuahua, 1854, vol. 2, pp. 598, 599.

of the Indians with the plant led to an experiment a few years later, when at the close of the Civil War, cotton was bringing such a very high price. Charles D. Poston, who, in 1864, was appointed Superintendent of Indian Affairs for Arizona, stated in that year that he had recently furnished the Pimas with 500 pounds of cotton seed.[1] This experiment resulted in but little and the introduction of foreign varieties of cotton into the agriculture of these Indians brought a source of confusion to any later studies of the type grown by them from time immemorial.

Mr. Frank Russell, writing in 1908 of the Pima Indians on the Gila River, says that the cotton plant is no longer raised by them, but that from pre-Spanish days down to the last quarter of a century it was cultivated both for the fiber and the seeds. The latter were pounded up with mesquite beans in a mortar, or they were sometimes parched and eaten without grinding.[2]

MODERN USES BY THE HOPI INDIANS

The Hopi Indians of Arizona highly esteem the cotton plant and its fiber enters into many of their ceremonial services as well as into daily practical use. The Indians consider that all strings used in the services must be made of native cotton. The most important uses of cotton in the ceremonials are as follows:

All prayer sticks (pahos) must be tied together with cotton string; prayer offerings of all kinds must be tied with cotton string; cotton strings are placed in the trails entering the pueblos when ceremonials are in progress; the badges of chiefs (called tiponis) are wrapped in native rough-spun cotton strings; light, fluffy cotton to represent snow or clouds; cotton also used to weave ceremonial kilts, large cotton belts and wedding blankets.[3]

When a Hopi girl is to wed, all the men of the bridegroom's clan meet and make for the bride a complete outfit of clothing, consisting of the following:

A wedding blanket of cotton embroidered on one edge to be used by the bride on ceremonial occasions, as dedication of children to the sun, etc.; a large cotton belt, called the "knotted belt," because of the knots tied in the warp strings at each end of the woof; a woolen blanket for everyday use; moccasins, etc.

[1] 26th Ann. Rep. Bur. Amer. Ethnol., 1908, pp. 33, 77.

[2] 26th Ann. Rep. Bur. Amer. Ethnol., 1908, pp. 77.

[3] For the list of ceremonial uses I am indebted to Dr. J. Walter Fewkes of the Bureau of American Ethnology.

Nordenskiöld refers to the use of cotton by the Hopis as follows:

Among the productions of the Moki industry we first remark the textile fabrics. Both of wool and cotton they weave mantles, blankets and rugs of artistic designs. Cotton they formerly cultivated at home, but now find it more convenient to buy the cloth ready made at the store.[1]

MODERN CULTIVATION BY THE HOPIS

At the small village of Moenkopi, which is now included in the Western Navajo Reservation, there are abundant springs and water available for the irrigation of the Indians' fields. A long arm of the Upper Sonoran life zone here projects up from the south and makes cotton raising possible.

According to Mr. C. R. Jefferis, Superintendent of the Western Navajo School at Tuba, Arizona, a considerable amount of cotton was formerly grown at this point and it was spun and woven into garments by the Indians living here and in other villages of the reservation, but at present very little is grown.

Near the village of Oraibi, on the Moqui Reservation[2] about fifty miles to the eastward, the cultivation of cotton on a small scale is carried on by the Indians as a regular crop in their pueblo gardens near the village, without any irrigation whatever. This is corroborated by Mr. Frank A. Thackeray, Supervisor of Schools, and by the Rev. H. R. Voth, for several years a missionary at Oraibi.

The cotton raised at Oraibi is worthy of careful study as that is probably the only Tusayan pueblo, at present inhabited, which occupies practically the same site that it did in 1540, when it was discovered by Pedro de Tobar of Coronado's expedition.

Mr. Lorenzo Hubbel, who conducts the trading post at Keam's Canyon, Arizona, writes that the Hopi Indians have given up the cultivation of cotton. According to Mr. Hubbel, they have for some time past been buying cotton batting from the traders and spinning it instead of that of their own raising, and that at present they are giving up the custom of buying the raw cotton in favor of cotton yarn spun at the mills.

EXPERIMENTS WITH HOPI COTTON

The Hopi cotton has been grown for study and for breeding experiments by the U. S. Department of Agriculture for the past seven

[1] Nordenskiöld, G.: Cliff-Dwellers of the Mesa Verde, 1893, p. 141.

[2] The official designation of the Office of Indian Affairs in the Interior Department. The Indians and the ethnologists much prefer the name "Hopi" (the good people), instead of "Moqui" (dead man), which is used as a term of reproach.

years, and when protected by isolation from hybridization with other cottons by bees, has shown itself to be a very distinct species, having certain well-marked characteristics. The original seed for this study was obtained in 1901, 1907 and 1911 from the Moqui and Western Navajo Reservations in northern Arizona by three different persons.

The first lot of seed tested was turned over to the Department of Agriculture by Dr. Walter Hough, of the U. S. National Museum. Dr. Hough, while engaged in studies on the Hopi Indian Reservation in Arizona for the Bureau of American Ethnology, obtained the cotton seed from a Hopi Indian named Sam Pawiki, living at Oraibi, Arizona, who stated that the seed was raised at Tuba, about 25 miles to the northwest.

The second stock of this truly American cotton was grown from a few bolls also raised at Tuba, Arizona, and obtained in 1907 by Mr. J. G. Kent, an agent sent by the Office of Indian Affairs on a mission to the Hopi Reservation. Mr. Kent sent the bolls to Dr. Hough, of the U. S. National Museum, who gave them to the writer.

The third lot of seed was procured for the writer by Mr. Frank A. Thackeray, Supervisor of Schools, from the Hopis of Oraibi village.

While the plants grown from these three lots of seed show some variation, one dominant type runs through all and is described on page 9.

This cotton is remarkable for its earliness; plants have ripened bolls in 84 days from the sowing of the seed. In a test of several hundred species and varieties of cottons from all parts of the world, it was the first to bloom. A study of the branching habits of this species shows that this precocity is due to the appearance of fruiting branches at a very early period in the growth of the plant. The following tabulation of a group of 44 normal plants, grown at San Antonio, Texas, 1911, shows the node at which the first fruiting branch appears, counting from that which bears the cotyledons. The first fruiting branch appeared at the 3d node in one plant, at the 4th node in six plants, at the 5th node in twenty-seven plants, at the 6th node in nine plants, at the 7th node in one plant.

As is usually the case with most wild or little-cultivated types of cotton, there is a great preponderance of 3- and 4-locked bolls. A count of 19 plants at San Antonio, grown from the original seed obtained by Mr. Kent, showed a total of 519 bolls, of which 30.05 per cent were 3-locked, 59.35 per cent were 4-locked and 10.6 per cent were 5-locked.

Seed of Hopi cotton was furnished Professor W. Lawrence Balls for use in experiments on Mendelian inheritance in cotton. He reports[1] this species as blooming earlier than the others in the experiment, the plants being in full bloom in 70 days and the first boll ripening 100 days after the planting of the seed.

In spite of the small bolls and short, sparse lint of the Hopi cotton, its extreme earliness and prolificness under very arid conditions may make it of value in breeding new types of cottons for special conditions.

DESCRIPTION OF HOPI COTTON

The plants studied and from which the description given on page 9 is drawn were all grown from the seed obtained by Dr. Hough and Mr. Kent from Tuba, Arizona, and Mr. Thackeray from Oraibi, to which reference has already been made. Seed of Hopi cotton was also received from Mr. C. R. Jefferis, Superintendent of the Western Navajo School at Tuba, Arizona; from Mr. Lorenzo Hubbel, trader, of Keam's Canyon, Arizona, and from Dr. J. Walter Fewkes, of the Bureau of American Ethnology. The last lot of seed was collected by Mr. Thos. B. Keam at Oraibi village in 1889 and was included in the Keam collection purchased by Dr. Fewkes for the Hemenway collection in the Peabody Museum at Cambridge, Mass. Other specimens of what appears to be the same cotton have been received from Mr. E. W. Hudson, at the Pima Reservation, Sacaton, Arizona; and Mrs. Matilda Coxe Stevenson from Tonyo Camp, Española, New Mexico.

The Hopi cotton is so conspicuously different from other species and especially the American Upland cottons that it is believed to represent a new species, the particular diagnostic characters of which may be expressed as follows:

(1) Yellow green color of the whole plant; even the pulvinus of the leaves is yellow or orange instead of red.

(2) Low branching, almost prostrate habit; fruiting branches often as low as the third or fourth node.

(3) Paired fruiting branches, and often an axillary vegetative branch from the same node on the stem.

(4) Zigzag character of stem and branches.

(5) Swollen nodes of the stem and especially the branches.

(6) Numerous entire leaves, especially upon secondary branches.

(7) Leaf nectaries close to base of leaf blade, 5-7 mm. distant.

(8) Large size of scars left by fallen leaves and flowers.

[1] Yearbook Khedivial Agricultural Society, Cairo, 1906, p. 18.

(9) Flowers developed on secondary fruiting branches simultaneously with those on the primary fruiting branch.

(10) Lemon yellow color of flowers and absence of red from claws of petals.

(11) Very short style.

(12) Smooth, unpitted surface of bolls.

(13) Extreme early appearance of the flowers.

TECHNICAL DESCRIPTION OF HOPI COTTON

GOSSYPIUM HOPI Lewton, new species

Plant small, spreading widely, compact, branching very low.

Stem ascending, almost prostrate, crooked or zigzag with swollen nodes, coarsely hairy, yellowish-green.

Limbs at base usually 1, sometimes 2 or 3, horizontal or ascending; axillary limbs very small and weak, developing later in the season from the lower nodes of the leaning stem, those from the upper nodes often adnate to small extra branches for nearly their entire length.

Branches usually a pair at each node, those of each pair often of the same length and diverging from each other at an angle of 90°, when one is much smaller it is usually adnate with the small axillary limb from the same node; secondary branches almost always developed, blooming with the primary ones; nodes much swollen; scars left by fallen leaves or flowers large and conspicuous.

Leaves flat, rather thick, yellowish-green, usually 3-lobed, but often cordate and entire or with one or two blunt lobes (the smaller leaves on the secondary branches almost always entire), the lobes broad and blunt; basal sinus very shallow and open; soft hairy both sides, with coarse hairs; pulvinus very small, green or orange, never red; petioles short, very hairy; nectaries on leaves of both stem and branches 1, close to base of leaf blade (5-7 mm. distant), small, round or oval, deep, the edges but slightly raised.

Bracts of *involucre* small, triangular-cordate or long-oval, hairy, thick, stiff leathery and much reticulated; laciniæ 5 to 9, coarse, short, hairy; nectaries 3, very large, round, smooth; bractlets sometimes present.

Calyx closely appressed to corolla, slightly lobed or undulate, smooth; black dots evenly distributed; external nectaries 3, small, triangular, smooth; internal nectary with narrow band of hairs above.

Flowers small, one-third longer than the involucre.

Petals lemon yellow, rarely almost white, without spots on claws, conspicuously black dotted.

Stamens many, long; staminal tube dentate at top, often petaliferous; filaments lemon yellow; pollen cream or white, plentiful.

Style very short, not exserted beyond stamens.

Bolls small, round or somewhat oval, blunt-pointed, 3- to 5-locked, smooth as if waxed; the black oil glands well below the surface.

Seeds dark brown, devoid of fuzz, except for a crown of brown or olivaceous hairs on the pointed end; rather sparsely covered with lint.

Lint white, strong, fine and silky, 18 to 25 mm. long, the ratio of lint to seed varying from 20 to 30 per cent.

Type in U. S. National Herbarium, No. 691075. Collected at Victoria, Texas, August 4, 1909, by F. L. Lewton (No. 1009), the plants grown from seed obtained from Hopi Indians at Tuba, Arizona.

REFERENCES TO HOPI COTTON AND SPECIMENS IN HERBARIA

The specimens of Hopi cotton in the U. S. National Herbarium, the Economic Herbarium of the U. S. Department of Agriculture, and those supplied Sir George Watt by Mr. L. H. Dewey, of Washington, D. C., and Mr. W. Lawrence Balls, of Cairo, Egypt, are all descended from the original seed given Dr. Hough by Sam Pawiki.[1] Professor Balls in his experiments on Mendelian inheritance in cotton used seed of Hopi cotton supplied by the U. S. Department of Agriculture, which was grown in Waco, Texas, from the original Arizona seed.[2] This accounts for the close similarity of the Egyptian and Washington specimens which evidently puzzled Dr. Watt and shows the fallacy of his theory of the origin of the "Hindi weed" cotton of Egypt as "but an older acclimatized (and possibly recessive) hybrid of Moqui."[3]

[1] The original seed was received under the name "Moqui" and the specimens grown therefrom, which are now in several herbaria and mentioned in the two works referred to below, were so labelled. See footnote 2 on page 6.

[2] Yearbook Khedivial Agricultural Society, Cairo, 1906, pp. 17-18, 38, 56.

[3] Watt, Sir George: The Wild and Cultivated Cotton Plants of the World, 1900, p. 181.

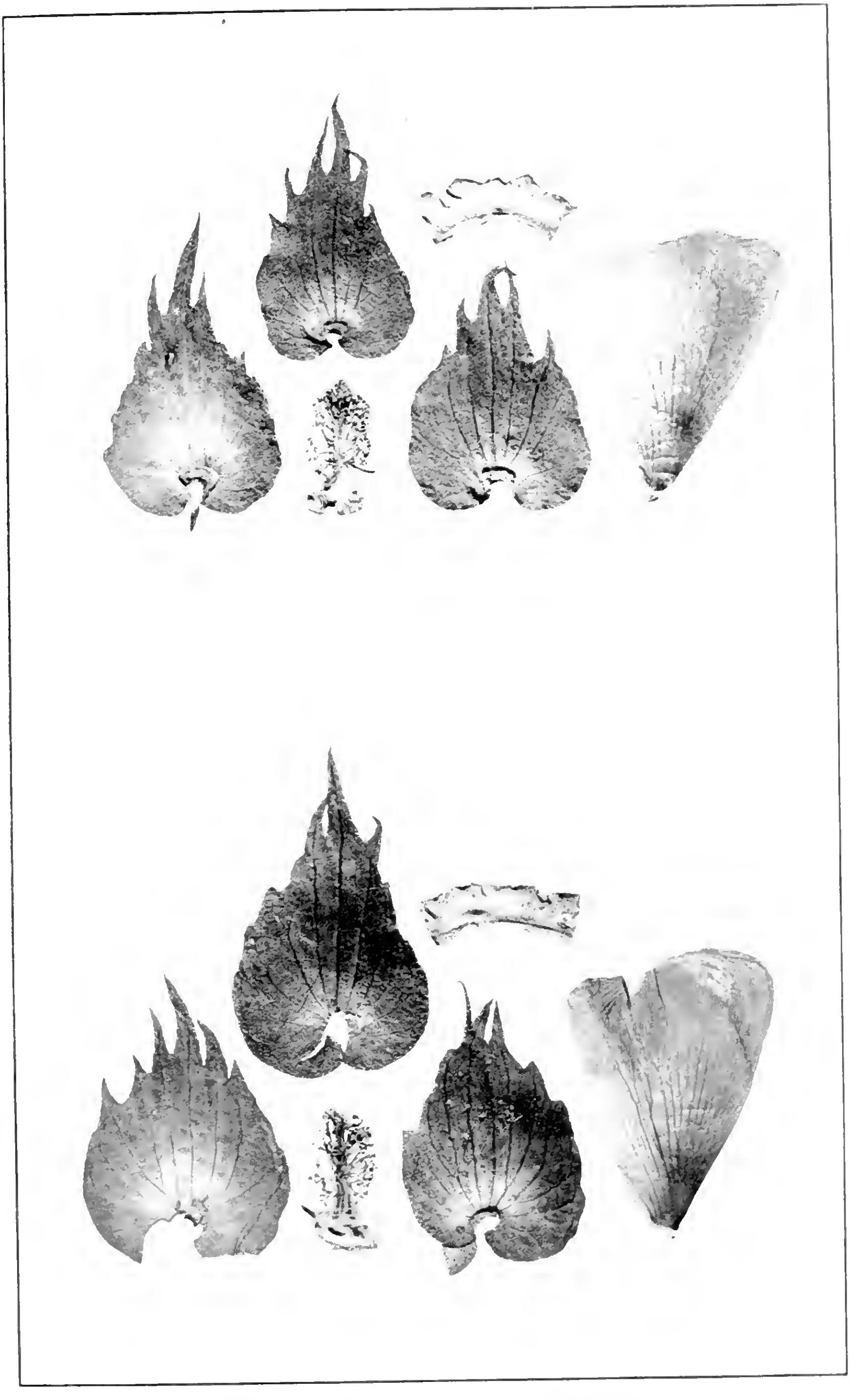
TYPICAL PLANT OF HOPI COTTON (GOSSYPIUM HOPI)

Cultivated at San Antonio, Texas

TYPICAL PLANT OF HOPI COTTON (GOSSYPIUM HOPI)

Leaves removed to show paired branches and low fruiting habit

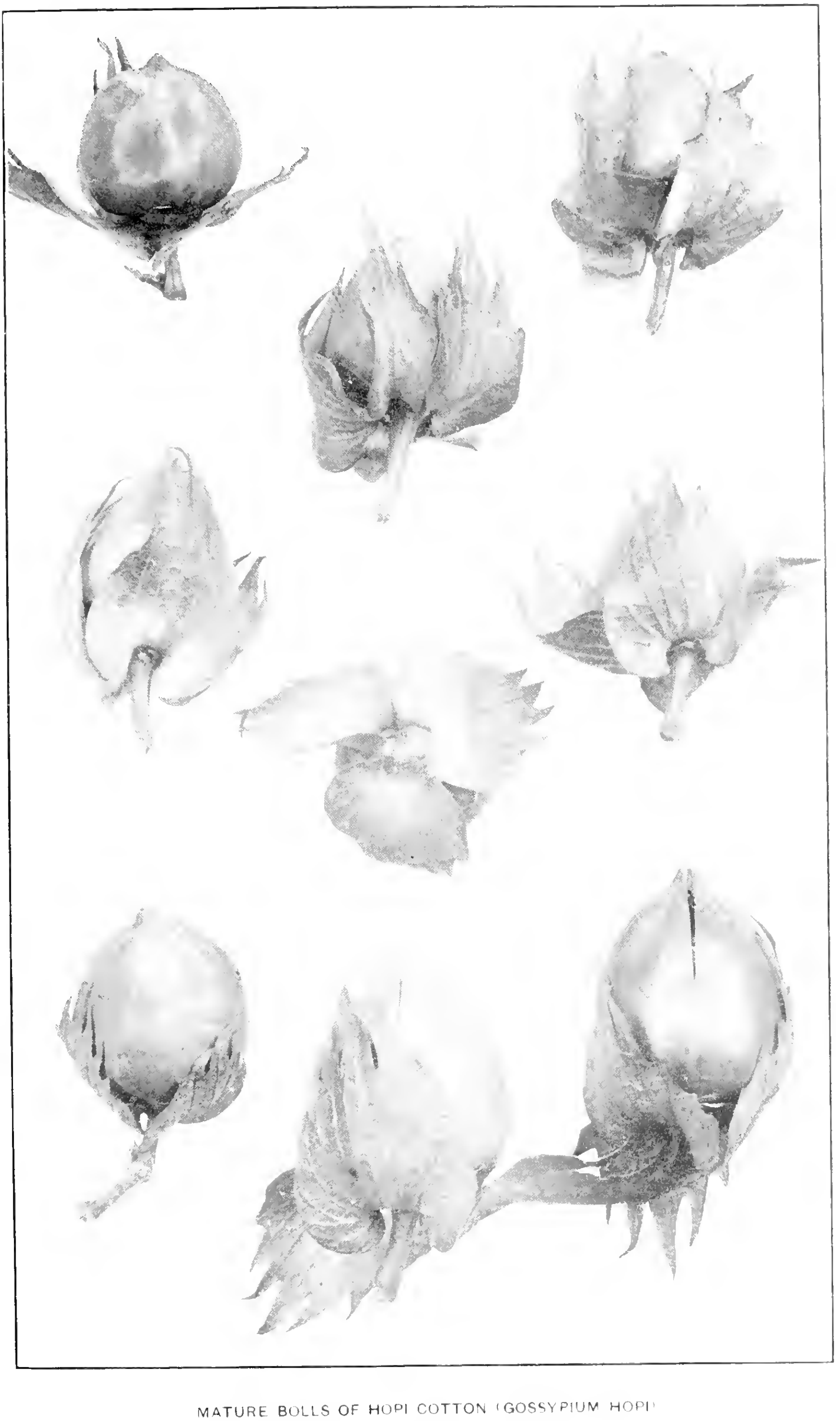
A specimen cultivated at San Antonio, Texas



TWO FLOWERS OF HOPI COTTON (GOSSYPIUM HOPI)

Dissected to show involucral bracts, inner and outer surface of calyx, staminal column and petals

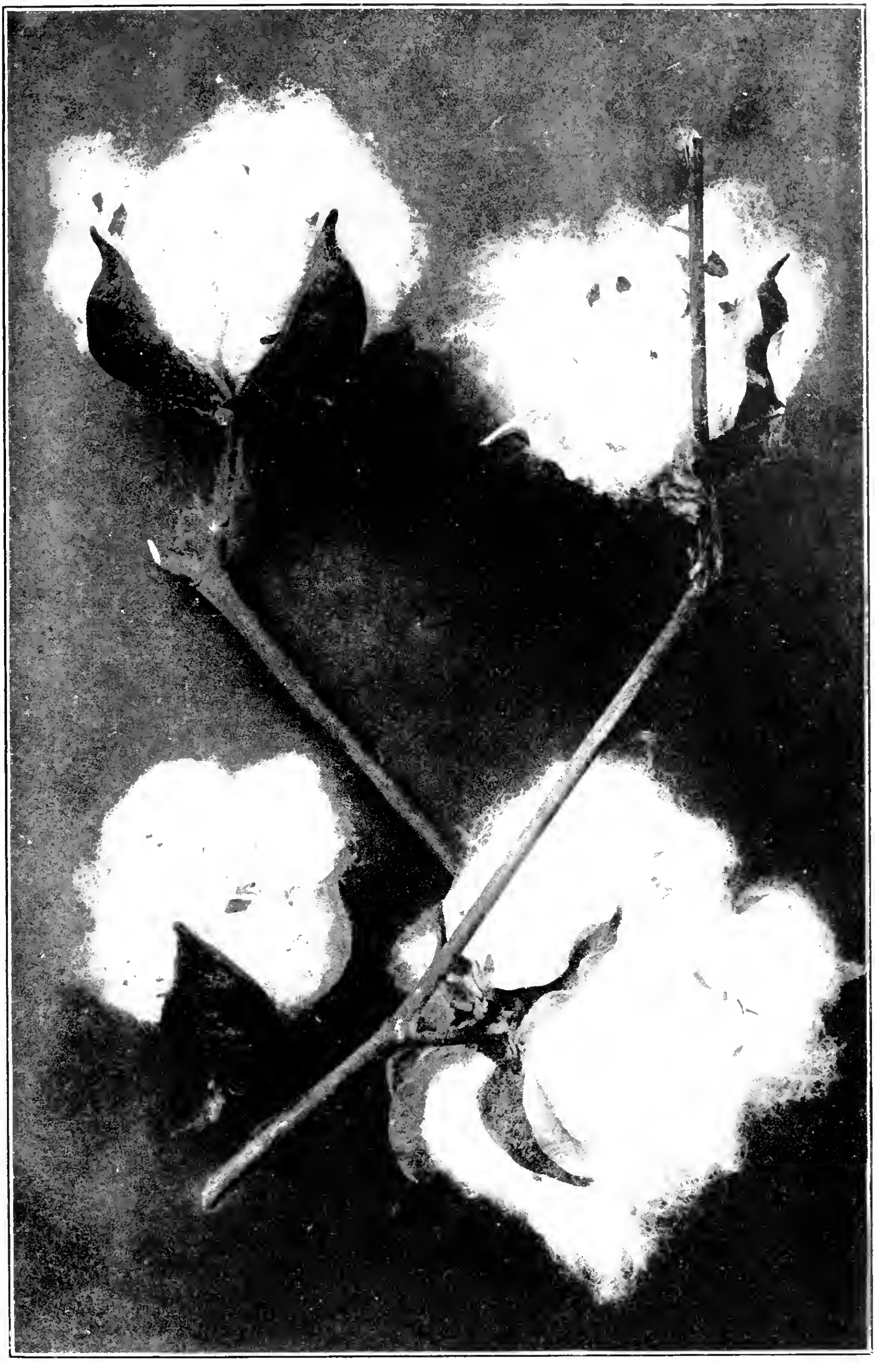
(Natural size)



MATURE BOLLS OF HOPI COTTON (GOSSYPIUM HOPI)

Showing unpitted surface of bolls, reticulation of involucral bracts and extra-floral nectaries

(Natural size)



RIPE BOLLS OF HOPI COTTON (GOSSYPIUM HOPI)

Collected by Mr. J. G. Kent from Hopi Indians at Tuba, Arizona

(Natural size)

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 7

DESCRIPTIONS OF ONE HUNDRED AND FOUR NEW SPECIES AND SUBSPECIES OF BIRDS FROM THE BARUSSAN ISLANDS AND SUMATRA

BY

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DESCRIPTIONS OF ONE HUNDRED AND FOUR NEW SPECIES AND SUBSPECIES OF BIRDS FROM THE BARUSSAN ISLANDS AND SUMATRA

By HARRY C. OBERHOLSER

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During Dr. W. L. Abbott's sojourn in the East Indies he obtained and presented to the United States National Museum a large number of birds. Among these are several rich and important collections from various islands and groups of islands in the Barussan chain[1] off the western coast of Sumatra, and also from Sumatra itself. The principal islands on which Doctor Abbott collected are: Simalur, Lasia, Babi, Nias, Engano, and the Banjak, Batu, and Pagi groups. As the final detailed reports on these collections are necessarily for some time delayed, it seems well to publish preliminary descriptions of such forms as appear now to be new.[2] The following pages give some idea of the richness of the endemic avian fauna of these Barussan Islands.

Family ARDEIDAE

BUTORIDES JAVANICUS ACTOPHILUS, new subspecies

Resembling *Butorides javanicus javanicus*, from Java, but much larger; neck and lower parts paler.

Type.—Adult female, No. 180100, U. S. N. M.; North Pagi Island, January 4, 1903; Dr. W. L. Abbott.

BUTORIDES JAVANICUS ICASTOPTERUS, new subspecies

Similar to *Butorides javanicus actophilus*, from North Pagi Island, but neck and lower parts darker. Like *Butorides javanicus javanicus*, but much larger; and somewhat lighter on neck and lower surface.

Type.—Adult male, No. 179000, U. S. N. M.; Simalur Island, December 10, 1901; Dr. W. L. Abbott.

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[1] The islands along the western coast of Sumatra were known to the ancients as "Insulae Barussae"; and since collectively they are unnamed in modern geographies, they may, as a whole, conveniently and appropriately be called the BARUSSAN ISLANDS.

[2] Dr. C. W. Richmond has already published diagnoses of 24 new birds from Doctor Abbott's collections on these islands (*cf.* Proc. Biol. Soc. Wash., Vol. 15, 1902, pp. 187-190; *ibid.*, Vol. 25, 1912, pp. 103-105; Proc. U. S. Nat. Mus., Vol. 26, 1903, pp. 485-524); and the present writer 9 others (*cf.* Proc. U. S. Nat. Mus., Vol. 35, 1909, pp. 657-680; Vol. 39, 1911, pp. 585-615; Vol. 42, 1912, p. 16).

Family RALLIDAE

AMAURORNIS PHOENICURA CLEPTEA, new subspecies

Resembling *Amaurornis phoenicura phoenicura,* but very much smaller; upper parts decidedly darker, particularly on pileum, and more clearly slate color, with scarcely a tinge of olive; lower abdomen and anal region (but not lower tail-coverts) pure white, instead of more or less tinged with isabella color.

Type.—Adult female, No. 180786, U. S. N. M.; Mojeia River, Nias Island, March 11, 1905; Dr. W. L. Abbott.

Family COLUMBIDAE

MACROPYGIA EMILIANA ELASSA, new subspecies

Resembling *Macropygia emiliana modiglianii,* but decidedly smaller; upper surface of tail duller, more brownish (less reddish); and lower surface of tail lighter, less reddish.

Type.—Adult male, No. 179606, U. S. N. M.; Sikakap Strait, North Pagi Island, November 12, 1902; Dr. W. L. Abbott.

MACROPYGIA EMILIANA HYPOPERCNA, new subspecies

Like *Macropygia emiliana elassa,* from North Pagi Island, but larger; lower parts and rump darker.

Type.—Immature, sex unknown, No. 179599, U. S. N. M.; Sibabo Bay, Simalur Island, October 26, 1902; Dr. W. L. Abbott.

Family TRERONIDAE

MUSCADIVORES AENEUS MISTUS, new subspecies

Like *Muscadivores aeneus consobrina,* but decidedly smaller. Wing (of type), 226.5 mm.; tail, 135; exposed culmen, 22; tarsus, 31.5.

Type.—Adult male, No. 179054, U. S. N. M.; Simalur Island, January 2, 1902; Dr. W. L. Abbott.

DENDROPHASSA[1] VERNANS MESOCHLOA, new subspecies

Similar to *Dendrophassa vernans vernans,* from the Malay Peninsula and Sumatra, but larger; male with olive of upper parts more greenish; female lighter above, and more greenish below.

[1] The generic name *Osmotreron* Bonaparte, by which this species is generally known, is long antedated by *Dendrophassa* Gloger (Gemein. Hand- u. Hilfsb. Naturg., 1842, p. 359), type, *Columba aromatica* Gmelin (by monotypy). There seems to be no reason for rejecting this name.

Type.—Adult female, No. 179590, U. S. N. M.; Nias Island, March 18, 1903; Dr. W. L. Abbott.

DENDROPHASSA VERNANS POLIOPTILA, new subspecies

Resembling *Dendrophassa vernans mesochloa,* from Nias Island, but female with upper and lower parts lighter and more grayish (less greenish or yellowish).

Type.—Adult female, No. 179578, U. S. N. M.; North Pagi Island, January 1, 1903; Dr. W. L. Abbott.

DENDROPHASSA VERNANS MIZA, new subspecies

Somewhat like *Dendrophassa vernans polioptila,* from North Pagi Island, but decidedly larger; female darker, rather less greenish (more grayish) below.

Type.—Adult female, No. 179035, U. S. N. M.; Simalur Island, November 22, 1901; Dr. W. L. Abbott.

DENDROPHASSA FULVICOLLIS MELOPOGENYS, new subspecies

Similar to *Dendrophassa fulvicollis fulvicollis* from Sumatra, but smaller; female with center of chin more clearly yellow.

Type.—Adult female, No. 179597, U. S. N. M.; Nias Island, March 18, 1903; Dr. W. L. Abbott.

TRERON CURVIROSTRA[1] HYPOTHAPSINA, new subspecies

Similar to *Treron curvirostra nasica,* from Borneo, and *Treron curvirostra harterti,* from Sumatra, but much larger; the olive green of lower parts much more yellowish (less grayish).

Type.—Adult male, No. 180650, U. S. N. M.; Engano Island, November 21, 1904; Dr. W. L. Abbott.

TRERON CURVIROSTRA SMICRA, new subspecies

Resembling *Treron curvirostra hypothapsina,* from Engano Island, but smaller; lower parts darker, much more greenish. Similar to

[1] The oldest name for this species (*Treron nipalensis* Hodgson) is undoubtedly *Columba curvirostra* Gmelin (Syst. Nat., Vol. 1, pt. 2, 1789, p. 777), as examination of the basis of the latter name clearly shows. The locality given, Tanna Island, is of course erroneous, and we therefore designate the Malay Peninsula as the type-locality. The name *Treron curvirostra* Gmelin will thus replace *Treron nipalensis* (Hodgson).

Treron curvirostra harterti, but olive green of under parts much more yellowish (less grayish).

Type.—Nearly adult male, No. 179596, U. S. N. M.; Tana Bala Island, Batu Islands, February 8, 1903; Dr. W. L. Abbott.

TRERON CURVIROSTRA PEGA, new subspecies

Similar to *Treron curvirostra nasica*, but much larger; lower parts lighter, less yellowish (more grayish).

Type.—Adult male, No. 179595, U. S. N. M.; Siaba Bay, Nias Island, March 19, 1903; Dr. W. L. Abbott.

TRERON CURVIROSTRA HALIPLOA, new subspecies

Resembling *Treron curvirostra pega*, from Nias, but male with lower surface much more yellowish (less grayish). Similar to *Treron curvirostra harterti*, but larger; upper and lower parts somewhat lighter.

Type.—Adult male, No. 179592, U. S. N. M.; Sibabo Bay, Simalur Island, October 22, 1902; Dr. W. L. Abbott.

Family PSITTACIDAE

CONURUS [1] FASCIATUS PERIONCUS, new subspecies

Similar to *Conurus fasciatus fasciatus*, but very much larger; pileum paler; and posterior lower parts lighter, less bluish. Resembling also *Conurus fasciatus major* (Richmond), from Pulo Babi, but averaging smaller, with pileum paler, and posterior lower surface lighter, less bluish.

Type.—Adult male, No. 180817, U. S. N. M.; Samasama, Nias Island, February 22, 1905; Dr. W. L. Abbott.

CONURUS FASCIATUS CALUS, new subspecies

Resembling *Conurus fasciatus fasciatus*, from the Malay Peninsula and Tenasserim, but decidedly larger.

Type.—Adult male, No. 179664, U. S. N. M.; Sibabo Bay, Simalur Island, October 21, 1902; Dr. W. L. Abbott.

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[1] The generic name *Conurus* must supplant *Palaeornis*, since *Conurus* Kuhl (Consp. Psitt., 1820, p. 4) is a perfectly valid name (*cf.* also Mathews, Novit. Zool., Vol. 18, 1911, p. 11).

PSITTINUS CYANURUS[1] PONTIUS, new subspecies

Like *Psittinus cyanurus cyanurus* in color, but decidedly larger.

Type.—Adult male, No. 179643, U. S. N. M.; South Pagi Island, December 18, 1902; Dr. W. L. Abbott.

LORICULUS GALGULUS LAMPROCHLORUS, new subspecies

Similar to *Loriculus galgulus galgulus*, but male decidedly smaller, and the colors averaging paler; female with green color more yellowish.

Type.—Adult male, No. 180821, U. S. N. M.; Mojeia River, Nias Island, March 14, 1905; Dr. W. L. Abbott.

LORICULUS GALGULUS DOLICHOPTERUS, new subspecies

Resembling *Loriculus galgulus galgulus*, but decidedly larger; female darker above and below.

Type.—Adult female, No. 180680, U. S. N. M.; Engano Island, November 6, 1904; Dr. W. L. Abbott.

Family CUCULIDAE

SURNICULUS LUGUBRIS BARUSSARUM, new subspecies

Resembling *Surniculus lugubris lugubris*, but smaller, with the bill at least relatively larger; and with less white on the inner webs of wing-quills.

Type.—Adult female, No. 179679, U. S. N. M.; Tana Bala Island, Batu Islands, February 10, 1903; Dr. W. L. Abbott.

CACOMANTIS MERULINUS SUBPALLIDUS, new subspecies

Similar to *Cacomantis merulinus merulinus*, but smaller; head and lower parts paler.

Type.—Adult male, No. 179682, U. S. N. M.; Lafau, Nias Island, March 26, 1903; Dr. W. L. Abbott.

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[1] Dr. Hartert has already shown (Novit. Zool., Vol. 9, 1902, p. 542) that the name *Psittacus incertus* Shaw, commonly used for this species, first appeared in 1807 (Nat. Misc., pl. 769), though usually quoted as 1790; and he proposes to use in its place *Psittacus malaccensis* Latham (Index Ornith., Vol. 1, 1790, p. 130). This name, however, is preoccupied by *Psittacus malaccensis* Gmelin (Syst. Nat., Vol. 1, 1788, p. 325), and must be replaced by *Psittacus cyanurus* Forster (Faunula Indica, ed. 2, 1795, p. 6); and the species, therefore, should be called *Psittinus cyanurus* (Forster).

Family PICIDAE

MEIGLYPTES[1] TUKKI CALCEUTICUS, new subspecies

Like *Meiglyptes tukki tukki,* but much larger.

Type.—Adult female, No. 179147, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 23, 1902; Dr. W. L. Abbott.

MEIGLYPTES GRAMMITHORAX MICROTERUS, new subspecies

Resembling *Meiglyptes grammithorax grammithorax,* but smaller.

Type.—Adult male, No. 180854, U. S. N. M.; Telok Bluku, Nias Island, March 3, 1905; Dr. W. L. Abbott.

MICROPTERNUS PHAIOCEPS[2] CELAENEPHIS, new subspecies

Similar to *Micropternus phaioceps badius* from Sumatra, but darker and somewhat larger.

Type.—Adult female, No. 179688, U. S. N. M.; Lafau, Nias Island, March 29, 1903; Dr. W. L. Abbott.

Family CAPITONIDAE

CHOTOREA[1] MYSTACOPHANES AMPALA, new subspecies

Like *Chotorea mystacophanes mystacophanes,* but larger, particularly the bill; red crown patch larger.

Type.—Adult male, No. 179699, U. S. N. M.; Tana Bala Island, Batu Islands, February 11, 1903; Dr. W. L. Abbott.

MEZOBUCCO[1] DUVAUCELII GIGANTORHINUS, new subspecies

Like *Mezobucco duvaucelii duvaucelii,* but with a much larger bill.

Type.—Adult male, No. 179703, U. S. N. M.; Lafau, Nias Island, March 26, 1903; Dr. W. L. Abbott.

Family BUCEROTIDAE

CRANORRHINUS CORRUGATUS MEGISTUS, new subspecies

Like *Cranorrhinus corrugatus corrugatus,* but with longer wing and tail.

Type.—Adult male, No. 179797, U. S. N. M.; Tana Bala Island, Batu Islands, February 11, 1903; Dr. W. L. Abbott.

---

[1] This is the original spelling of the generic name.

[2] This is the original spelling of the specific name.

Family ALCEDINIDAE

ALCEDO MENINTING CALLIMA, new subspecies

Resembling *Alcedo meninting meninting*, but decidedly larger; and with upper parts slightly more greenish. Similar to *Alcedo meninting proxima*, but with upper parts much less greenish.

Type.—Adult male, No. 179782, U. S. N. M.; Tana Bala Island, Batu Islands, February 8, 1903; Dr. W. L. Abbott.

ALCEDO MENINTING SUBVIRIDIS, new subspecies

Similar to *Alcedo meninting meninting*, but smaller; upper parts, especially rump and center of back, more greenish.

Type.—Adult male, No. 179785, U. S. N. M.; Lafau, Nias Island, March 23, 1903; Dr. W. L. Abbott.

CEYX ENOPOPYGIUS, new species

Similar to *Ceyx tridactylus*, but lower back and rump brilliant cobalt blue, instead of magenta; lower parts much less yellowish (more tawny or rufous), the upper throat more purely white, the abdomen creamy white instead of deep yellow; sides of neck more rufescent; back and scapulars black, streaked with cobalt blue, in place of being almost entirely blue.

Type.—Adult female, No. 181101, U. S. N. M.; Aru Bay, eastern Sumatra, December 5, 1905; Dr. W. L. Abbott.

Family CAPRIMULGIDAE

CAPRIMULGUS MIRIFICUS, new species

Somewhat like *Caprimulgus concretus*, but slightly larger; outer tail-feathers entirely without white or buffy tips or subterminal bands; upper parts darker, more blackish; abdomen partly whitish, partly buff, with narrow, irregular, dark brown bars.

Type.—Adult male, No. 181230, U. S. N. M.; Siak River, eastern Sumatra, December 22, 1906; Dr. W. L. Abbott.

Family HEMIPROCNIDAE

HEMIPROCNE LONGIPENNIS OCYPTERA, new subspecies

Resembling *Hemiprocne longipennis longipennis*, but under parts paler; size averaging larger.

Type.—Adult male, No. 180833, U. S. N. M.; Lafau, Nias Island, March 23, 1905; Dr. W. L. Abbott.

HEMIPROCNE LONGIPENNIS THOA, new subspecies

Like *Hemiprocne longipennis longipennis,* but larger. Like *Hemiprocne longipennis perlonga,* but smaller.

Type.—Adult male, No. 179724, U. S. N. M.; Pulo Pinie, Batu Islands, March 7, 1903; Dr. W. L. Abbott.

Family EURYLAIMIDAE

EURYLAIMUS[1] OCHROMALUS[2] MECISTUS, new subspecies

Like *Eurylaimus ochromalus ochromalus,* but decidedly larger, especially the bill and wing.

Type.—Adult female, No. 179175, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 29, 1902; Dr. W. L. Abbott.

Family PITTIDAE

PITTA MOLUCCENSIS LEPTA, new subspecies

Like *Pitta moluccensis moluccensis,* but smaller, especially the bill.

Type.—Adult male, No. 179801, U. S. N. M.; Siaba Bay, Nias Island, March 15, 1903; Dr. W. L. Abbott.

Family TIMALIIDAE

ANUROPSIS MALACCENSIS NESITIS, new subspecies

Somewhat like *Anuropsis malaccensis malaccensis,* but rather larger; upper parts darker and posteriorly more rufescent; sides and flanks of a deeper shade. Wing (of type), 71.5 mm.; tail, 34.5; exposed culmen 17; tarsus, 30.5.

Type.—Adult male, No. 179366, U. S. N. M.; Tana Masa Island, Batu Islands, February 20, 1903; Dr. W. L. Abbott.

ANUROPSIS MALACCENSIS EXSANGUIS, new subspecies

Much like *Anuropsis malaccensis nesitis,* from the Batu Islands, but lighter, more rufescent above, with flanks and sides paler. Wing (of type), 71 mm.; tail, 34.5; exposed culmen, 16; tarsus, 29.5.

Type.—Adult male, No. 179355, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 24, 1902; Dr. W. L. Abbott.

ALCIPPE CINEREA HYPOCNECA, new subspecies

Similar to *Alcippe cinerea cinerea,* but smaller; anterior upper parts somewhat more rufescent; lower parts lighter, less grayish (more washed with buffy).

[1] This is the original spelling of the generic name.

[2] Original spelling of the specific name.

Type.—Adult [male], No. 179949, U. S. N. M.; Pulo Pinie, Batu Islands, March 4, 1903; Dr. W. L. Abbott.

STACHYRIS MACULATA HYPOPYRRHA, new subspecies

Resembling *Stachyris maculata maculata*, but upper parts darker, more rufescent, the rump more deeply ferruginous; and posterior lower parts more rusty.

Type.—Adult male, No. 179976, U. S. N. M.; Pulo Pinie, Batu Islands, March 6, 1903; Dr. W. L. Abbott.

CYANODERMA ERYTHROPTERUM PELLUM, new subspecies

Similar to *Cyanoderma erythropterum fulviventre* Richmond, but posterior lower parts darker, duller, slightly less buffy; above darker and duller, the crown patch not distinct.

Type.—Adult male, No. 179971, U. S. N. M.; Tana Masa Island, Batu Islands, February 20, 1903; Dr. W. L. Abbott.

MIXORNIS PILEATA[1] ZAPTERA, new subspecies

Resembling *Mixornis pileata sumatrana*, but larger; upper parts, sides, and flanks paler. Wing (of type), 61.5 mm.; tail, 53; exposed culmen, 14.5; tarsus, 19.

Type.—Adult male, No. 179981, U. S. N. M.; Tana Masa Island, Batu Islands, February 17, 1903; Dr. W. L. Abbott.

MIXORNIS PILEATA ZARHABDOTA, new subspecies

Similar to *Mixornis pileata sumatrana*, but larger, particularly the bill; the blackish streaks on throat and jugulum broader; sides and flanks less grayish (more yellowish olive). Wing (of type), 61.5 mm.; tail, 53; exposed culmen, 14; tarsus, 19.

Type.—Adult male, No. 179357, U. S. N. M.; Pulo Bangkaru, Banjak Islands, January 19, 1902; Dr. W. L. Abbott.

Family PYCNONOTIDAE

AEGITHINA TIPHIA HORIZOPTERA, new subspecies

Similar to *Aegithina tiphia viridis*, from Borneo, but smaller; male with upper parts darker; forehead with little if any tinge of yellowish; and flanks more deeply olive green. Wing (of type), 60 mm.; tail, 49; exposed culmen, 15; tarsus, 19.

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[1] The *Motacilla gularis* of Raffles (Trans. Linn. Soc. Lond., Vol. 13, 1822, p. 312) is preoccupied by *Motacilla gularis* Gmelin (Syst. Nat., Vol. 1, pt. 2, 1789, p. 997) and therefore untenable. The next name appears to be *Prinia pileata* Blyth (Journ. As. Soc. Bengal, Vol. 11, 1842, p. 204). The species should consequently be called *Mixornis pileata* (Blyth).

Type.—Adult male, No. 180934, U. S. N. M.; Telok Bluku, Nias Island, March 3, 1905; Dr. W. L. Abbott.

AEGITHINA VIRIDISSIMA NESIOTICA, new subspecies

Much like *Aegithina viridissima viridissima* from Sumatra, but somewhat larger, especially the bill; and with the green of lower surface less yellowish, particularly on hinder portion. Wing (of type), 62 mm.; tail, 45; exposed culmen, 15; tarsus, 19.

Type.—Adult male, No. 179989, U. S. N. M.; Tana Bala Island, Batu Islands, February 5, 1903; Dr. W. L. Abbott.

MICROTARSUS MELANOCEPHALOS[1] CHRYSOPHORUS, new subspecies

Similar to *Microtarsus melanocephalos melanocephalos*, from Sumatra, but yellowish of rump and posterior lower parts more golden.

Type.—Adult male, No. 179998, U. S. N. M.; South Pagi Island, November 15, 1902; Dr. W. L. Abbott.

MICROTARSUS MELANOCEPHALOS HYPEREMNUS, new subspecies

Resembling *Microtarsus melanocephalos melanocephalos*, but lower parts much darker; upper surface slightly darker; and bill much stouter.

Type.—Adult male, No. 179324, U. S. N. M.; Simalur Island, November 22, 1901; Dr. W. L. Abbott.

PYCNONOTUS ERYTHROPTHALMOS[2] CYANOCHRUS, new subspecies

Similar to *Pycnonotus erythropthalmos erythropthalmos* (Hume), from Tenasserim, but smaller; upper and lower parts much darker. Resembling *Pycnonotus erythropthalmos salvadorii* Sharpe, from Borneo, but upper surface darker, less rufescent; lower parts less brownish or buffy (more grayish or yellowish), and somewhat darker.

Type.—Adult male, No. 181127, U. S. N. M.; Rupat Strait, eastern Sumatra, February 27, 1906; Dr. W. L. Abbott.

PYCNONOTUS ERYTHROPTHALMOS ISUS, new subspecies

Similar to *Pycnonotus erythropthalmos erythropthalmos*, but smaller; pileum less grayish, more brownish olive like the back.

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[1] *Lanius melanocephalos* Gmelin, Syst. Nat., Vol. 1, pt. 1, 1788, p. 309 ("insulis Sandwich"—errore!). We designate Sumatra as the type-locality.

[2] *Ixos erythropthalmos* Hume, Stray Feathers, Vol. 6, 1878, p. 314 (Pakchan, Tenasserim). This is the oldest tenable name for the species called *Pycnonotus pusillus* by Salvadori (*cf.* Richmond, Proc. U. S. Nat. Mus., Vol. 26, 1903, p. 507).

Type.—Adult male, No. 179341, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 25, 1902; Dr. W. L. Abbott.

PYCNONOTUS ERYTHROPTHALMOS PAMMICRUS, new subspecies

Like *Pycnonotus erythropthalmos cyanochrus*, from Sumatra, but much smaller.

Type.—Adult female, No. 180939, U. S. N. M.; Mojeia River, Nias Island, March 15, 1905; Dr. W. L. Abbott.

With the addition of the above, there are now five recognizable subspecies of *Pycnonotus erythropthalmos*, as follows:

Pycnonotus erythropthalmos erythropthalmos (Hume).—Tenasserim and Malay Peninsula.

Pycnonotus erythropthalmos cyanochrus Oberholser.—Sumatra.

Pycnonotus erythropthalmos pammicrus Oberholser.—Island of Nias.

Pycnonotus erythropthalmos isus Oberholser.—Banjak Islands.

Pycnonotus erythropthalmos salvadorii Sharpe.—Borneo.

PYCNONOTUS OLIVACEUS CHLOEODIS, new subspecies

Similar to *Pycnonotus olivaceus olivaceus* (Moore), but larger; paler below, and averaging darker above.

Type.—Adult male, No. 179343, U. S. N. M.; Tapanuli Bay, northwestern Sumatra, February 16, 1902; Dr. W. L. Abbott.

PYCNONOTUS PLUMOSUS PORPHYREUS, new subspecies

Like *Pycnonotus plumosus plumosus*, but darker, especially on the upper parts.

Type.—Adult male, No. 180019, U. S. N. M.; North Pagi Island, November 23, 1902; Dr. W. L. Abbott.

Family MUSCICAPIDAE

MUSCITREA GRISOLA NESIOTIS, new subspecies

Resembling *Muscitrea grisola grisola*, but anterior lower parts darker; pileum not so purely gray (more brownish); remainder of upper surface more rufescent, particularly the edgings of wing-quills.

Type.—Adult male, No. 179929, U. S. N. M.; Sibabo Bay, Simalur Island, October 24, 1902; Dr. W. L. Abbott.

GERYGONE MODIGLIANII MUSCICAPA, new subspecies

Similar to *Gerygone modiglianii modiglianii*, but smaller; posterior lower parts more extensively and more deeply yellow; sides, head, and neck paler, the lores and forehead particularly so, and contrasted more with the surrounding parts.

Type.—Adult male, No. 180768, U. S. N. M.; Pulo Dua, Engano Island, November 2, 1904; Dr. W. L. Abbott.

RHINOMYIAS UMBRATILIS ECLIPIS, new subspecies

Similar to *Rhinomyias umbratilis richmondi,* but decidedly smaller; upper parts rather lighter, posteriorly somewhat more tawny; sides of breast darker, more tawny; and lores less whitish.

Type.—Adult male, No. 179925, U. S. N. M.; Tana Masa Island, Batu Islands, February 19, 1903; Dr. W. L. Abbott.

CULICICAPA CEYLONENSIS PERCNOCARA, new subspecies

Similar to *Culicicapa ceylonensis ceylonensis,* from the Malay Peninsula, but decidedly larger; pileum darker, more blackish (less tinged with brownish).

Type.—Adult male, No. 179425, U. S. N. M.; Simalur Island, November 23, 1901; Dr. W. L. Abbott.

CULICICAPA CEYLONENSIS AMPHIALA, new subspecies

Resembling *Culicicapa ceylonensis percnocara,* from Simalur Island, but slightly smaller; pileum paler; and yellowish olive green of upper parts less golden. Similar to *Culicicapa ceylonensis ceylonensis,* but larger; yellowish olive green of upper surface duller and less golden.

Type.—Adult male, No. 179927, U. S. N. M.; North Pagi Island, January 8, 1903; Dr. W. L. Abbott.

CULICICAPA CEYLONENSIS PELLONOTA, new subspecies

Similar to *Culicicapa ceylonensis ceylonensis,* but larger, and with a darker back. Like *Culicicapa ceylonensis amphiala,* from North Pagi Island, but yellowish olive green of back darker, more golden.

Type.—Adult male, No. 180907, U. S. N. M.; Samasama, Nias Island, February 20, 1905; Dr. W. L. Abbott.

Family TURDIDAE

COPSYCHUS SAULARIS ZACNECUS, new subspecies

Similar to *Copsychus saularis musicus,* but male with flanks and crissum tinged with buff; female darker, and with flanks and crissum more conspicuously ochraceous buff.

Type.—Adult male, No. 179291, U. S. N. M.; Simalur Island, December 2, 1901; Dr. W. L. Abbott.

KITTACINCLA MELANURA HYPOLIZA, new subspecies

Similar to *Kittacincla melanura melanura*, from the island of Nias, but smaller; rufous of posterior lower parts averaging lighter.

Type.—Adult male, No. 179300, U. S. N. M.; Simalur Island, January 3, 1902; Dr. W. L. Abbott.

KITTACINCLA MELANURA OPISTHOCHRA, new subspecies

Resembling *Kittacincla melanura melanura*, but with posterior lower parts lighter. Similar to *Kittacincla melanura hypoliza*, from Simalur Island, but larger, and with posterior lower parts paler.

Type.—Adult female, No. 179299, U. S. N. M.; Pulo Lasia, January 7, 1902; Dr. W. L. Abbott.

KITTACINCLA MALABARICA[1] OPISTHOPELA, new subspecies

Similar to *Kittacincla malabarica malabarica*, from Sumatra, but male with posterior lower parts averaging darker; female with rufous of posterior lower parts darker and more extensive; upper surface and throat much darker and more richly metallic blue black (less slaty).

Type.—Adult female, No. 180090, U. S. N. M.; Tana Bala Island, Batu Islands, February 5, 1903; Dr. W. L. Abbott.

KITTACINCLA MALABARICA OPISTHISA, new subspecies

Resembling *Kittacincla malabarica opisthopela* from the Batu Islands, but tail longer; male with posterior lower parts decidedly paler.

Type.—Adult male, No. 179301, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 23, 1902; Dr. W. L. Abbott.

Family SYLVIIDAE

ORTHOTOMUS CINERACEUS BAEUS, new subspecies

Like *Orthotomus cineraceus cineraceus*, but smaller.

Type.—Adult male, No. 179957, U. S. N. M.; Siaba Bay, Nias Island, March 19, 1903; Dr. W. L. Abbott.

ORTHOTOMUS CINERACEUS OCHROMMATUS, new subspecies

Similar to *Orthotomus cineraceus baeus*, from Nias Island, but larger; upper and lower parts paler, the middle of abdomen more extensively whitish.

[1] The *Muscicapa malabarica* of Scopoli (Del. Flor. Faun. Insubr., Vol. 2, 1786, p. 96) antedates both *Turdus macrourus* Gmelin and *Turdus tricolor* Vieillot, and is of identical application (*cf*. Richmond, Proc. U. S. Nat. Mus., Vol. 26, 1903, p. 512).

Type.—Adult male, No. 179958, U. S. N. M.; North Pagi Island, November 23, 1902; Dr. W. L. Abbott.

BURNESIA DYSANCRITA, new species

Somewhat resembling *Burnesia superciliaris,* but larger, the tail very much longer; lower parts with no yellow, but with a strong tinge of buff, particularly on breast, sides, flanks, and crissum; crissum ochraceous, not olive yellow. Length of wing (of type), 50 mm.; tail, 85 mm.

Type.—Adult male, No. 179306, U. S. N. M.; Loh Sidoh Bay, northwestern Sumatra, November 7, 1901; Dr. W. L. Abbott.

BURNESIA DYSANCRITA HALISTONA, new subspecies

Similar to *Burnesia dysancrita dysancrita,* but upper surface darker, less uniform, the pileum slate color, and more contrasted with the back; tail shorter; and superciliary stripe less extensive.

Type.—Adult female, No. 180950, U. S. N. M.; Teliwaa, Nias Island, March 22, 1905; Dr. W. L. Abbott.

Family CAMPEPHAGIDAE

ARTAMIDES SUMATRENSIS HALISTEPHIS, new subspecies

Similar to *Artamides sumatrensis sumatrensis,* but larger; male lighter above, with no black bars and only dull grayish light bars on the rump; female with narrower black bars and narrower, duller, white ones on the rump; and with somewhat heavier dark bars on the crissum.

Type.—Adult male, No. 179896, U. S. N. M.; South Pagi Island, December 13, 1902; Dr. W. L. Abbott.

PERICROCOTUS IGNEUS TROPHIS, new subspecies

Like *Pericrocotus igneus igneus*, but decidedly larger.

Type.—Adult male, No. 179224, U. S. N. M.; Simalur Island, December 8, 1901; Dr. W. L. Abbott.

PERICROCOTUS ANDAMANENSIS MINYTHOMELAS, new subspecies

Similar to *Pericrocotus andamanensis modiglianii* from Engano Island, but smaller; male with less black on outer webs of middle tail-feathers; female darker above and below. Like *Pericrocotus andamanensis flammifer*, but much larger.

Type.—Adult male, No. 179226, U. S. N. M.; Simalur Island, December 12, 1901; Dr. W. L. Abbott.

LALAGE NIGRA[1] EMPHERIS, new subspecies

Like *Lalage nigra nigra*, but with the rump much more whitish.

Type.—Adult male, No. 180884, U. S. N. M.; Telok Bluku, Nias Island, March 2, 1905; Dr. W. L. Abbott.

Family DICRURIDAE

DICRURUS LEUCOGENIS[2] DIPORUS, new subspecies

Similar to *Dicrurus leucogenis leucogenis*, but smaller, excepting the bill; chin and throat *abruptly* paler than chest; upper and lower parts darker. Resembling *Dicrurus leucogenis stigmatops*, but larger; upper and lower surfaces paler; white on sides of head more extensive; throat and chin *abruptly* lighter than chest.

Type.—Adult male, No. 179821, U. S. N. M.; North Pagi Island, November 14, 1902; Dr. W. L. Abbott.

DICRURUS CINERACEUS CELAENUS, new subspecies

Like *Dicrurus cineraceus cineraceus* from Java, but darker, particularly on lower surface.

Type.—Adult male, No. 179248, U. S. N. M.; Simalur Island, November 27, 1901; Dr. W. L. Abbott.

DISSEMURUS PARADISEUS OLIZURUS, new subspecies

Like *Dissemurus paradiseus paradiseus* from eastern Sumatra, but with shorter wing and tail, shorter racket, and slenderer bill. Wing (of type), 140 mm.; tail, 309.5; total culmen, 32; height of bill at base, 11; tarsus, 23.

Type.—Adult male, No. 179242, U. S. N. M.; Simalur Island, November 19, 1901; Dr. W. L. Abbott.

DISSEMURUS PARADISEUS ADELPHUS, new subspecies

Similar to *Dissemurus paradiseus paradiseus* from eastern Sumatra, but much larger, especially the bill; frontal crest usually longer; and racket larger. Wing (of type), 155 mm.; tail, 349; total culmen, 34.5; height of bill at base, 13; tarsus, 25.

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[1] The earliest name for this species (*Lalage terat* Auct.) is without doubt *Turdus dominicus* Müller (Natursyst., Suppl., 1776, p. 145), but this is preoccupied by *Turdus dominicus* Linnaeus (Syst. Nat., ed. 12, Vol. 1, 1766, p. 295), which is *Mimus polyglottos dominicus*. The next available specific term is *Turdus niger* Forster (Indische Zool., 1781, p. 41), which antedates *Turdus terat* Boddaert (Tabl. Planch. Enlum., 1783, p. 17); and the species should therefore stand as *Lalage nigra* (Forster).

[2] This is the original spelling of the specific name.

Type.—Adult male, No. 180883, U. S. N. M.; Teliwaa, Nias Island, March 5, 1905; Dr. W. L. Abbott.

DISSEMURUS PARADISEUS PACHISTUS, new subspecies

Resembling *Dissemurus paradiseus adelphus,* from Nias Island, but with frontal crest and antrorse bristles shorter, and racket smaller. Like *Dissemurus paradiseus paradiseus* from eastern Sumatra, but much larger, and with shorter racket. Wing (of type), 155.5 mm.; tail, 370; total culmen, 33.5; height of bill at base, 12.5; tarsus, 25.5.

Type.—Adult male, No. 179239, U. S. N. M.; Pula Lasia, January 5, 1902; Dr. W. L. Abbott.

DISSEMURUS PARADISEUS ELASSOPTERUS, new subspecies

Resembling *Dissemurus paradiseus pachistus,* from Pulo Lasia, but wing and tail shorter, bill larger, racket narrower, and frontal crest somewhat longer. Wing (of type), 152.5 mm.; tail, 367; total culmen, 34; height of bill at base, 13; tarsus, 24.5.

Type.—Adult male, No. 179238, U. S. N. M.; Pulo Babi, January 11, 1902; Dr. W. L. Abbott.

Family ORIOLIDAE

ORIOLUS MACULATUS RICHMONDI,[1] new subspecies

Similar to *Oriolus maculatus maculatus,* but wing shorter; bill rather longer; male with secondaries and tertials much less broadly edged with yellowish. Resembling *Oriolus maculatus mundus* Richmond, but bill somewhat smaller; male with posterior upper parts less purely yellow (more tinged with olive), as in *Oriolus maculatus maculatus;* secondaries and tertials more broadly margined with yellowish.

Type.—Adult male, No. 179886, U. S. N. M.; North Pagi Island, December 31, 1902; Dr. W. L. Abbott.

Family GRACULIDAE[2]

GRACULA JAVANENSIS MIOTERA, new subspecies

Like *Gracula javanensis javanensis* but smaller, and with a slenderer bill.

[1] Named for Dr. Charles W. Richmond, as a slight token of the author's regard.

[2] By the change of the generic name *Eulabes* Cuvier to *Gracula* Linnaeus, the name of the family becomes Graculidae in place of Eulabetidae.

Type.—Adult male, No. 179288, U. S. N. M.; Simalur Island, November 24, 1901; Dr. W. L. Abbott.

GRACULA JAVANENSIS OPHELLOCHLORA, new subspecies

Similar to *Gracula javanensis robusta*, from Nias Island, but smaller, and with the sides of the crown more greenish.

Type.—Adult male, No. 179284, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 23, 1902; Dr. W. L. Abbott.

LAMPROCORAX CHALYBEUS PACHISTORHINUS, new subspecies

Similar to *Lamprocorax chalybeus altirostris*, from Nias Island, but with wing longer, and plumage somewhat less glossy.

Type.—Adult male, No. 179863, U. S. N. M.; South Pagi Island, November 19, 1902; Dr. W. L. Abbott.

LAMPROCORAX CHALYBEUS RHADINORHAMPHUS, new subspecies

Resembling *Lamprocorax chalybeus pachistorhinus*, from South Pagi Island, but bill more slender; size smaller; plumage somewhat less glossy, particularly below.

Type.—Adult male, No. 179272, U. S. N. M.; Simalur Island, December 12, 1901; Dr. W. L. Abbott.

Family NECTARINIIDAE

CHALCOSTETHA CALCOSTETHA[1] PAGICOLA, new subspecies

Similar to *Chalcostetha calcostetha calcostetha*, but smaller; female with back more grayish, scarcely tinged with olive green.

Type.—Adult male, No. 180023, U. S. N. M.; North Pagi Island, January 2, 1903; Dr. W. L. Abbott.

AETHOPYGA SIPARAJA TINOPTILA, new subspecies

Resembling *Aethopyga siparaja siparaja* from Sumatra, but somewhat larger; male with posterior lower parts less olivaceous and usually more extensively blackish; female with lower parts darker, duller, and rather more ashy. Similar to *Aethopyga siparaja niasensis*, but much larger and otherwise different.

Type.—Adult male, No. 179410, U. S. N. M.; Pulo Simmat, near Simalur Island, December 28, 1901; Dr. W. L. Abbott.

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[1] The name *Chalcostetha insignis* (Jardine), by which most authors call this species, should give way in favor of *Chalcostetha calcostetha* (Jardine), since *Nectarinia calcostetha* Jardine (Nat. Hist. Nectariniadae, 1843, p. 263) has anteriority over *Nectarinia insignis* Jardine (Nat. Hist. Nectariniadae, 1843, p. 274).

AETHOPYGA SIPARAJA MELANETRA, new subspecies

Similar to *Aethopyga siparaja tinoptila*, from Simalur Island, but bill smaller; male with posterior lower parts darker, more extensively blackish; female lighter, more greenish above, much lighter and more yellowish below.

Type.—Adult male, No. 179401, U. S. N. M.; Pulo Lasia, January 5, 1902; Dr. W. L. Abbott.

AETHOPYGA SIPARAJA PHOTINA, new subspecies

Like *Aethopyga siparaja tinoptila*, from Simalur Island, but male with metallic patch on forehead larger; female lighter, brighter, more yellowish and greenish above; much lighter, more yellowish below.

Type.—Adult male, No. 180058, U. S. N. M.; North Pagi Island, December 22, 1902; Dr. W. L. Abbott.

CINNYRIS ORNATA[1] POLYCLYSTA, new subspecies

Similar to *Cinnyris ornata ornata*, from Java, but much larger, particularly the bill; yellow of posterior lower parts and olive of upper surface much darker.

Type.—Adult male, No. 180774, U. S. N. M.; Engano Island, November 24, 1904; Dr. W. L. Abbott.

CINNYRIS BRASILIANA[2] OENOPA, new subspecies

Similar to *Cinnyris brasiliana brasiliana*, but bill somewhat larger; male with posterior lower parts averaging darker; female darker, duller below and more greenish above.

Type.—Adult male, No. 180920, U. S. N. M.; Mojeia River, Nias Island, March 14, 1905; Dr. W. L. Abbott.

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[1] The name *Cinnyris pectoralis* Horsfield (*Nectarinia pectoralis* Horsfield, Trans. Linn. Soc. Lond., Vol. 13, 1821, p. 167) by which this species is currently known, is preoccupied by *Cinnyris pectoralis* Vieillot (Nouv. Dict. d'Hist. Nat., Vol. 31, 1819, p. 497), applied to *Cinnyris afra*. Since the next name, *Nectarinia eximia* Temminck (Planch. Color., Vol. 4, 1822, pl. 138, figs. 1, 2), is invalidated by *Nectarinia eximia* Horsfield (Trans. Linn. Soc. Lond., Vol. 13, 1821, p. 168) (=*Aethopyga eximia*), the succeeding designation, *Cinnyris ornatus* Lesson (Dict. Sci. Nat., Vol. 1, 1827, p. 15), must be adopted, and the species called *Cinnyris ornata* Lesson.

[2] The earliest name for *Cinnyris hasseltii* (Temminck) is *Certhia brasiliana* Gmelin (Syst. Nat., Vol. 1, pt. 1, 1788, p. 474), and the species should, therefore, stand as *Cinnyris brasiliana* (Gmelin). The locality (Brazil) which Gmelin gives being erroneous, we designate Java as the type-locality.

CINNYRIS BRASILIANA MECYNORHYNCHA, new subspecies

Like *Cinnyris brasiliana ocnopa*, from Nias Island, but with the bill very much larger.

Type.—Adult male, No. 179396, U. S. N. M.: Simalur Island, November 19, 1901; Dr. W. L. Abbott.

CINNYRIS BRASILIANA HYPOLAMPIS, new subspecies

Resembling *Cinnyris brasiliana brasiliana*, but adult male with posterior lower parts somewhat darker, the abdomen and crissum more blackish; immature male with posterior under parts more deeply yellow, the upper surface more greenish.

Type.—Adult male, No. 180051, U. S. N. M.: South Pagi Island, December 11, 1902; Dr. W. L. Abbott.

ARACHNOTHERA LONGIROSTRA[1] MELANCHIMA, new subspecies

Much like *Arachnothera longirostra longirostra* from the Malay Peninsula, but with the olive green of upper parts darker, and less yellowish or bronzy.

Type.—Adult male, No. 181328, U. S. N. M.; Upper Siak River, eastern Sumatra, November 23, 1906; Dr. W. L. Abbott.

ARACHNOTHERA LONGIROSTRA EXOCHRA, new subspecies

Similar to *Arachnothera longirostra melanchima*, from Sumatra, but with yellow of posterior lower parts somewhat paler; upper surface lighter, somewhat more bronzy.

Type.—Adult male, No. 180030, U. S. N. M.; South Pagi Island, November 15, 1902; Dr. W. L. Abbott.

ARACHNOTHERA LONGIROSTRA HYPOCHRA, new subspecies

Resembling *Arachnothera longirostra exochra*, from South Pagi Island, but yellow of posterior lower parts paler; not, however, so pale as in *Arachnothera longirostra niasensis*.

Type.—Adult male, No. 180039, U. S. N. M.; North Pagi Island, November 24, 1902; Dr. W. L. Abbott.

ARACHNOTHERA LONGIROSTRA ZARHINA, new subspecies

Similar to *Arachnothera longirostra exochra*, from South Pagi Island, but bill much longer; wing somewhat shorter; and upper surface decidedly duller.

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[1] This is the original spelling of the specific name.

Type.—Adult male, No. 179386, U. S. N. M.; Pulo Bangkaru, Banjak Islands, January 18, 1902; Dr. W. L. Abbott.

ARACHNOTHERA CHRYSOGENYS COPHA, new subspecies

Similar to *Arachnothera chrysogenys chrysogenys*, from southeastern Sumatra, but larger; upper and lower parts darker and duller.

Type.—Adult male, No. 179381, U. S. N. M.; Tapanuli Bay, northwestern Sumatra, February 28, 1902; Dr. W. L. Abbott.

ARACHNOTHERA CHRYSOGENYS ISOPEGA, new subspecies

Resembling *Arachnothera chrysogenys copha*, from northwestern Sumatra, but larger, excepting the bill; and lower parts lighter.

Type.—Adult, sex unknown, probably male, No. 180028, U. S. N. M.; Pagi Islands, December 26, 1902; Dr. W. L. Abbott.

ARACHNOTHERA CHRYSOGENYS PLEOXANTHA, new subspecies

Similar to *Arachnothera chrysogenys copha*, from northwestern Sumatra, but smaller; olive green of upper surface somewhat more yellowish; anterior lower parts more yellowish; and yellow of abdomen more golden (less greenish). Resembling *Arachnothera chrysogenys chrysogenys*, but darker both above and below.

Type.—Adult female, No. 180909, U. S. N. M.; Gunong Lembu, Nias Island, February 27, 1905; Dr. W. L. Abbott.

ANTHREPTES MALACENSIS[1] NESAEUS, new subspecies

Similar to *Anthreptes malacensis malacensis*, but averaging larger; male darker below, particularly on breast; female with yellow of under parts lighter; olive green of upper surface more grayish or greenish (less golden).

Type.—Adult male, No. 180048, U. S. N. M.; Sikakap Strait, Pagi Islands, November or December, 1902; Dr. W. L. Abbott.

ANTHREPTES MALACENSIS PELLOPTILUS, new subspecies

Like *Anthreptes malacensis malacensis*, but averaging larger; female and juvenal male darker above and below.

Type.—Adult male, No. 179392, U. S. N. M.; Simalur Island, November 22, 1901; Dr. W. L. Abbott.

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[1] This is the original spelling of the specific name.

ANTHREPTES MALACENSIS POLLOSTUS, new subspecies

Somewhat like *Anthreptes malacensis malacensis*, but much smaller; female darker above.

Type.—Adult male, No. 180913, U. S. N. M.; Gunong Lembu, Nias Island, February 27, 1905; Dr. W. L. Abbott.

CHALCOPARIA SINGALENSIS[1] PANOPSIA, new subspecies

Resembling *Chalcoparia singalensis singalensis*, from Malacca, but female with posterior lower parts more brightly yellowish; and the upper parts lighter, more greenish.

Type.—Adult female, No. 179397, U. S. N. M.; Pulo Tuanku, Banjak Islands, January 25, 1902; Dr. W. L. Abbott.

Family DICAEIDAE

DICAEUM TRIGONOSTIGMA ANTIOPROCTUM, new subspecies

Like *Dicaeum trigonostigma trigonostigma*, but rump more greenish (less orange) yellow; orange of posterior lower surface not so deep.

Type.—Adult male, No. 179398, U. S. N. M.; Simalur Island, November 25, 1901; Dr. W. L. Abbott.

DICAEUM TRIGONOSTIGMA LYPRUM, new subspecies

Resembling *Dicaeum trigonostigma trigonostigma*, but slate color of upper parts darker.

Type.—Adult male, No. 180068, U. S. N. M.; Lafau, Nias Island, March 21, 1903; Dr. W. L. Abbott.

DICAEUM TRIGONOSTIGMA MELANTHE, new subspecies

Similar to *Dicaeum trigonostigma trigonostigma*, but throat and slate color of upper parts decidedly darker; rump less orange, more greenish, yellow.

Type.—Adult male, No. 179400, U. S. N. M.; Pulo Lasia, January 7, 1902; Dr. W. L. Abbott.

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[1] The earliest name for *Nectarinia phoenicotis* Temminck (= *Chalcoparia phoenicotis* Auct.) is undoubtedly *Motacilla singalensis* Gmelin (Syst. Nat., Vol. 1, pt. 2, 1789, p. 964), although the latter author cites an erroneous locality (Ceylon). The species should, therefore, stand as *Chalcoparia singalensis*, for which we designate Malacca as the type-locality.

ANAIMOS[1] MACULATUS OPISTATUS, new subspecies

Similar to *Anaimos maculatus maculatus*, from Borneo, but smaller; olive green of upper and lower parts less yellowish.

Type.—Adult male, No. 180933, U. S. N. M.; Telok Bluku, Nias Island, March 3, 1905; Dr. W. L. Abbott.

[1] The generic name *Prionochilus* Strickland (Proc. Zool. Soc. Lond., 1841, p. 29; type *Pardalotus percussus* Temminck [designated by Gray, 1842]) is invalidated by *Prionochcilus* Chevrolat (in Dejean, Cat. Col., ed. 3, 1837, p. 451) for a genus of Coleoptera. The proper generic title of this group is therefore *Anaimos* Reichenbach (Handb. Spec. Ornith., 1853, p. 245; type, *Pardalotus thoracicus* Temminck [by monotypy]).

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NEW GENERA AND RACES OF AFRICAN UNGULATES

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NEW GENERA AND RACES OF AFRICAN UNGULATES

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In attempting to determine the skull-characters of the various species of East African ungulates, several species have been found to possess generic characters different from those of the species with which they have hitherto been associated. They are described in the present paper, together with six new races of antelopes detected among the specimens collected by the Smithsonian African Expedition under direction of Colonel Roosevelt. In making these studies, the material in the British Museum has been drawn upon extensively and has been of invaluable assistance.

Family EQUIDÆ

DOLICHOHIPPUS, new genus

Type; *Equus grevyi* Oustalet.

Characters.—Skull elongate and narrow, the rostal portion and to a lesser degree, the occipital region, produced along the main axis of the skull; rostral portion long and narrow, the diastema equalling the alveolar length of the four last cheek teeth; lambdoidal crest of occipitals produced behind condyles and extending almost on a level with the auditory meatus, not vertically above it as in *Equus* or *Hippotigris;* facial portion of lachrymal bone large, forming one-third of orbital rim, and extending well behind nasal bones posteriorly; its length 2 to 2½ times its greatest depth, interorbital region flat or truncate medially; ascending process of premaxilla narrow; its suture with the nasal lying below the nasal notch which is wholly in the nasal bone; palatal foramina long and narrow; brain-case very shallow and depressed; color pattern composed of numerous narrow black and white transverse stripes, the loins without any "gridiron" pattern; ears large and broad; hoofs large and somewhat elongate; ergots on forelegs usually small.

The shape of the skull of *Dolichohippus grevyi* is decidedly dolichocephalic, both the rostral and occipital portions being produced somewhat as in the skull of the white rhinoceros, *Ceratotherium.* The general shape of the skull is, in fact, much nearer that of

Equus caballus, but it stands at the extreme as regards length and narrowness, the horse being intermediate in shape of skull between this type and the asses and zebras. Four skulls of *Equus caballus przecvalskii* in the British Museum have been used for making these comparisons, as they represent best the original wild horse type. These four skulls are shorter and broader than that of the normal domestic horse and resemble the skulls of wild asses more closely. Skulls of the domestic breeds of horses vary considerably in length and narrowness, but none are as dolichocephalic as *Dolichohippus,* and all differ from this genus in the shorter rectangular shape of the facial portion of the lachrymal bone. In fact, *Dolichohippus grevyi* is the only species of the old genus *Equus* which shows appreciable distinctive skull characters. It is more widely separated from true *Equus* than this is from *Asinus* or *Hippotigris.* The two latter genera show no skull characters which will separate them. *Hippotigris* represents the extreme as regards shortness of skull, roundness of interorbital region, and small size of lachrymal bone; *Asinus* is somewhat more dolichocephalic and flatter in the interorbital region, while *Equus* is often quite dolichocephalic anteriorly, but lacks any occipital elongation.

The three equine genera *Equus, Asinus* and *Hippotigris* differ collectively from *Dolichohippus* by their shorter and broader skulls, shorter and more rectangular lachrymal bone (the depth of which nearly equals its length from the orbital rim), the position of the lateral nasal notch (which is at the suture of the nasals and premaxillæ), and the shorter lambdoidal crest (which terminates vertical in respect to the auditory meatus). *Hippotigris* differs further in having a rounded or convex interorbital region, and shorter posterior extension of the facial portion of the lachrymal bone which does not extend beyond the nasal bones. Other differences in that genus are the small ears, broad stripes, narrower hoofs and larger ergots on forelegs. The mountain zebra, *H. zebra,* shows only slight skull differences from the quaggas or *burchelli* group, although the wide color differences and diverse habits would lead one to anticipate other structural peculiarities in this form. The shape of the ear of *Dolichohippus* is quite different in its greater breadth from that of *Asinus,* in which genus the ears though equally long are narrow. The hoof, though strikingly different from that of *Hippotigris* and the narrow-hoofed species of *Asinus* in its large size and breadth, is very similar in these two characters to that of the kiang, *Asinus kiang.*

The Abyssinian zebra, *Dolichohippus grevyi,* is associated over much of its range with *Hippotigris burchelli granti.* Both species occur together at the southern limit of the range of the Abyssinian zebra in the northern Guaso Nyiro watershed north of Mount Kenia. In the middle course of the river directly north of Kenia, the two species are found associated in the same herds on both sides of the river.

Where this overlapping of ranges occurs, mixed herds of both species are of as common occurrence as unmixed, and mixing of almost every degree takes place from the association of single individuals of one species with large herds of the other species to herds where the numbers of each species are approximately equal. Notwithstanding such close association, no hybridization occurs. Several hundred miles northward in southern Abyssinia near Lake Zwai *Hippotigris* is again met with near the northern limits of the range of *Dolichohippus.*

The alarm or call note of the Abyssinian zebra is a series of deep grunts interrupted by a whistle-like squeal. At a long distance only the grunts are audible, and they are then scarcely distinguishable from the grunting noise made by the lion. The sharp barking kwa-ha of the Burchell zebra or the bray of the ass are strikingly different sounds.

Family BOVIDÆ

The sub-family Bubalinæ contains the most diverse and grotesquely-shaped species of antelopes. The genera included agree in the possession of an elongate skull, with very long nasal bones; in lacking lachrymal-nasal sinuses; in the shallow anteorbital fossa in the lachrymal bone; in the position of the infraorbital foramen which is on the side of the maxillary directly above the first or second upper premolar; in the hypselodont teeth and occasional absence of the first lower premolar. Both sexes are horned alike, but the horns are very diverse in shape in the different genera. The mammæ are two in number. The body is much higher at the shoulders than at the rump. The three genera, *Bubalis, Damaliscus,* and *Connochætes,* to which the species of the sub-family are usually assigned, are in each case made up of diverse species which show important difference in skull characters entitling them to generic rank. One of these genera, *Gorgon,* (type, *C. taurinus*) has already been named by Gray. This genus differs widely from *Connochætes,* (type, *C. gnu*) which is the most highly specialized member of the family. *Gorgon* is quite *Bubalis*-like in its skull formation, and differs from *Con-*

nochætes in its long nasal bones, and elongate rostral part of the skull, in its premaxillæ with rounded border, and the broad ascending nasal processes. The direction of the horns is outward and not forward and upward over the eyes as in *Connochætes*. The thoracic vertebræ are one less than in *Connochætes*, which is unique among African antelopes in the possession of fourteen. Both genera have as a rule only two lower premolars in the permanent dentition, the first milk molar not being replaced by a premolar. Among the species of *Bubalis* one species, *lichtensteini*, stands out from the others as a very different form, and shows a considerable degree of distinctness both in horn shape and skull characters. The broad horn pedicle[1] gives the posterior portion of the skull a striking resemblance to that of *Gorgon*. It is here considered as the type of a separate genus.

SIGMOCEROS, new genus

Type; *Bubalis lichtensteini* Peters.

Characters.—Horns with a peculiar S- or Z-shaped curvature, broad and depressed at the base, and sharply turned backward at the tips; median frontal suture raised into a prominent ridge in the interorbital region; horn pedicle[1] wide and short, its bifurcation occurring directly above the posterior margin of the condyles, the width of the pedicle equalling the distance from the bifurcation to the posterior border of the orbital rim.

In the closely allied genus *Bubalis* the horn pedicle is very long and narrow, the bifurcation taking place well posteriorly to the condyles, and the width of the pedicle is always much less than its length from the bifurcation to the orbital rim. The frontal region differs further in being flat and the horns at the base are circular without any marked depression as in *Sigmoceros*.

The geographical distribution of this distinct type is peculiar. It occupies the territory between two species of typical *Bubalis* with neither of which it is at all closely allied. Its range extends from central German East Africa southward through Nyasaland and Portuguese East Africa to the vicinity of Delagoa Bay.

The Caama, a typical *Bubalis* of the extreme dolichocephalic lelwel type, extends northwards from the Cape region as far as the Limpopo River, but does not reach the southern limits of the range of *Sigmoceros*. In central German East Africa, *Sigmoceros* reaches

[1] The term "horn pedicle" is used here and elsewhere in this paper to designate the posterior upper portion of the cranium, from the orbits to the vertex.

its northern limits, and here it meets the wide-spreading-horned species *B. cokei*, but does not, apparently, actually occur with it anywhere.

How such a distinct type as *Sigmoceros* has come to inhabit territory intermediate between two fairly closely allied species, and yet remain aloof from the territory of both does not at present admit of any ready explanation.

BUBALIS COKEI KONGONI, new subspecies

Type from Loita Plains, Southern Guaso Nyiro River, British East Africa; adult male No. 162992, U. S. Nat. Mus.; shot by Col. Theodore Roosevelt, June 19, 1909; original (Heller) number 139.

Characters.—Similar to *cokei* but differing by lighter coloration, the coat more purely buffy with very little reddish tint on the body, the rufous of the forehead and snout of *cokei* replaced by tawny; skull averaging broader with wider and shorter horn pedicle.

Coloration.—Dorsal coloration tawny-ochraceous, the rump and thighs lighter buff in color and showing considerable contrast from the darker dorsal coloration; sides of body buff in color and somewhat lighter than the medium dorsal area, merging imperceptibly into the cream-buff of the underparts. Top of head slightly darker than the back, tawny; cheeks and throat lighter more buffy, the latter pure buff in color; tip of chin hair-brown; back of ears tawny-ochraceous the inside clothed by cream-buff hairs. Front of legs tawny from the hoofs to the knees and hocks; back, and sides of legs, cream-buff like the belly. Tail with black crest and tip, the base buff like the rump.

Measurements.—Head and body, 1,820 mm.; tail, 480; hind foot, 505; ear, 210.

Skull: Condylo-basal length, 402; greatest length (bifurcation of horn pedicle to premaxillæ tip), 455; nasal, 205; breadth of horn pedicle, 94; length of horn pedicle from orbit to bifurcation, 114; length of upper tooth row 90.5; distance from first premolar to premaxillæ tip, 139.

The hartebeests inhabiting the highlands of the interior are distinctly lighter colored, or more purely buffy, in tone than those from the low coast lands. The horn- and skull-variations are so great, however, that definite skull-characters are hardly determinable. The horns show great age variation. In immaturity, they are much less bracket-shaped with long slender points, but in old age, when the teeth show much wear, the horn-points are also greatly shortened, due to wear, and the basal shank of the horn stands out at a wider angle giving the horns a more pronounced bracket shape.

The type-specimen of *Bubalis cokei* in the British Museum consists of the dried head-skin and the skull, the latter without the mandible or nasal bones. The whole top of the head in this scalp is deep cinnamon-rufous, the cheeks and back of ears and neck tawny and the throat tawny-ochraceous. The skull is somewhat immature, the premolars having just errupted, the last one being not yet up to the level of the general tooth-line. A part of the condyles, basi-occipital and sphenoid region of the skull have been cut away. The measurements of this skull are as follows: Condylo-basal length, 383 mm.; greatest length (bifurcation to premaxillæ tip), 453; zygomatic breadth, 123; length of upper tooth-row, 93; distance from first premolar to tip of premaxillæ, 131.

Horns: Length on outside curve, 413; breadth at tip, 315; greatest breadth, 395; circumference at base, 235.

Among the Suahili this antelope is known as the kongoni, and the term has become so familiar through its constant use by the negro porters on safari that it has been adopted by sportsmen generally for this species.

BUBALIS NAKURÆ, new species

Type from Nakuru, British East Africa; adult male; No. 163130, U. S. Nat. Mus.; shot by Kermit Roosevelt, October 20, 1909; original (Heller) number, 418.

Characters.—Similar to *neumanni* of the Lake Rudolf region but differing by lighter body coloration and narrower or less broadly bracket shaped horns; similar to *cokei* in size and general body color but feet with black band bordering hoof clefts, horns narrower and less bracket shaped.

Coloration.—General dorsal color tawny-ochraceous the color becoming lighter on the sides where it is buffy but merges gradually into the cream-buff of the lower parts; rump scarcely lighter than back but the thighs buff in color like sides. Top of head tawny, the cheeks lighter tawny-ochraceous and merging into the buff of the throat; chin seal-brown at tip; back of ears ochraceous, the inside surfaces clothed by cream-buff hairs. Front of legs with seal-brown spot above hoofs which merges into a tawny stripe extending to the knees and hocks; back and inside of legs buff. Tail crest and tip black, base tawny-ochraceous.

Measurements.—Skull: Condylo-basal length, 400 mm.; greatest length (bifurcation of horn pedicle to premaxillæ tip), 463; zygomatic breadth, 128; nasals, 230; breadth of horn pedicle, 89; length of horn pedicle from orbit to bifurcation, 111; length of upper tooth row, 97; distance from first premolar to premaxillæ tip, 36.5.

The Smithsonian African collection contains three specimens of this race shot near Lake Nakuru by Kermit Roosevelt. These are distinctly different from the two mounted heads of *neumanni* from Lake Rudolf in the Tring and British Museums.

The horns of the Lake Rudolf specimen are much wider, practically the shape of those of *tora,* of which *neumanni* appears to be a race. The Nakuru specimens, on the other hand, have less widely spread horns, more or less intermediate between those of *cokei* and *jacksoni* in shape, and on this account they have usually been considered hybrids between these species by sportsmen. This, however, is not the case, although they occupy a somewhat intermediate geographical position. They are found on the northwestern edge of the range of *cokei,* and are really surrounded by this species and actually removed by many miles from the nearest *jacksoni.* The Nakuru race is known only by a single herd which inhabits the country lying between Lakes Nakuru and Elementaita. From *neumanni,* which occupies the region bordering the northeastern shores of Lake Rudolf, they are separated by several hundred miles.

BUBALIS LELWEL ROOSEVELTI, new subspecies

Type from Gondokoro, Uganda; adult male; No. 164734, U. S. Nat. Mus.; shot by Col. Theodore Roosevelt, February 15, 1910; original (Heller) number, 643.

Characters.—Closely allied to *insignis* of Central Uganda, but lacking the dark dorsal stripe, face blazes and hoof-bands; differing from *niedecki* by much lighter body-color.

Coloration.—Dorsal color ochraceous-buff, the rump and sides somewhat lighter being pure buff; underparts cream-buff merging gradually into the buff color on the sides. Top of head darker than the back, slightly tawny-ochraceous in color; cheeks slightly lighter ochraceous-buff; throat purer buff but chin sharply contrasted by seal-brown color; legs in front with seal-brown patch above hoofs, which is continuous with a wide tawny streak to the knees and hocks; back and inside of legs buff. Tail crest and tip black; base buff.

Measurements.—Head and body, 1,800 mm.; tail, 545; hind foot, 555; ear, 200. Skull: Condylo-basal length, 425; greatest length (bifurcation of horn pedicle to premaxillæ tip), 520; zygomatic breadth, 125; nasals, 234; breadth of horn pedicle, 95; length of horn pedicle from orbit to bifurcation, 143; length of upper tooth row, 105; distance from first premolar to premaxillæ tip, 144.

This race is lighter and more yellowish in color than any of the other races of *lelwel.* The skull differs considerably from *jacksoni* by its longer nasal bones and upper tooth-row. The horns differ, further, in that their tips are parallel or turn inwards, as in *niediecki;* not outwardly, as in *jacksoni.* The horns are decidedly straighter in profile than in *jacksoni* the angle made by the tips being much more obtuse. On the west bank of the Nile we meet with the typical *lelwel* which has similar horn and skull-characters, but has extensive black markings about the hoofs and legs, the black on the fore-feet being continued as a broad stripe from the hoof-bands to the knees.

In the genus *Damaliscus* we find a considerable difference in the shape of the horns in the different forms of the topi, on the one hand, and in the bontebok of South Africa on the other, but the skull-differences between these species are quite slight. This is, however, by no means the case with the peculiar East African species known as *Damaliscus hunteri.* The shape of the skull and horns and the coloration in this species are so different from those of the other members of the genus, that it seems necessary to separate it generically from the latter in order to avoid confusion. It is, therefore, described below as the representative of a new genus.

BEATRAGUS, new genus

Type; *Damaliscus hunteri* Sclater.

Characters.—Nasal bones long, reaching as far posteriorly as the anterior edge of the orbits, acutely pointed at frontal contact; lachrymal bone with its facial portion projecting forward along the nasal suture as a narrow, acutely-pointed process; infraorbital foramen divided; knobbed processes on basioccipital at basisphenoid suture small; lower premolars only two; horns wide spread at base, U-shaped; color characters, a white tail and white interorbital bar across forehead.

Damaliscus differs from *Beatragus* chiefly in the shorter nasal bones (which stop well in advance of the orbits and end obtusely or are truncated), the shorter lachrymal bone, single infraorbital foramen, and the presence of the three lower premolars.

To some degree this genus is intermediate between *Bubalis* and *Damaliscus,* especially as regards the elongate nasal bones, but the general shape of the occipital part of the skull is distinctly *Damaliscus*-like. The double infraorbital foramina and the presence of only two lower premolars suggest kinship with *Gorgon* and *Connochætes*, to which genera it obviously has, however, no real affinity. It is apparently a specialized offshoot from the *Damaliscus* stock.

The five skulls of *Beatragus* in the British Museum agree in the possession of the characters given for that genus. Three of the skulls lack mandibles, but two, recently presented to the museum by Mr. G. Blaine, who secured them on the Tana River, have enabled the writer to determine the dental characters of the genus.

SYLVICAPRA GRIMMI ROOSEVELTI, new subspecies

Nile Bush Duiker

Type from Rhino Camp, Lado Enclave; Egyptian Sudan; young adult male (first milk molar still in place); No. 164664, U. S. Nat. Mus.; shot by Theodore Roosevelt; January 25, 1910; original (Heller) number, 616.

Characters.—Smaller than any other race, and lighter colored; the body color grayish rather than yellowish, and the dark areas of lower part of legs broccoli-brown not black, dark band on forelegs from hoof to knees only faintly indicated.

Coloration.—Dorsal body coloration wood-brown vermiculated with blackish, darkest on median line, basally the hair is ecru-drab; the sides of the body lighter, becoming pure fawn where they meet the white of the underparts; the neck showing very little black vermiculation, almost wholly cinnamon-brown, this color extending onto the head, where it deepens to russet on crown and borders the wide black median stripe which extends from rhinarium to base of horns; cheeks and sides of face lighter fawn color; rump more grayish than back, drab-grey predominating; tail with a heavy black dorsal stripe, the sides and lower surfaces white, the tip chiefly white. Belly and inside of legs white, the hair at extreme base drab, chest mixed white and fawn with the drab of the basal part showing through; lower throat fawn, like the sides; gular region and upper lips and throat white, tip of chin with dark brown spot on each side separated by white of throat. Limbs grayish fawn like the back with a broccoli-brown band encircling the hoof as high as the false hoofs; a stripe of the same color extending to knees on forelegs. Outside of ears dark, covered by minute scattered cinnamon hairs; tips showing no darker borders; inside of ears clothed by long, white hairs.

Measurements.—Head and body, 860 mm.; tail, 55; hind foot, 215; ear, 73 (taken from tanned skin).

Skull: Condylo-basal length, 146; basilar length, 136; greatest length, 156; zygomatic breadth, 67; nasals, 56 x 30; interorbital width, 37; vertical diameter of orbit, 27; length of upper tooth-row, 51; first premolar to premaxillæ tip, 46; length of bullæ, 22.

The series of specimens from the Lado Enclave show very little variation from the characters given for the type, all being decidedly light-grayish in color and small in size. Specimens in the British Museum from the Bahr-el-Ghazal region, further north, show the same light coloration and small size. This species, *grimmi,* with its various racial forms, has the widest geographical and altitudinal range of any African antelope. It is found practically everywhere from Abyssinia southward to the Cape region, and from the east coast westward to the Gambian region. Its altitudinal range extends from sea-level to twelve thousand feet on the æquatorial mountain ranges. The color changes over this wide area are remarkably slight, with the single exception of the rufous race, *coronatus;* of the west coast. The southern as well as the alpine races show the darkest coat and the greatest amount of black annulation in the hair accompanied by the largest size.

In the Labo Enclave this duiker was frequently flushed from coverts of tall dry grass which are its chief haunts here in the absence of thickets of bushes. Its partiality for thick cover causes it to seek the protection of the densest patches of tall grass, but its food consists exclusively of the foliage and fruit of shrubs. One of the commonest substances found in its stomach was the hard yellow berry of the thorny nightshade, *Solanum campylacanthum.* Only solitary individuals were seen, and these when flushed, seldom stopped going until safely within the protection of some neighboring cover.

SYLVICAPRA GRIMMI ALTIVALLIS, new subspecies

Alpine Bush Duiker

Type from summit of Aberdare Range near Kinanagop Peak, altitude 10,500 ft.; adult female, (premolars worn); No. 164746, U. S. Nat. Mus.; shot by Theodore Roosevelt, August 10, 1909; original (Heller) number, 295.

Characters.—Similar to *hindei*, but larger and dorsal color darker, much more vermiculated with black and less reddish; pelage much heavier, color of dorsal hair basally broccoli-brown, in *hindei* it is much lighter; hoofs larger; hair of under parts basally ecru-drab, not white to the roots as in *hindei.*

Coloration.—Median dorsal color mummy-brown heavily lined by black, the hair basally broccoli-brown; rump somewhat grayer; sides of body and neck tawny-olive, the color merging gradually into the white underparts; neck and sides without black vermiculation, top of head bright cinnamon rufous, with a broad median band of black from rhinarium to coronal tuft, the tuft, however, chiefly cinnamon rufous; sides of face lighter cinnamon. Underparts white, the hair basally ecru drab, chest mixed with fawn centrally; lower throat tawny-olive like sides; throat and median line of chin and upper lips white; the sides of the chin seal-brown in marked contrast. Hind limbs vermiculated with black like the rump; the hoofs and false hoofs bordered by seal-brown, which extends a few inches above the hoofs as a faint streak; forelimbs vermiculated with black like the hind, the seal-brown of the hoofs more extensive and extending up the front of the limb nearly to the shoulders. Ears clothed by short tawny hairs on the outside, inside with long white hair.

Measurements.—Head and body, 940 mm.; tail, 110; hind foot, 270; ears, 109; length of pelage, 45 mm. (in *hindei* 35 on middle of back).

Skull: Condylo-basal length, 159; basilar length, 148; greatest length, 168; zygomatic breadth, 79; nasals, 58 x 31; interorbital width, 42; vertical diameter of orbit, 315; length of upper tooth row, 465; first premolar to premaxillæ tip, 52; length of bullæ, 25.

This is a mountain race, living in the moorland of the Abedare Range and Mt. Kenia, where it attains the highest altitude of any of the *Bovidæ* in Africa.

The type-specimen was shot by Col. Roosevelt at dusk on the moorland at the summit of the Aberdare Range. The spot was within a stone's throw of the Safari camp at an elevation of approximately 10,500 feet. At this elevation, the mountain range has a broad flattened summit which extends in a North and South direction in a series of rolling downs for many miles. The downs are clothed everywhere by a thick carpet of alpine shrubs, chiefly various species of *Alchemilla,* interspersed with a few tussocks of rank grass, and widely scattered thickets of heather bushes.

The wet spongy ground is broken up into hummocks, and the Alchemallæ shrubs grow so densely that travel over the moorland is very much like wading through soft snow-drifts. The duikers do not live in the open moorland, but frequent the heather thickets where the ground is firmer. At night, however, they wander about over these boggy and shrubby moors, upon the shrubs of which they feed. Surrounding this moorland on the slopes of the range is a dense forest of bamboo, including a scattered growth of trees. On the lower slopes the trees form a solid dense forest to the exclusion of the bamboo. This fringing forest is not inhabited by any of the *Sylvicapra* duikers, which are strictly plains or bush duikers, but serves as a barrier to their migration downwards to the plains, which are inhabited by another closely allied race, *hindei*.

We have the same conditions duplicated on Mount Kenia, the same race of high mountain duikers *S. g. altivallis*, inhabiting the moorland down to the beginning of the dense bamboo and forest zone which absolutely limits their lower vertical range, and keeps them apart from their close allies of the plains below.

OUREBIA MONTANA ÆQUATORIA, new subspecies

Nile Oribi

Type from Rhino Camp, Lado Enclave; adult male, No. 164713, U. S. Nat. Mus.; shot by Col. Theodore Roosevelt, January 12, 1910; original (Heller) number, 608.

Characters.—Nearest *cottoni*, but differing by the smaller, less vertical horns, which are less heavily ringed and lighter; dorsal coloration with darker tips to the ears and a few dark hairs in the tip of the tail; hair shorter; horns much heavier than *montana*, but slanting backward at same angle, tympanic bullæ and nasal bones larger. Intermediate in horn characters between *cottoni* and *montana*, but coloration nearer *cottoni*.

Coloration.—Dorsal color running-brown, vermiculated by Vandyke-brown; neck, rump and sides without the darker vermiculation, and tawny in color; crown of head bright rufous, bordered on sides by a broad white supraorbital band; snout and sides of face, buffy, the rhinarium bordered above by a broccoli-brown patch. Tail tawny like rump, with a few black hairs in tip, bordered below by a few white hairs. Limbs tawny like sides, the clefts of hoofs and posterns whitish. Ears, on outside, buffy with extreme tip seal-brown, lined on inside by long white hairs. Under parts and inside of limbs silky white; the hair white to the roots; chest suffused with buffy; throat ochraceous buff; chin, upper lips and gular region white.

Skull: Mature adult, all the cheek-teeth showing considerable wear; skull large and heavy; raised and bulging on dorsal profile along lachrymal nasal suture where the lachrymal projects laterally and roofs over the immense anteorbital fossa; nasals very large and long, triangular, the sides posteriorly extending out to edge of anteorbital fossa, and forming part of roof; supraorbital pits large; lower edge of anteorbital fossa formed into a sharp knife edge, terminating in a prominent masseter knob; mesopteryoid fossa ending in a sharp obtuse angle, and well behind lateral fossa, which are rounded and terminate on a line with middle of first upper molar; bullæ large, long and narrowed on lower surface into a sharp ridge; tooth-row long, equalling distance from first premolar to tip of premaxillæ; inner margin straight.

Measurements.—Head and body, 960 mm.; tail, 80; hind foot, 280; ear, 107.

Skull: Condylo-basal length, 166; basilar length, 155; interorbital width, 51; zygomatic breadth, 74; nasals, 74 x 29; diameter of orbit, 32; length of upper tooth-row, 53; first premolar to premaxillæ tip, 53; length of bullæ, 22.5.

Horns: Length on curve, right, 112, left 114; circumference at base, right, 52, left, 50.

The races of *Ourebia* are strikingly alike in color and size, but most of them inhabit widely separated areas, and are well delimited geographically. The skull-variation is really immense and very little dependence can be placed on such characters. The horns, however, show good average characters as regards their slant, size and shape, but these are all quite slight and only appreciable as averages. The series from the Upper Nile shows very little color-variation, and much less skull-variation than the series of *cottoni* from the Guaso Ngishu Plateau. The difference between this race and *cottoni* is surprisingly slight, notwithstanding the fact that these two races live at the extremes of the vertical range of the genus.

OREODORCAS, new genus

Type; *Redunca fulvorufula* Afzelius.

Characters.—Tympanic sheath which encloses the tympanohyal pit low, and not extending downward on sides of bullæ; knobbed processes of basioccipital small and short; facial portion of lachrymal bone long and narrow and extending far posteriorly on orbit, well behind termination of nasal bones; orbit large, the vertical diameter one-half length of nasal bones; infraorbital opening situated posteriorly, above anterior end of middle upper premolar; masseter knob on sides of maxillary small; pit at base of condyles posterior to bullæ deep; lachrymal-nasal sinus narrow; premaxillæ long, length one and one-fourth times in nasal length.

Female skulls lack the great development of the knobbed processes of the basioccipital but the length of this latter bone is much less than in the genus *Redunca*. The most closely allied genus is *Redunca,* which differs chiefly in the long tympanic sheath, the greater development of the knobbed processes of the basioccipital bone, smaller orbit and wider and shorter lachrymal bone.

The skull-differences between *Oreodorcas* and *Redunca* are quite great notwithstanding the similarity of the general body-form, pelage and horns, which give these two types a false appearance of close kinship.

The habits of *Oreodorcas* are strikingly different from those of the swamp inhabiting *Redunca*. Its haunts are grassy or rocky hill-sides, usually in close proximity to the haunts of the Klippspringer.

In attempting to break up the sub-family Tragelaphinæ into natural genera, many difficulties are met with, owing to the absence of appreciable structural characters among the species. The sub-family is based chiefly upon the spiral twist of the horns. Accompanying this horn-character is a close similarity in shape of skull and of the individual bones which compose it. The situation of the foramina, fossa and sinuses is nearly the same throughout the group. The teeth are also practically identical in shape and relative size. The group may be defined as follows: *Bovidæ* in which the males are armed with spirally twisted horns, arising above the orbits and extending backward and upward at an angle to the general dorsal profile of the skull; horns of the female, when present, closely resembling those of the male; antiorbital fossa wanting; lachrymal-nasal sinus well-developed, but not enlarged; lachrymal bone large, the facial portion about equalling the orbit in size; intraorbital foramen placed far forward, immediately in advance of the first premolar, and on the maxillary canthus, the opening directed forward; cheek-teeth somewhat brachyodont and simple, the enamel fossets not having accessory lobes; body banded by transverse light stripes or by spots formed by the breaking up of the striped pattern.

Nearly all the species of the Tragelaphinæ are so closely allied that they might all be included in a single genus. Such an arrangement would, however, result in considerable geographical confusion and obscure the real relationships of the species. The attempt to make genera of equal weight so as to express the relationships clearly, or avoid confusion, results in a multiplicity of genera from splitting into groups such closely allied species as those now under consideration. The genera adopted by most writers are based almost solely upon horn-characters.

As a single character, the shape of the horns is certainly the most reliable guide to the natural affinities of the various species. A careful study of the skulls, however, reveals some important differences between species which have hitherto been combined in the same genus on account of horn resemblances solely. The genus of the Kudus, *Strepsiceros,* is an instance of this sort. The Lesser Kudu, *Strepsiceros inberbis,* is, without doubt, as closely allied to the bushbuck, *Tragelaphus* as to the Greater Kudu, as regards its skull characters and pattern of coloration. It is a geographical associate of both genera, and deserves recognition as a separate genus in order to emphasize its true relationships. The Nyala, *Tragelaphus angasi,* is another species which must also be accorded distinct generic rank. Here, however, we have to do with a species showing almost identical horn characters, with *Tragelaphus,* but differing distinctly in skull-characters, pattern of coloration and habits.

AMMELAPHUS, new genus

Type: *Strepsiceros imberbis* Blyth.

Characters.—Lachrymal-nasal sinus wide and rectangular in shape; premaxillæ long, three-fourths length of nasal bones lachrymal with a long acute projection following the nasal bones; maxillary border of jugal long with a wide right angled notch below the orbit; supraorbital sinus small; masseter knob on sides of maxillary small; anterior palatine foramina long; dorsal profile of snout raised in a slight hump at posterior end of nasal bones; horns narrowly spiral with distinct annular rings; male without throat mane, both sexes with white throat and chest patches and transverse body stripes. *Strepsiceros* differs by having a narrow triangular lachrymal nasal sinus, masseter knob greatly developed; horns more openly whorled and smoother with rings obsolete; male with a heavy throat mane and both sexes without white throat patches.

Tragelaphus differs somewhat less from *Ammelaphus* in skull-characters than *Strepsiceros,* the chief differences being shallower nasal notches, larger lachrymal-nasal sinus, shorter premaxillæ, less deeply angulated maxillary-jugal suture, and smaller basioccipital processes. In color-pattern, *Tragelaphus* differs from *Ammelaphus* by its spotted coat and absence of transverse body stripes. The horns of *Tragelaphus* are more openly whorled, have a distinct keel and lack rings.

NYALA, new genus

Type; *Tragelaphus angasi* Angas.

Characters.—Orbit small; facial portion of lachrymal bone long and narrow; lachrymal-nasal sinus small; nasal processes of premaxillæ broad at the tips; nasal bones notched at tip on the outer border, horn whorl open, short, three-fourths of a turn; male with heavy dorsal and throat manes and spotted coloration; female with transverse white body stripes.

In *Tragelaphus* we find a lachrymal bone which is widest along its maxillary suture, its width on the orbital rim being much less, the nasals also differ by having the terminal notches or clefts central, the nasal processes of the premaxillæ are more slender and attenuate at the tips and the orbit is larger than in *Nyala*. The most closely allied genus is *Limnotragus* which shares the small orbit, narrow lachrymal bones and short, open-whorled horns. The long throat-mane of the male suggests *Strepsiceros*, as do also the transverse white body-stripes of the female, which, however, are lacking in the male whose light spots have the characteristic *Tragelaphus* arrangement. The gregarious habits of the Nyala show further affinity to *Strepsiceros*.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 9

A RECENT METEORITE FALL NEAR HOLBROOK, NAVAJO COUNTY, ARIZONA

BY

GEORGE P. MERRILL

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(Publication 2149)

CITY OF WASHINGTON

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A RECENT METEORITE FALL NEAR HOLBROOK, NAVAJO COUNTY, ARIZONA

By GEORGE P. MERRILL

HEAD CURATOR OF GEOLOGY, U. S. NATIONAL MUSEUM

Through the courtesy of Mr. F. C. Chekal, editor of the *Holbrook News*, the U. S. National Museum recently came into possession of four pieces of a meteoric stone which fell near the little railroad station of Aztec, on the Santa Fe Railroad, some six miles east of Holbrook, Arizona. It is this material which forms the subject of the present paper, the data regarding the fall being derived from the account in the *Holbrook News*, supplemented by correspondence with Mr. Chekal.

According to the printed account, the fall took place about 7.15 on the evening of Friday, July 19, 1912. It was accompanied by "a heavy explosion similar to that of a heavy blast, followed by a fusillade of smaller explosions which terminated in a thunder-like rumble of approximately two minutes duration. . . . The sky was lightly overcast with patches of high floating clouds, but immediately after the explosion a smoky trail similar to the exhaust of an automobile was visible. The trail disappeared in a direction a little north of east. The volume of the explosion can be best judged by the fact that it was heard at White River on the south, and at Kean's Canyon on the north, or about one hundred miles north and south of Holbrook. Saturday word was received that a shower of falling stones took place at Aztec, six miles east of here immediately after the explosion was heard. The fall, as near as can be judged, was scattered over an area of more than one square mile."

Through correspondence I learned subsequently that some 250 pounds of complete individuals and fragments have been shipped to Philadelphia, the largest complete stone weighing about 14½ pounds, and that some eight pounds of fragments yet remain in the hands of local collectors, the entire number of individual samples being estimated at some three thousand. In this respect the occurrence would therefore seemingly be a counterpart of the celebrated Pultusk fall, the similarity being further heightened by the lithological nature of the stone. The total weight of all the known material, accepting the figures given above and adding thereto the weight of that received here, would be approximately 270 pounds, or 122, 580 grams.[1]

Microscopically the stone is of a light ash-gray color closely simulating that of Allegan, Michigan, but is much more firm and compact. Like the Allegan, the particles of native iron are so small as to be scarcely distinguishable by the unaided eye. It differs, however, radically in the size of sulphide particles and in their relative abundance as compared with the iron. Chondrules are abundant but small and quite inconspicuous, and of a color only a shade darker than the ground. They rarely break with the matrix. The largest noted are not over 2 or possibly 3 mm. in diameter. The crust is in all cases lustreless black, or brown-black, sometimes smooth or again roughly chagreen.

The stone is interesting for the small proportion of visible metallic iron and the abundance of iron sulphide, troilite. The latter occurs in granules of all sizes up to 8 mm., and has a peculiar bronze lustre like ordinary terrestrial pyrrhotite. It is, however, non-magnetic, not being affected by an electro-magnet of considerable power, and is unquestionably troilite, as shown by the analysis. It is very brittle. On one of the samples a large nodule, some 6 to 8 mm. in diameter, lying near the surface, has been burnt out to a depth of some 5 mm., the residue having a glazed, somewhat porous surface and much the appearance of a furnace slag. The cavity left is characteristic of the deeper pits common to meteorites and leaves no doubt as to their origin.

Under the microscope the stone resolves itself into a fine but rather loosely compacted aggregate of polarizing particles in which are imbedded the numerous chondrules and large single and clustered imperfectly outlined crystals of an orthorhombic and occasional monoclinic pyroxenes and of olivine with small scattering areas of metallic iron and iron sulphide. The fine loosely aggregated ground is composed of siliceous particles in which only olivine and pyroxenes can be satisfactorily identified. The chondritic structure is obscure and only occasionally recognizable in this section. No well-defined feldspars nor other minerals than those mentioned were identified, and there is little if any true glass. Sections, however, show frequent colorless, nearly isotropic areas, and occasionally a nearly colorless body polarizing faintly in light and dark color, not extinguishing uniformly throughout, and with at times a faint suggestion of polysynthetic twin

[1] See Supplementary Note at end of this article.

structure as in a feldspar. These are often so charged with a black, amorphous powder as to quite obscure their real nature, and it is only by analogy or surmise that one is led to believe them to be maskelynite.[1]

A chemical investigation of the stone by Dr. J. E. Whitfield, of Philadelphia, yielded the results as below:[2]

	Per cent
Schreibersite	0.11
Troilite	7.56
Metal	4.85
Silicates	87.48
	100.00

The metallic portion yielded:

Nickel	8.68
Cobalt	0.64
Copper	0.29
Iron	90.50
	100.11

The silicate portion yielded:

Silica	41.93
Alumina	4.30
Ferrous oxide	21.85
Lime	2.40
Magnesia	29.11
Soda	trace
Manganese protoxide	0.25
Nickel oxide	0.08
	99.92

Specific gravity at 22.6° C. 3.48.

The stone is low in iron, though not unprecedentedly so, and high in sulphur, but otherwise presents no unusual features. A total lack of chlorine is to be noted, but unfortunately this element is so fre-

[1] It may be well to state here that not being satisfied with my determinations of this supposed maskelynite in Coon Butte, Rich Mt., Thompson and other meteoric stones, I submitted uncovered slides of the first mentioned to Dr. F. E. Wright of the Carnegie Geophysical Laboratory. In these he determined the index refraction of the doubtful mineral to be 1.51. According to Larsen's determinations (Amer. Journ. Sci., vol. 28, 1909) on refractive indices of feldspathic glasses, this would relegate it to a feldspar near *oligoclase* in composition.

[2] This analysis is one of several made for the writer under a grant from the J. Lawrence Smith fund by the National Academy of Sciences, to which body he is indebted for permission to use it here.

quently disregarded in analyses that satisfactory comparisons are not possible.

The sulphide separated mechanically and free from metal or silicate impurities, yielded:

	Per cent
Iron	63.62
Sulphur	36.50
Nickel, cobalt and copper	none
	100.12

Specific gravity determined in picnometer flask at 22.6° 4.61. The composition is therefore that of troilite, though the specific gravity is low.[1] The occurrence is contrary to the assumption made by Rose to the effect that the sulphide of the stony meteorites was pyrrhotite. I have discussed this matter further in a paper now in press on a stony meteorite from Cullison, Kansas.[2]

Inasmuch as the station called Aztec above is not a post office station, and as, moreover, there is a post office by this name in Yuma County in the extreme southwest part of the state, and also one in New Mexico, it seems advisable that this name be ignored and the stone be known as the Holbrook meteorite. Following Brezina it would be classed as a spherulitic chondrite, crystalline, Cck.

Supplementary Note.—In the American Journal of Science for November, W. M. Foote gives a detailed account of this fall in which the total weight is estimated at 481⅓ lbs., or 218,310 grams. This is probably more nearly correct than the estimate given me by Mr. Checkal. It will be noted that my determination of the mineral composition is at variance with that given by Foote. I find no free quartz nor spinel, and the chemical analysis reveals no chromium. The "pyrrhotite" I have shown to be troilite.

[1] The iron sulphide of the Bjurbole meteorite is also in the form of troilite, as shown by Ramsay and Börgstrom, Bull. No. 12, de la Commission Geologique de Finland, May, 1902.

[2] Proc. U. S. Nat. Mus., Vol. 43, 1912.

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THE CRINOIDS OF THE NATURAL HISTORY MUSEUM AT HAMBURG

BY

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(Publication 2150)

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THE CRINOIDS OF THE NATURAL HISTORY MUSEUM AT HAMBURG

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PREFACE

During the summer of 1910 I visited Hamburg where, thanks to the kindness and courtesy of Professors K. Kraepelin and G. Pfeffer, I was so fortunate as to be able to study in great detail the collection of crinoids preserved in the Natural History Museum.

This collection is a large and exceedingly important one, and I soon found that it would be quite impossible to do justice to it in the limited time at my disposal. It was, therefore, arranged that I should lay aside such specimens as were exceptionally puzzling, or called for comparison with types or other specimens in the U. S. National Museum, and that these would be sent to me after my return to America.

As a result of this act of generosity on the part of Professors Kraepelin and Pfeffer the U. S. National Museum now possesses a complete set of photographs of all the types, and other interesting specimens, which are preserved in the Hamburg Museum.

HISTORICAL ACCOUNT

The first notice of a crinoid in the collection of the Hamburg Museum was Professor Sven Lovén's description of the famous "recent cystidean" *Hyponome sarsi*, which appeared in 1868. This was soon identified as the detached visceral mass of an endocyclic comatulid, and later shown to belong to one of the species of the genus *Zygometra*.

In the preparation of the *Challenger* report upon the comatulids Dr. Philip Herbert Carpenter visited Hamburg, and in 1882 published a detailed account of the specimens he examined, describing eleven new species. The new species described by Carpenter (with their present determinations) are as follows:

Actinometra robusta......................*Comatula solaris*
Actinometra grandicalyx..........*Comantheria grandicalyx*
Actinometra meyeri...................*Comanthus annulata*
Antedon variipinna.................*Amphimetra variipinna*
Antedon crenulata..................*Amphimetra crenulata*
Antedon lævipinna..................*Amphimetra lævipinna*
Antedon acuticirra................*Craspedometra acuticirra*
Antedon ludovici.................*Craspedometra acuticirra*
Antedon bipartipinna..............*Craspedometra acuticirra*
Antedon æquipinna..................*Dichrometra protectus*
Antedon imparipinna................*Dichrometra protectus*

Of these four are synonyms of previously described forms, and two are synonyms of a species described in the same paper, leaving five as the total of actual new species.

Carpenter incorporated the data published in this paper in his *Challenger* monograph (1888), and, by inserting his supposed new species in his specific keys, indicated their relationships with allied forms.

In the preparation of his memoir upon the comatulids of the Indian Ocean, Dr. Clemens Hartlaub also visited the Hamburg Museum, examining Carpenter's types and studying the specimens which had been received since Carpenter's visit. In his preliminary paper (1890) he included descriptions of twelve new species, seven of which were exclusively and five in part based upon material at Hamburg. The new species described by Hartlaub (with their present determinations) are as follows:

Actinometra macrobrachius........*Capillaster macrobrachius*
Antedon crassipinna (part).......*Himerometra magnipinna*
Antedon kraepelini................*Himerometra* (? species)
Antedon nematodon................*Amphimetra nematodon*
Antedon oxyacantha (part)......*Stephanometra oxyacantha*
Antedon monacantha (part).....*Stephanometra monacantha*
Antedon erinacea.......................*Oxymetra erinacea*
Antedon lepida.....................*Dichrometra protectus*
Antedon tenera (part)..................*Dichrometra gyges*
Antedon afra..........................*Tropiometra afra*
Antedon hupferi.........................*Antedon hupferi*
Antedon nana............................*Iridometra nana*

Of these one is not sufficiently well preserved to be determinable, two are synonyms of previously described species, and one, a type in part, is not the same species as that represented by the remainder of the type material, leaving eight as the total of actual new forms.

In the finished memoir (1891) Hartlaub elaborated his preliminary descriptions of these new species, publishing figures of most of them.

A specimen of *Solanometra magellanica* collected by Dr. H. Rehberg was recorded by Hartlaub in 1895, while a part of the material collected by Professor W. Kükenthal at Spitzbergen and at Ternate, recorded by Professor Pfeffer, and of that collected at Spitzbergen by Römer and Schaudinn, recorded by Professor Ludwig Döderlein, is in the Hamburg Museum.

The present author's report upon the crinoids collected by the Hamburg West Australian Expedition, under Drs. W. Michaelsen and R. Hartmeyer, was based upon material which is now divided between the Hamburg Museum and the Museum für Naturkunde at Berlin.

ANNOTATED LIST OF THE SPECIES

The following list includes reidentifications of all the specimens in the Hamburg Museum previously recorded with, when necessary, redescriptions. There are also notices of many specimens which have been received from various sources since the publication of Hartlaub's memoir, and which are here identified for the first time. A few specimens collected by the Hamburg West Australian Expedition, which were sent to me with the collection of the Hamburg Museum, were unfortunately overlooked at the time I prepared my memoir upon the West Australian crinoid fauna; these are recorded herein.

The citations given under the species headings refer only to the specimens recorded, as indicated by the numbers in parentheses following.

Family COMASTERIDÆ

Subfamily CAPILLASTERINÆ

COMATELLA STELLIGERA (P. H. Carpenter)

Actinometra stelligera 1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 104 (1).

1. *Samoa and Fiji*.—Two specimens, each with thirty arms.

2. *? Chinese Coast* (the accompanying label reads, in Chinese characters, "very deep water").—One specimen; the centrodorsal is thick discoidal with a flat dorsal pole 4.5 mm. in diameter; the cirri are XVIII, 20-21, 20 mm. long; there are thirty-eight arms about 80 mm. long; the distal edges of the brachials are produced and finely spinous and the distal ends of the elements of the division series are prominent, these two features together giving the animal a very rugose appearance.

COMATELLA MACULATA (P. H. Carpenter)

Actinometra pulchella 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 105 (1).

1. *Ruk, Caroline Islands.*—One small specimen with twenty arms; the cirri are XXIII, 15-17.

CAPILLASTER MACROBRACHIUS (Hartlaub)

Actinometra macrobrachius 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai 1890, p. 186 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 101 (1).

1. *China Sea.*—One specimen, well described by Hartlaub; in general appearance this curious form resembles such species as *Comantheria briareus,* but the arm structure is that of a typical *Capillaster.*

CAPILLASTER SENTOSA (P. H. Carpenter)

1. *Cebu.*—One large specimen with the brachials and the elements of the outer division series strongly everted distally.

CAPILLASTER MARIÆ (A. H. Clark)

Actinometra multiradiata (part) 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 104.

Dr. Hartlaub records a specimen of this species from Kagoshima, Japan, in the Stuttgart Museum.

CAPILLASTER MULTIRADIATA (Linné)

Actinometra multiradiata (part) 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.) vol. 16, p. 521 (1).—1888. "Challenger" Report, Comatulæ, p. 325 (1).—1891. HARTLAUB, Nova Acta Acad. German, vol. 58, No. 1, p. 103 (2).

Actinometra fimbriata 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 102 (3).

Actinometra coppingeri 1900. PFEFFER, Abhandl. der Senck. naturforsch. Gesell., vol. 25, p. 85 (4).

1. *Sumatra.*—Fragments of a dry specimen.

2. *Formosa* (*Actinometra gracilis* Lütken, MS.).—One rather slender medium sized specimen with thirty-six arms and cirri XII, 22-24.

3. *Ruk, Caroline Islands.*—One specimen, described in detail by Hartlaub; the cirri are XXI, 24-28.

4. *Ternate.*—Two specimens, one with fifteen the other with seventeen arms; the brachials of both have very strongly everted distal edges.

5. *Ekalin, St. Matthias Island, Dr. G. Duncker.*—One typical specimen.

Subfamily COMACTINIINÆ

COMATULA SOLARIS Lamarck

Actinometra solaris 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 514 (1).—1888. "Challenger" Report, Comatulæ, p. 288 (1, 2).—1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 107.

Actinometra robusta 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 517 (2).

1. *Hong Kong.*—One fine large specimen of the slender armed type; this individual was well described by Carpenter.

2. *Australia.*—One dry specimen.

3. *Singapore.*—One specimen similar to the one from Hong Kong but slightly more slender; there are 21 cirrus segments. This and the individual from Hong Kong resemble the slender form of *pectinata* except for the much greater size and number of cirrus segments; they have not the broadly expanded arms and stout cirri of the Australian "*robusta*" type, nor are the arms so flat dorsally. Both are in color light brown with a fine median dorsal line and borders to the arms of white. The Hong Kong specimen has three cirri and the one from Singapore two, and two stumps. In both the centrodorsal is undergoing reduction.

4. *Rockhampton, Queensland.*—One typical specimen.

COMATULA PURPUREA (J. Müller)

1. *Abrolhos Islands (Houtman's Rocks), Western Australia.*—Two specimens; one has the anterior arms 120 mm. long and the posterior arms 60 mm. long; the cirri are VIII, 14-15, of the stout type though the arms are only very slightly broadened; the color is a very light brown, the centrodorsal and most of the IBr series rose pink; the other differs only in having the cirri slightly more slender, XIII.

2. *South Passage, Sharks Bay, Western Australia; 9 meters; June 16, 1905; Drs. Michaelsen and Hartmeyer.*—One specimen with the anterior arms 70 mm. long; the cirri are IX (one unpaired), robust.

Subfamily COMASTERINÆ

COMASTER BELLI (P. H. Carpenter)

Comaster typica (part) 1911. A. H. CLARK, Die Fauna Südwest-Australiens, Bd. 3, Lief. 13, p. 453 (Port Hedland, Western Australia).

1. *Abrolhos Islands (Houtman's Rocks), Western Australia.*—One small specimen with seventy-three arms about 85 mm. long; the cirri are VI, 14-16, 10 mm. to 12 mm. long.

2. *Broome, Roebuck Bay, Western Australia.*—Two medium-sized specimens; one has seventy-three arms 135 mm. long, and cirri XVII, 11 mm. long; there are a few scattered small nodules on the disk; the color is grayish brown; the other has sixty-eight arms 125 mm. long, and cirri XIV; the disk is thickly studded with small calcareous nodules; the color is bright yellow green, the centrodorsal and cirri light slaty.

The three small specimens from Port Hedland which I referred to *Comaster typica* in my report upon the crinoids collected by the Hamburg West Australian Expedition are undoubtedly representatives of this species.

Comaster belli is a very curious form; large specimens are in superficial appearance strikingly like similarly large specimens of *Comanthina schlegelii,* both species agreeing in possessing a unique type of arm division. Carpenter placed the two forms side by side in his "Parvicirra Group" of *Actinometra,* and heretofore I have followed him in keeping them close together. The terminal combs of *belli* and the arm division beyond the IIIBr series, however, are of the type typical of *Comaster,* and I find that, taking all the characters together, the smaller the individual the greater the resemblance to other species of *Comaster,* and the greater the difference from similar small specimens of *Comanthina schlegelii.* It thus becomes necessary to place *Actinometra belli* in the genus *Comaster,* where it finds its proper systematic position near *C. typica.*

COMASTER TYPICA (Lovén)

Actinometra typica 1888. P. H. CARPENTER, "Challenger" Report, Comatulæ, p. 296 (1).

1. *Fiji.*—One specimen.

COMASTER NOVÆGUINEÆ (J. Müller)

Actinometra novæ-guineæ 1900. PFEFFER, Abhandl. der Senck. naturforsch. Gesell., vol. 25, p. 85 (1).

1. *Ternate.*—Two small specimens.

COMANTHERIA GRANDICALYX (P. H. Carpenter)

Actinometra grandicalyx 1882 P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 520 (1).—1888. "Challenger" Report, Comatulæ, p. 330 (1).

1. *Canton, China; Werner.*—One specimen, the type of the species; the centrodorsal is large, low hemispherical, 9 mm. in basal diameter; the dorsal pole is concave in the center, 4 mm. in diameter; the cirri are about XL, 22-24 (usually the latter), 25 mm. long; the longest proximal segments (the eighth or ninth) are slightly longer than broad; the outermost ten or eleven are rather abruptly shorter than the preceding, about twice as broad as long, highly polished, with low obscure broad median tubercles which become better developed distally; the forty-seven arms are about 100 mm. long; the IIBr series are all 4(3+4), the IIIBr series all 2, and the IVBr series all 4(3+4); the disk is 35 mm. in diameter; the terminal comb on the proximal pinnules has from twelve to fifteen (usually fourteen) teeth which are low and rounded; they arise gradually and distally gradually become obsolete; the basal segments of the pinnules (the second to the fifth) have spinous rounded distal processes, suggesting the conditions carried to an extreme in *Comaster belli;* the color is grayish brown, with a broad median line of white on the division series and arms.

The general appearance of this animal is similar to that of *Comanthus pinguis,* and there is the same large centrodorsal; the brachials imbricate slightly.

2. *Fuchow, Province of Fokien, China; Consul G. Siemssen; April 4, 1906.*—One specimen closely resembling the type, but slightly smaller and less robust; the centrodorsal is large, with a strongly concave dorsal pole 3 mm. in diameter; the cirri resemble in general form those of *Comanthus bennetti;* they are 25 mm. long with 23-25 segments of which the first three are very short, the fifth is about as long as broad, and the seventh-tenth the longest, slightly longer, though scarcely so much as one-third longer, than broad; the following decrease very slowly in length to about as long as broad or slightly broader than long; but the terminal nine or ten are abruptly shorter than the preceding, twice as broad as long or even broader; these, as in the type, have a polished surface in contrast to those preceding which have a dull surface, and bear a low rounded and obscure dorsal hump which becomes more evident toward the end of the cirrus; the forty-eight arms are about 110 mm. long; the IIBr series are all 4(3+4); all but two of the IIIBr series are 2, the exceptions being 4(3+4); six of the IVBr series are 4(3+4) and two are 2; the division series are rather broad, well-rounded dorsally and not in lateral

contact; the disk is 30 mm. in diameter; the color is a uniform deep yellow brown.

3. *Fuchow, Province of Fokien, China.*—One specimen.

COMANTHINA SCHLEGELII (P. H. Carpenter)

Actinometra parvicirra 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 96 (1).

1. *Mortlock Island, Carolines; Capt. Pohl.*—One specimen with fifty-two arms about 85 mm. long, and cirri VIII, 13-14, small but typical; four of the rays have the division series as characteristic for the species; the fifth has one of the external IIIBr series 4(3+4) instead of 2.

2. *Cebu; Capt. Ringe.*—One typical specimen with a single cirrus remaining.

3. *Ekalin, St. Matthias Island; reef; Dr. G. Duncker.*—One small specimen without cirri.

COMANTHUS BENNETTI (J. Müller)

Actinometra bennetti 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 526 (1, 2).—1888. "Challenger" Report, Comatulæ, p. 382 (1).—1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 95 (3).

1. *Singapore.*—One magnificent specimen resembling the one from the Pelew Islands in the Copenhagen Museum.

2. *No Locality.*—A similar, but broken, specimen.

3. *Port Denison, Queensland* (*Actinometra brachymera* Lütken, MS.).—One specimen.

4. *Jaluit, Marshall Islands; Hernsheim; September 5, 1888.*—One broken specimen; the centrodorsal is large, hemispherical, 6 mm. in diameter at the base; the cirri are XX, 17-20, 20 mm. long, stout; the proximal segments are about as long as broad, the distal one-third to one-half again as broad as long, perfectly smooth dorsally; there are about sixty arms about 130 mm. long; all the division series are 4(3+4); the division series are strongly rounded dorsally and well separated. This appears to be a dwarf specimen.

5. *Ekalin, St. Matthias Island; reef; Dr. G. Duncker.*—Two specimens; one is medium sized with about seventy arms; the dorsal surface of the division series and brachials is finely granular and very rough; the disk is 35 mm. in diameter; the other is smaller, with forty-eight arms about 115 mm. long; one of the IIBr series is 2, and bears externally a single IIIBr 2 series.

COMANTHUS PINGUIS (A. H. Clark)

1. *35° 12′ N. lat., 159° 44′ E. long.; 30 fathoms.*—One specimen; the division series are not so broad as in typical examples.

2. *35° 07′ N. lat., 139° 41′ E. long.; 21 fathoms.*—One specimen.

COMANTHUS SAMOANA (A. H. Clark)

Actinometra parvicirra 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 96 (1, 2).

1. *Tonga and Fiji.*—One specimen with thirty-nine arms.

2. *Samoa.*—Two specimens labeled *Actinometra trachygaster* Lütken; one has twenty-one arms, the single (external) IIIBr series being 2, all the other division series 4(3+4); the other is similar.

3. *Ruk, Caroline Islands.*—One specimen with twenty-three arms and cirri VIII, 11-12; the centrodorsal is especially small.

4. *Abrolhos Islands (Houtman's Rocks), Western Australia.*—One specimen with eighteen arms about 50 mm. long; the IIBr series are all 4(3+4); the cirri are about XXV, 17, 12 mm. long; the longest cirrus segments (the fourth or fifth) are twice as long as broad or slightly longer; the distal cirrus segments are twice as broad as long; the disk is thickly covered with small but prominent calcareous nodules of approximately equal size.

COMANTHUS ANNULATA (Bell)

Actinometra meyeri 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 525 (1).

Actinometra parvicirra 1888. P. H. CARPENTER, "Challenger" Report, Comatulæ, p. 338 (1).—1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 96 (2, 3).

1. *Australia.*—One dry specimen.

2. *Tonga and Fiji.*—One specimen with forty-four arms.

3. *Fiji.*—One typical specimen, the size of the individual in the Copenhagen Museum which I described as *C. intricata;* it has forty arms, all the IIIBr series being present.

4. *South Passage, Sharks Bay, Western Australia; 9 meters; Drs. Michaelsen and Hartmeyer; June 16, 1905.*—Nine specimens; one large individual has sixty-one arms 120 mm. long, and cirri VI, 8.5 mm. long, confined to the anterior semi-circumference of the centrodorsal; all the division series are 4(3+4); the color is dark brown, the division series and arm bases with uniformly distributed small equal sized light green spots; a second specimen has thirty-seven arms 120 mm. long and cirri IV, 9 mm. long; all the division series

are 4(3+4); the color is the same as in the preceding; a third has thirty-four arms 105 mm. long, and cirri IV, 8 mm. long; it is colored like the preceding; a fourth has forty-one arms 75 mm. long; the cirri are VIII, 14, 9 mm., long; there are three IIBr 2 series; the coloration is as described; a fifth has twenty-six arms of which the anterior are 85 mm. and the posterior 40 mm. long; the cirri are II, 6 mm. long; six of the IIBr series are 2 and four are 4(3+4); the color is plain dark brown; the remaining four specimens are small.

COMANTHUS PARVICIRRA (J. Müller)

Actinometra parvicirra 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 519 (1).—1888. "Challenger" Report, Comatulæ, p. 338, (1, 2, 3).—1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 96 (1, 2, 4, 5).—1900. PFEFFER, Abhandl. der Senck. natur. Gesell., vol. 25, p. 85 (6).

1. *Peru; Vierau.*—Four specimens, all of medium size; one has twenty-one arms; the IIBr series bearing the single (internal) IIIBr series is 2, all the other division series being 4(3+4); the cirri are IX (with some rudimentary), 16-17; another has twenty arms, with all the division series 4(3+4), and cirri VI, 16-17; a third has nineteen arms; five of the IIBr series are 4(3+4) and three are 2; a single IIIBr series is developed on the inner side of a post-radial series bearing two IIBr 2 series; the fourth specimen is smaller than the others; it has eighteen arms, with eight IIBr 4(3+4) series.

Carpenter and Hartlaub assumed that "Peru," the locality whence these specimens are said to have come, is the country of that name in South America; but the western coast of both South and North America is quite barren of crinoids except in very deep water and in the extreme south and extreme north. I have suggested that the "Peru" meant might be Peru or Francis Island situated in about 1° 30′ S. lat., 176° E. long., in the Gilbert or Kingsmill group. This species is known to occur in these islands. Professor Pfeffer and Dr. Michaelsen tell me that the specimens collected by Vierau form part of a very old collection and that the localities as given are unreliable.

2. *Moreton Bay, Queensland.*—Three specimens; two of these have nineteen arms; the third has twenty-seven arms; all of the post-radial series but two are regenerating at the synarthry between the elements of the IBr series; one of the unregenerated post-radial series (the right posterior) has the IBr series 6(5+6), this bearing two IIBr 4(3+4) series.

3. *Sulu (Jolo) Archipelago.*—Two specimens, each with some of the arms greatly lengthened and attenuated.

4. *Lombok Strait.*—One specimen with thirty-seven arms and no cirri; this individual might equally well be referred to *C. annulata.*

5. *Tonga and Fiji.*—One medium sized specimen.

6. *Ternate.*—One specimen.

7. *Pitilu, Admiralty Islands; Dr. G. Duncker; October 12-13, 1908.*—One specimen with twenty-five arms, the longest 120 mm. long, and cirri IV, 12-13, 6.5 mm. long; eight of the IIBr series are 2, and two are 4(3+4); four of the IIIBr series are 4(3+4) and one is 2; two of the IIIBr series are developed externally and three are developed internally.

8. *Ekalin, St. Matthias Island; shore and reefs.*—One specimen with thirty-one arms and cirri IV, 10-11, 6.5 mm. long; all of the IIBr series are 2; two of the IIIBr series are 2.

Family ZYGOMETRIDÆ

ZYGOMETRA MICRODISCUS (Bell)

? *Hyponome sarsi* 1868. Lovén, Förhandl. Skand. Naturf. Christiania, X, p. liv (1).—1869. Billings, Canadian Naturalist, vol. 4, No. 3, p. 270 (1).—1869. Lütken, Canadian Naturalist, vol. 4, No. 3, p. 267 (1).—1869. Lovén, Ann. and Mag. Nat. Hist. (4), vol. 4, p. 159 (1).—1869. Lovén, Canadian Naturalist, vol. 4, p. 265 (1).—1869. Lütken, Vidensk. Medd. fra den naturhist. Forening i København, 1868, p. 184 (1).—1872. Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, p. 417 (1).—1879. P. H. Carpenter, Proc. Roy. Soc., vol. 28, p. 388 (1).—1883. Perrier, Comptes Rendus, vol. 106, No. 7, p. 450 (1).—1883. P. H. Carpenter, Ann. and Mag. Nat. Hist. (5), vol. 11, p. 336 (1).—1884. P. H. Carpenter, Proc. Roy. Soc. Edinburgh, vol. 12, p. 309 (1).—1884. Lockington, Standard Natural History, vol. 1, p. 140 (1).—1891. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 24, p. 45 (1).—1891. Neviani, Rivista Italiana di Scienze nat., ann. 11, fasc. 2, p. 6 (1).—1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 25 (1).

? *Hypomene sarsi* 1879. Wachsmuth and Springer; Proc. Acad. Nat. Sci. Philadelphia, 1879, p. 202 (1).—1879. Wachsmuth and Springer, Revision of the Palæocrinoidea, p. 28 (1).

1. *Cape York.*—A detached disk, the type of *Hyponome sarsi.*

Detached disks of species of this genus cannot with certainty be determined, but Carpenter believed it probable that this specimen should be referred to his *Antedon (i. e., Zygometra) multiradiata,* which is a synonym of the earlier *Antedon (Zygometra) microdiscus* of Bell.

2. *South Passage, Sharks Bay; 9 meters; Drs. Michaelsen and Hartmeyer; June 16, 1905.*—One specimen with fifty arms 140 mm. long, and cirri about XXXV, 30-31, stout, 25 mm. long; one $IIBr_2$ of a

IIBr 4(3+4) series bears instead of a pinnule a slightly undersized arm the first division series of which consists of five ossicles all apparently united by synarthry and none bearing pinnules; this carries two IVBr series, both 4(3+4); the arms have a knotty and irregular appearance, which is probably due to parasitization; P_1 is from 23 mm. to 25 mm. long, very stout, tapering gradually to a delicate tip, and composed of from twenty-five to twenty-seven segments.

ZYGOMETRA COMATA (A. H. Clark)

Zygometra comata 1911. A. H. CLARK, Australian Museum Memoir IV, p. 762 (footnote).

1. *Hong Kong; A. Wieler, 1888.*—One small specimen with twenty arms; I cannot see that it differs from specimens from Singapore.

EUDIOCRINIS VARIEGATUS (A. H. Clark)

1. *No Locality; C. Eberstein.*—One rather small and immature specimen, which may be described as follows:

The centrodorsal is thin discoidal with a flat dorsal pole 1 mm. in diameter; the cirri are arranged in a single irregular marginal row.

The cirri are XVII, 14-15, 5 mm. long; the fourth and fifth segments are the longest, very slightly longer than the proximal diameter; the second to the fifth are centrally constricted with widely flaring distal ends which project strongly dorsally; this rapidly decreases distally and disappears after the eighth.

The distal border of the radials is slightly swollen, smooth or finely beaded; the proximal border of the IBr_1 is slightly everted, and bears a small but prominent median tubercle; the distal edge is also everted, the eversion being thickened and slightly produced in the center; the proximal oblong brachials have the distal edges very slightly turned outward and slightly thickened in the center; the arms beyond the proximal discoidal brachials have a smooth dorsal line and apparently lack the usual zigzag carination.

The five arms are 40 mm. long.

The disk is completely plated.

The pinnules of the first pair are 3 mm. long and consist of nine segments which at first are short, becoming about as long as broad on the third and nearly three times as long as broad terminally; the first segment has a high rounded carinate process which is nearly half as high as the lateral diameter of the segment; the second has a carinate process which is not quite so high, and which has a straight distal border parallel to the median axis of the segment; the third has a carinate process similar to that of the second, but smaller; the following segments are without carinate processes, and therefore appear more slender. The pinnules of the second pair are 4 mm. long and consist of eleven or twelve segments; they are stiffened, but only slightly enlarged; the first segment is twice as broad as the median length, and has the distal angle very slightly produced; the second is slightly broader than the median length, but not quite so broad as the first; the third is half again as long as broad, only about half as broad basally as the first; the fourth is similar to the third but longer, twice as long as broad; the following slowly increase in length to about three times as long as the proximal diameter, the terminal one or two being small as usual; the distal edges of the third and following are produced and spinous, the spines being especially long on the prismatic angles; the pinnules as a whole are rounded prismatic, and taper regularly from the third segment to the tip. The pinnules of the third pair are 3 mm. long and are composed of eleven segments; they resemble those of the second pair, but are more slender with more elongated outer segments. The pinnules of the fourth pair are very slender, weak and delicate, not stiffened, about 3 mm. long with ten or eleven segments which at first are short, becoming half again as long as broad on the third, twice as long as broad on the fourth and four times as long as broad terminally; the third and following have produced and spinous distal edges. The distal pinnules are exceedingly slender, 7 mm. long with fifteen or sixteen segments of which the third and following are greatly elongated with produced and spinous distal edges.

Family HIMEROMETRIDÆ

AMPHIMETRA PHILIBERTI (J. Müller)

1. *Kwala Cassan, Malay Peninsula; Ed. L. Mayer.*—Six specimens, all rather smaller than usual and apparently not quite fully grown; one has twenty-four arms 100 mm. long; one of the IIIBr series is 2, all the other division series being 4(3+4); there are 32 or 33 cirrus segments of which the longest are very nearly as long as broad; another has twenty-two arms 100 mm. long; four of the IIBr series and two of the IIIBr series are 2, the latter both internal; the cirri have 33 or 34 segments; a third has twenty-two arms 95 mm. long; both the IIIBr series (one external and one internal) are 2, all the other division series being 4(3+4); the cirri are XXIII, 29-33, 23 mm. long; a fourth has twenty-seven arms 90 mm. long; one of the IIBr series is 2, the others being 4(3+4); six of the IIIBr series are

2, only one being 4(3+4); the cirri have 26-29 segments; a fifth has eighteen arms 85 mm. long; the eight IIBr series are 4(3+4); one ray has both the IIBr series missing; the cirri have 27 or 28 segments; one has the distal half regenerated; the sixth has twenty-one arms 80 mm. long; one of the IIBr series is 2, the other nine, and the single IIIBr series, being 4(3+4); the cirri have 26-30 segments of which the longest are nearly as long as broad.

AMPHIMETRA SCHLEGELII (A. H. Clark)

1. *No Locality; C. Eberstein.*—One specimen, which may be described as follows:

The cirri are XV, 29-35, 20 mm. to 23 mm. long; the longer proximal segments are about as long as, or slightly longer than, broad; the distal segments are nearly twice as broad as their median length; the twelfth, thirteenth or fourteenth and following bear a long and prominent, rather broad, dorsal spine; the segments which bear the dorsal spines have the dorsal surface flattened so that there is a rather conspicuous rounded ridge along the boundary between the lateral and dorsal surfaces.

The radials have a finely beaded distal edge as is frequently the case in *A. philiberti.*

The twelve arms are 85 mm. long; one ray bears one IIBr 4(3+4) series, which carries (internally) a IIIBr 2 series.

P_1 is small and slender, 6 mm. long with twenty-four segments which become about as long as broad on the fifth, the remainder being slightly longer than broad; the second-eighth bear a high broad finely spinous carinate process which rapidly decreases in height after the third; P_2 is 10 mm. long with twenty-five segments of which the fifth-seventh are about as long as broad and the distal are twice as long as broad; the second-ninth are diminishingly carinate, the outer border of the carination being convex on the second but parallel to the longitudinal axis of the segment on the remainder; the pinnule is evenly tapering and is proportionately larger than P_1; P_3 is 13 mm. long with twenty-four segments; it resembles P_2, but the supplementary ridge is strongly indicated, and it becomes more distinctly triangular distally; P_4 is 7 mm. long with eighteen segments, the second-fifth with proportionately higher carinate processes than the corresponding segments of the preceding pinnules; P_5 is 4.5 mm. long with fourteen segments of which the second-fifth are very strongly and the sixth somewhat carinate; the following pinnules resemble P_5; the distal pinnules are slender, 7 mm. long with nineteen segments of which the outer are about twice as long as broad.

This species is closely related to *A. philiberti*, but it may be easily distinguished by the longer proximal cirrus segments, the longer and more prominent spines on the distal cirrus segments, and by the smaller number of arms. It is a considerably smaller and more delicate species than *A. philiberti.*

At the time I described *A. schlegelii* (Proc. Biol. Soc. Washington, vol. 21, 1908, p. 223) I had before me two specimens, one with ten, the other with thirteen arms, which were of the same size and general appearance; such differences as I found I considered as probably the result of individual variation. In this collection there are two specimens, one with ten the other with twelve arms which resemble the pair in the Copenhagen Museum.

The presence of the type of *A. lævipinna* and of a large series of *A. philiberti* (a species which I had not seen when I described *A. schlegelii*) shows clearly that the ten armed specimen in the original material and the one in the present lot are identical with Carpenter's *lævipinna*, while the twelve and thirteen armed specimens represent a distinct form, easily differentiated by the strong carination of the pinnules, related to *A. philiberti.*

The specimen which I selected as the type of *schlegelii* at the time of the original description happened to be the one with thirteen arms. Thus while the one with ten arms, originally considered as identical with it, must be referred to *lævipinna*, the name *schlegelii* is available for the thirteen armed specimen, and for the twelve armed example under consideration, which represents the same form.

Amphimetra schlegelii appears to be the northern representative of *A. philiberti*, just as *A. lævipinna* is the northern representative of the *discoidea* group of species.

AMPHIMETRA NEMATODON (Hartlaub)

Antedon nematodon 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai, 1890, p. 185 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 27, pl. 1, fig. 9 (1).

1. *Bowen, Queensland.*—One specimen, the type; there are thirty-eight arms about 105 mm. long; two of the cirri still *in situ* have 42 and 43 segments of which the twelfth and following bear dorsal spines; the longest cirrus segments are not quite so long as broad; in the outer two-thirds, or at least one-half, of the cirri the segments are twice as broad as long; the dorsal spines are rather small and slender, though sharp and prominent; the enlarged proximal pinnules are comparatively slender, smooth, not carinate; the division series

are narrow and rather widely separated; the brachials are extremely short, discoidal, with produced distal edges.

This species appears to be most closely related to *A. philiberti*, but it is very easily distinguished from that form by the absence of carination on the proximal pinnules and by having the IIIBr series 2 instead of 4(3+4).

AMPHIMETRA CRENULATA (P. H. Carpenter)

Antedon crenulata 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 507.

The type of this species is a dry specimen in the Hamburg Museum from the neighborhood of Borneo; I unfortunately overlooked it while at Hamburg, but from the original description there can be no doubt that it is the form which has commonly been known as *variipinna*. As this name is of the same date as *variipinna*, occurring on the next page of the same publication, and antedates all other names for the species, it is the name by which the form must henceforth be known.

AMPHIMETRA VARIIPINNA (P. H. Carpenter)

Antedon variipinna 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 506 (1).

Antedon brockii 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 183.—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 23, pl. 1, figs. 4, 12, 13; pl. 2, fig. 17.

1. *Canton, China; Werner.*—One specimen, the type of the species; this may be described as follows:

The centrodorsal is moderate in size with a slightly convex dorsal pole 2 mm. in diameter.

The cirri are about XX, 28-33, 17 mm. to 20 mm. long; the longer proximal segments are about as long as the distal diameter, sometimes very slightly longer; the outer segments are about one-third broader than long; the earlier segments have slightly thickened and prominent distal dorsal edges; the ninth to the twelfth (usually the latter) and following develop long and sharp dorsal spines.

The twenty-three arms were probably about 50 mm. long; three of the IIBr series are 2, and seven are 4(3+4); the three IIIBr series are all 2, and all are internally developed.

The distal edges of the third and following segments of the proximal pinnules are strongly everted and very finely spinous instead of being provided with broad lateral processes.

The disk is completely covered with a pavement of small irregular plates.

The longest pinnules have about twenty-two segments.

This species differs from *A. producta* in having long spines on the outer cirrus segments instead of a slight carination; it is also a stouter form than *producta*, the cirri especially being stouter and longer without the distal taper seen in those of *producta*. The lower pinnules are more cylindrical (less prismatic) than are those of *producta*, and the spinous eversion of the distal edge of the segments is not increased at the prismatic angles, but is uniform all around the dorsal side.

So far as I can see this specimen only differs from that described as *brockii* by Hartlaub in its smaller size.

AMPHIMETRA LÆVIPINNA (P. H. Carpenter)

Antedon lævipinna 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 502 (1).

Antedon milberti (part) 1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 81 (1).

Himerometra schlegelii (part) 1908. A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, p. 223.

Amphimetra schlegelii (part) 1909. A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, p. 7.—Vidensk. Medd. fra den naturhist. Forening i København, 1909, p. 158.

1. *Canton, China; Werner.*—The ten arms are about 95 mm. long; the cirri are XI, 27-33, 23 mm. long, moderately slender; the longest proximal segments are slightly broader than long to about as long as broad; the short outer segments are about twice as broad as long; long, sharp and prominent dorsal spines are developed from the tenth or eleventh segments onward; the cirri have a very slight distal taper; the synarthrial tubercles are prominent, but broad and blunt, not produced as in *A. ensifer*.

This specimen is quite indistinguishable from the ten armed specimen in the type series of *A. schlegelii*, with which I was able to compare it directly; in size, as in other characters, there is the closest agreement.

2. *No Locality; C. Eberstein.*—One specimen closely resembling the type in every particular, but slightly smaller; the arms are 70 mm. long.

HIMEROMETRA MAGNIPINNA (A. H. Clark)

Antedon crassipinna (part) 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 185 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 32 (1).

1. *Cochin China.*—One magnificent specimen with forty-five arms 160 mm. long and cirri about XXX (with some undeveloped), 28-32, 35 mm. to 41 mm. long; the longest proximal cirrus seg-

ments are slightly broader than long; the cirri are moderately stout; there are no dorsal spines; the dorsal surface of the short distal segments is convex; the antepenultimate has a small tubercle which quickly becomes obsolete on the one or two preceding; P_D is 28 mm. long with thirty-three or thirty-four segments, very stout basally, tapering evenly to a delicate tip; the earlier segments are twice as broad as long, the following gradually increasing in length and becoming about as long as broad on the fourteenth, and twice as long as broad on the small terminal segments; the segments in the middle half of the pinnule have the distal dorsal edge slightly swollen and prominent; P_P is 26 mm. long with thirty-three segments, similar in every way to P_D ; P_1 is 18 mm. long with twenty-five segments, similar to the preceding but proportionately smaller; the cirri, centrodorsal and division series are pinkish flesh color; the arms are slaty; the proximal pinnules and the outer portion of the middle and outer pinnules are pinkish.

2. *Isabela, Basilan, Province of Mindanao; Dr. H. Hallier; January 22, 1904.*—One broken specimen with forty arms, and cirri 32 mm. long with 32 segments of which the terminal fifteen have a minute submedian tubercle which increases in size distally; the distal edges of the segments of the proximal pinnules, which are large and very stout, are everted but not spinous; the IIBr series are 4(3+4) ; the IIIBr series are 4(3+4) externally and 2 internally, or all 4(3+4) ; the following division series, when present, are 4(3+4).

3. *Ekalin, St. Matthias Island; Dr. G. Duncker.*—One fragmentary specimen; the cirri and lower pinnules are very slightly stouter than in the preceding, the segments of the latter with less prominent distal ends.

4. *Pitilu, Admiralty Islands; Dr. G. Duncker.*—Three fine specimens with thirty-six, forty-four and forty-seven arms 130 mm. long.

HIMEROMETRA, Sp.

Antedon kraepelini 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 183 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 22, pl. 2, fig. 15 (1).

1. *Akyab, Arrakan Coast, Burma.*—This appears to be a small specimen of *H. robustipinna* with which it agrees in the absence of a thickening or eversion of the distal edges of the segments of the enlarged proximal pinnules. The lack of the pinnule tips and of the cirri prevent accurate determination.

CRASPEDOMETRA ACUTICIRRA (P. H. Carpenter)

Antedon acuticirra 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 509 (1).
Antedon australis 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 510.
Antedon ludovici 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 510 (2).—1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 29 (1, 2, 3).
Antedon bipartipinna 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 512 (3).

1. *No Locality.*—One specimen; there are twenty-six arms; the synarthrial tubercles are rather prominent; the distal edges of the brachials are rather strongly overlapping. This example is just like others which I have seen from the Andaman Islands and from other localities.

2. *Hong Kong.*—One specimen, undoubtedly representing the same species as the preceding.

3. *Hong Kong.*—One specimen with slightly smoother arms than the type of *acuticirra* (No. 1) but undoubtedly of the same species; the development of the synarthrial tubercles is similar; the specimen is rather smaller, and is purple in color.

Family STEPHANOMETRIDÆ

STEPHANOMETRA ECHINUS (A. H. Clark)

Himerometra echinus 1908. A. H. CLARK, Smiths. Miscell. Coll. (Quarterly Issue), vol. 52, part 2, p. 218.
Stephanometra coronata 1909. A. H. CLARK, Proc. U. S. Nat. Mus., vol. 36, p. 639.

1. *No Locality.*—Arm fragments.

STEPHANOMETRA OXYACANTHA (Hartlaub)

Antedon oxyacantha 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai, 1890, p. 178 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 55, pl. 3, figs. 35, 37 (1).

1. *Amboina; Dr. J. Brock.*—One specimen with thirty arms 140 mm. long; the centrodorsal is low hemispherical, 6 mm. in basal diameter; the dorsal pole is small, flat, 2.5 mm. in diameter; the cirrus sockets are arranged in three closely crowded irregular rows; the cirri resemble those of *S. monacantha* or *S. tuberculata*; the longer proximal segments are twice as long as broad or slightly longer; those in the outer third or half of the cirri are about as long as broad; this is a more robust form that *S. tuberculata* or *S. monacantha*, and P_2, P_3

and P_4 are similar; P_1 is 12 mm. long, slender, with twenty-one segments; P_2 is 13 mm. to 16 mm. long, enlarged, stiffened and spine-like, with thirteen or fourteen segments; P_3 is 13 mm. to 16 mm. long, similar in every way to P_2, with twelve or thirteen segments; P_4 is 9 mm. long, similar to the preceding but proportionately smaller, with ten segments; P_5 is 6 mm. long, similar to P_4 but proportionately smaller, with ten segments; the following pinnules are small and weak, 4.5 mm. or 5 mm. in length, gradually increasing in size outwardly; the distal pinnules are 9 mm. long with twenty segments, very slender.

STEPHANOMETRA TUBERCULATA (P. H. Carpenter)

Antedon tuberculata 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 57 (1).

1. *Ruk, Caroline Islands.*—One specimen with thirty-one arms 85 mm. long; the cirri have 26-27 segments and are about 23 mm. long; the longest cirrus segments are usually not quite so long as broad, rarely as long as broad; the outermost nine to twelve are broader than long; the enlarged lower pinnules have ten or eleven segments. P_4 is more like the succeeding pinnules than in the specimen from the Admiralty Islands, and the shorter and somewhat stouter cirri with shorter segments give this individual a somewhat different appearance.

2. *Pitilu, Admiralty Islands; Dr. G. Duncker.*—One specimen with twenty-seven arms 95 mm. long; the cirri are XXX, 20-23, 25 mm. to 27 mm. long; the longest segments of the longer cirri are twice as long as the median diameter or somewhat longer; P_1 is 10 mm. or 11 mm. long, weak and slender, with seventeen or eighteen segments; P_2 is stout and spine-like, 10 mm. long with ten or eleven segments; P_3 is similar, 9 mm. to 10 mm. long with nine or ten segments; P_4 is 7 mm. long, smaller than the preceding, but stiffened; P_5 is 5 mm. long with ten segments; the following pinnules are similar, slightly smaller and weaker; the distal pinnules are very slender, 9 mm. long with eighteen or nineteen segments.

3. *Pelew Islands.*—One specimen with thirty arms 115 mm. long, and cirri 25 mm. to 30 mm. long with 20-23 segments of which the longer proximal are twice as long as broad and the shorter distal slightly longer than broad; the cirri are moderately slender and very long as in the specimen from Pitilu, though not quite so slender as in that individual; P_1 is 13 mm. long, slender and flagellate, with twenty-six segments; P_2 is 15 mm. long, very stiff and spine-like, but slightly

more slender than usual, with thirteen segments; P_3 is 12 mm. long with eleven segments and resembles P_2; P_4 is 9 mm. long with eleven segments, resembling P_3 but much more slender.

STEPHANOMETRA MONACANTHA (Hartlaub)

Antedon monacantha 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai, 1890, p. 179 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 59, pl. 3, figs. 33, 38 (1).

Antedon militaris HARTLAUB, MS. (1).

1. *Mortlock Island, Carolines.*—One specimen.

The specimen recorded by Hartlaub from Torres Strait appears to be nearer *S. indica* than *S. monacantha.*

Family PONTIOMETRIDÆ

PONTIOMETRA ANDERSONI (P. H. Carpenter)

Antedon andersoni 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 78, pl. 3, fig. 36 (1).

1. *Pelew Islands.*—One medium sized specimen.
2. *Cebu, Philippines.*—One medium sized specimen.
3. *Sulu (Jolo).*—Arm fragments.

Family MARIAMETRIDÆ

OXYMETRA ERINACEA (Hartlaub)

Antedon erinacea 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai, 1890, p. 177 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 52, pl. 3, fig. 29 (1).

1. *Cebu, Philippines; Capt. Ringe.*—The centrodorsal is large and hemispherical as in *Selenemetra finschii,* almost entirely covered by by cirrus sockets; the dorsal pole is very small, irregular in shape, slightly concave.

The cirri number XXX-XXXV. The proximal cirrus segments are about as long as broad, after the middle of the cirrus gradually decreasing in length so that those in the outer portion are twice as broad as long; the shorter segments in the distal half have the distal dorsal edge thickened and everted and very finely spinous, this eversion gradually becoming more and more triangular in end view, the spinosity concurrently becoming gradually restricted to the lateral part of the eversion, and on the terminal segments becoming a single smooth sharp spine.

The fifty-one arms are 115 mm. long; their arrangement on the rays is in 3, 2; 2, 3 order so that the normal number of arms

($[3+2+2+3] \times 5$) is fifty. The structure of the division series and of the arm bases is exactly as in *S. finschii;* the division series are strongly convex with perfectly straight sides.

The segments of the enlarged lower pinnules are all short, about as long as broad, of uniform size; these pinnules are stiffened, though scarcely so much so as those of the species of *Stephanometra,* and the tip, though sharp, ends in the normal manner. The pinnules are more slender than those of *Stephanometra* and are evenly tapering.

This species is most nearly related to that which I recently described under the name of *Selenemetra tenuicirra,* which has similarly stiffened and enlarged proximal pinnules; but in *tenuicirra* the pinnules are stouter proximally and more delicate distally so that they taper less regularly, and they are considerably shorter; and the cirri are very much longer with more numerous segments of which the distal are much longer.

From the published description and figure I assumed that this form was allied to the species of *Stephanometra* with which it was associated by Hartlaub and, as it differed materially from all the forms which I had grouped in that genus, I suggested the generic name *Oxymetra* for it. Examination of the specimen, however, shows that it has nothing to do with the species of *Stephanometra,* but is closely related to the species which I have grouped in the genus *Selenemetra,* especially to *S. tenuicirra.*

Now the generic name *Oxymetra* (Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13) with *Antedon erinacea* Hartlaub as the type has precedence over the generic name *Selenemetra* (Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541) with *Antedon finschii* Hartlaub as the type, so that all the species heretofore assigned to the genus *Selenemetra* must be transferred to the genus *Oxymetra,* and the name *Selenemetra* must be relegated to the synonymy of *Oxymetra.*

DICHROMETRA FLAGELLATA (J. Müller)

Antedon flagellata 1891. HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, p. 73 (1).

1. *Pelew Islands.*—One specimen with about forty arms about 140 mm. long; the centrodorsal is large, low hemispherical, 7 mm. in diameter at the base and 3 mm. in diameter at the concave dorsal pole; the cirrus sockets are arranged in three closely crowded irregular rows; the cirri are about XL, 27-29, 25 mm. long; the longer proximal segments are about as long as broad; dorsal spines, which are rather low and blunt, are developed from the tenth or twelfth onward; the

cirri are, as usual, rather stout; the division series and arm bases are strongly convex and rugged; P_3 is the longest, about 15 mm. long with about twenty segments.

2. *Pitilu, Admiralty Islands; Dr. G. Duncker.*—One specimen with twenty-eight arms 150 mm. long; the longest cirri have 32 or 33 segments, dorsal spines being developed from the eleventh or twelfth onward; P_3 is 15 mm. long with twenty-eight or twenty-nine segments. This specimen is intermediate in character between the two at Leyden upon which Müller based the names *flagellata* and *elongata*, though rather nearer the latter.

DICHROMETRA FLAGELLATA var. AFRA, new variety

Antedon flagellata 1899. LUDWIG, Senck. naturforsch. Ges., vol. 21, Heft 4, p. 538 (Reef opposite harbor of Lamu, Zanzibar).

Dichrometra sp. 1911. A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, p. 27 (two headings; Cape St. André, Madagascar; Zanzibar).—1911. A. H. CLARK, Bull. du muséum d'hist. nat., No. 4, 1911, p. 254 (Cap Saint-André, Madagascar).

1. *Madagascar; C. Moll.*—The centrodorsal is low hemispherical, 4 mm. in diameter at the base; the dorsal pole is flat, 2.5 mm. in diameter; the cirrus sockets are arranged in two irregular marginal rows.

The cirri are about XX, 23-29, 15 mm. to 18 mm. long; the first segment is very short, the following gradually increasing in length to the fifth or sixth which is about as long as broad and the sixth-ninth or seventh-tenth which are the longest, slightly longer than broad; the following gradually decrease in length, those in the outer half being slightly broader than long; the ninth or tenth and following bear prominent blunt dorsal spines of moderate size.

There are twenty-nine arms about 85 mm. long; IIIBr series are developed externally; the division series are broad with the ventro-lateral edges of the segments extended laterally as a thin narrow border the outer edge of which is parallel to the axis of the division series; synarthrial and articular tubercles are not developed.

P_1 is 8 mm. long with from twenty-one to twenty-five segments, slender, delicate and flagellate; the first segment is twice as broad as long, the third about as long as broad, and those in the outer half twice as long as broad; the pinnule tapers rather rapidly in the first four segments, more gradually from that point onward. P_2 is 9.5 mm. to 10 mm. long, with from twenty-two to twenty-five segments, similar to P_1 but stouter and tapering more evenly. P_3 is 10 mm. long with from twenty-two to twenty-four segments, similar to P_2 and about of the same size. The following pinnules are small. The distal pinnules are very slender, 8 mm. long with twenty segments. The enlarged lower pinnules are slender and flagellate, of the type seen in typical *flagellata*.

This form differs from typical *flagellata* much as *Capillaster multiradiata* var. *coccodistoma* differs from true *C. multiradiata*. It is smaller and more delicate, with fewer arms, and lacks the characteristic rugosity of the arm bases and the prominent synarthrial tubercles. P_2 and P_3 are proportionately less enlarged and more delicate, and are not greatly longer than P_1.

DICHROMETRA PALMATA (J. Müller)

1. *Gimsah Bay, African coast of the Gulf of Suez; Dr. R. Hartmeyer.*—One fine specimen with twenty-nine arms 120 mm. long and cirri XXVII, 21-24; the dorsal pole of the centrodorsal is 3 mm. in diameter, slightly concave.

DICHROMETRA PROTECTUS (Lütken)

Antedon lepida 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 176 (1).

Antedon æquipinna 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 504 (2).

Antedon imparipinna 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 505 (3).—1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 63 (2, 3, 4).

Antedon palmata (part) 1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 49 (1).

Antedon brevicuneata 1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 68 (5).

1. *Tonga and Fiji.*—Two small specimens.

2. *No Locality.*—Two specimens; the larger has the centrodorsal broad, thin discoidal, the cirrus sockets arranged in two irregular rows; the bare dorsal pole is 4.5 mm. in diameter; the cirri are about XXXVII, 22-28 (usually nearer the latter), 20 mm. to 23 mm. long; the forty arms are 20 mm. to 23 mm. long; P_2 has about thirty segments and is about 17 mm. long, moderately slender; it is greatly enlarged on the outside of the rays and nearly as much so on the innermost side of the IIBr series; the segments in the outer half of the cirri have a low sharp narrow median carination; the smaller specimen had probably between twenty-five and thirty arms; P_2 is slightly more slender than usual, resembling that in the other individual; the cirri have 22-23 segments.

3. *No Locality.*—Two typical specimens; one of them has rather long proximal pinnules, the other has them rather short.

4. *Hong Kong.*—One specimen.

5. *Mortlock Island, Carolines.*—Two specimens, each with thirty arms 80 mm. long; there are 22 or 23 cirrus segments; P_2 is from 10 mm. to 12 mm. long with from twenty-six to thirty-seven segments, rather slender; there is no apparent enlargement on the outer arms, but the outer pinnules are much longer, reaching 18 mm.

6. *No Locality.*—One specimen; P_2 on the outer arms is exceptionally long.

7. *Isabela, Basilan, Province of Mindanao; Dr. H. Hallier.*—One specimen; the dorsal pole of the centrodorsal is 3 mm. in diameter; the centrodorsal is thin discoidal, bearing cirrus sockets in two irregular marginal rows; the cirri are XXIV, 26-29, 23 mm. to 25 mm. long; the pinnulation agrees with that of the type of *æquipinna,* and this is in every way very similar to that specimen.

DICHROMETRA GYGES (Bell)

Antedon gyges 1884. Bell, "Alert" Report, p. 160, pl. 12, figs. B, B *a, b.*
Antedon reginæ 1884. Bell, "Alert" Report, p. 160, pl. 12, figs. A, A *a.*
Antedon tenera 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 180 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 66 (1).

1. *Port Denison, Queensland.*—One specimen.

2. *Port Denison, Queensland.*—One specimen with about forty-three arms about 85 mm. long and cirri XLII, 24-27, 17 mm. long; P_2 is 18 mm. long, very slender, with thirty-three segments; on the innermost side of the IIBr series P_2 is nearly as large as on the outer side, but elsewhere it is small; on some of the arms P_3 resembles P_2; the proximal pinnules are less carinate than usual.

3. *Bowen, Queensland.*—One specimen, smaller than the preceding.

Family COLOBOMETRIDÆ

PETASOMETRA, new genus

This new genus is related to *Decametra* and to *Cyllometra.* The arms are from ten to twenty or more in number, the IIBr series being 4(3+4), rarely 2. P_a is always absent. P_1 is as long as, and similar to, P_2; the following pinnules are shorter.

Genotype.—*Antedon claræ* Hartlaub, 1890.

PETASOMETRA HELIANTHOIDES, new species

1. *South Passage, Sharks Bay, 9 meters; Drs. Michaelsen and Hartmeyer; June 16, 1905.*—One fine specimen, which may be described as follows:

Centrodorsal thin discoidal, with a broad flat dorsal pole 4 mm. in diameter; cirrus sockets arranged in a single regular closely crowded marginal row.

Cirri XIX, 28-31, 20 mm. to 22 mm. long; the cirrus segments are subequal, about twice as broad as long, the basal shorter, the last five or six becoming somewhat longer; the dorsal surface of the segments is broad and flat; the second has the distal dorsal edge produced and bluntly serrate; on the following this serrate ridge becomes more and more deeply crescentic, on the fourteenth and following becoming a median straight finely, and rather bluntly, serrate transverse ridge appearing as a minute spine in lateral view; opposing spine large, the apex subterminal, arising from the entire dorsal surface of the penultimate segment, rising to a height about equal to one-half of the diameter of the penultimate segment; owing to the closely crowded condition of the cirrus sockets the first three segments of the cirri are sharply flattened laterally as in related forms.

The radials are concealed in the median line, but are visible as low triangles in the angles of the calyx; the IBr_1 are very short, about six times as broad as long, the proximal and distal edges parallel to each other, and the lateral edges parallel to the longitudinal axis of the ossicle, not in lateral contact; axillaries very broadly pentagonal, from two to three times as broad as long, the lateral edges about two-thirds as long as those of the IBr_1, turned slightly outward and therefore making a slight angle with the longitudinal axis; the lateral corners of the IBr_1 and of the IBr axillary are rounded off; there are ten IIBr 4(3+4) series and two IIIBr 4(3+4) series, both of the latter developed on the same IIBr series; the division series are strongly rounded dorsally without lateral borders, resembling those of *Heterometra savignii*.

The twenty-two arms are 85 mm. long; the first two brachials are subequal, slightly wedge-shaped, about four times as broad as the median length; the first is internally united for the proximal two-thirds, beyond this point diverging at a right angle; the first syzygial pair (composed of the third and fourth brachials) oblong, two and one-half times as broad as long; the next four brachials are short, approximately oblong, about four times as broad as long, the following obliquely wedge-shaped, two and one-half times as broad as long, becoming less obliquely wedge-shaped distally.

P_a always absent; P_D 11 mm. to 12 mm. long with from twenty-seven to twenty-nine segments of which the first four or five are broader than long and the remainder about as long as broad, slightly longer than broad terminally; the pinnule is moderate in size, smooth, evenly tapering and very delicate distally; P_1 10 mm. long with twenty-two segments, resembling P_D but very slightly more slender; P_2 is 10 mm. long with twenty-five segments, resembling P_1; P_3 is 6 mm. long with nineteen segments, smaller and weaker than the preceding; the following pinnules are similar to P_3; the distal pinnules are 11 mm. long, slender, with twenty-nine segments which are short, scarcely half again as long as broad.

The color is light yellowish, with the dorsal pole of the centrodorsal (except for a central spot) and the articulations dark brown.

This species differs from *P. clarae* of the Moluccas in its much greater number of arms (twenty-two instead of from ten to twelve), in the greater number of cirrus segments, and in its longer and more numerously segmented proximal pinnules.

OLIGOMETRA SERRIPINNA (P. H. Carpenter)

Antedon serripinna 1891. Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, p. 82 (1).

1. *Tonga Islands.*—Seven specimens; one of these has the cirri XXIII, 21, the segments terminally becoming nearly as long as broad; the centrodorsal is thin discoidal, the cirrus sockets, which are oblong, two and one-half to three times as high as broad, arranged in a single regular marginal row; the dorsal pole is slightly concave, 3 mm. in diameter; P_2 is 7 mm. long with fifteen segments of which the fifth is the longest, twice as long as broad; there is a very slight spinous production of the distal edges of the segments. Another specimen also has 21 cirrus segments which distally are nearly as long as broad; P_2 has from fifteen to eighteen segments of which the basal are flattened exteriorly; the distal edges of the third and following segment are slightly produced and spinous. In a third specimen the arms are about 60 mm. long; the cirri are 15 mm. long with 20-21 segments; P_1 has from ten to thirteen segments; P_2 has twelve segments, which have no perceptible production of the distal edges. A fourth specimen is interesting in possessing eleven arms, one IIBr 1 series being present; P_1 has sixteen segments. The remaining three are similar to those described.

These specimens possess in general the characters of the form from southeastern Africa which I called *occidentalis,* and possibly should be recorded under that name. They have but the merest trace of the character from which *serripinna* gets its name, though this is not entirely absent as in *japonica.*

The distribution of this general type of *serripinna*—southeastern Africa, Lesser Sunda Islands and Tonga—is curiously parallel to that of the variation of *Stephanometra monacantha* in the direction of *S. indica*—southeastern Africa, Ceylon, Lesser Sunda Islands, Torres Strait.

Oligometra caledoniæ from New Caledonia and *O. japonica* from Japan represent the extremes of the smooth pinnuled variation from the *O. serripinna* stock.

2. *Fuchow, Province of Fokien, China; Consul S. Siemssen; December 18, 1905.*—One specimen; there are 23-24 cirrus segments which become nearly as long as broad distally; P_2 is 7 mm. long with eighteen segments which possess only a slight trace of lateral processes; the second-fourth segments of the earlier pinnules are carinate.

Family TROPIOMETRIDÆ

TROPIOMETRA AFRA (Hartlaub)

Antedon afra 1890. Hartlaub, Nachr. Ges. Göttingen, Mai, 1890, p. 172 (1). —1891. Nova Acta Acad. German., vol. 58, No. 1, p. 86, pl. 5, figs. 50, 52 (1).

1. *Bowen, Queensland.*—One specimen, the type of the species.

TROPIOMETRA MACRODISCUS (Hara)

1. *Misaki, Japan; 30-50 fathoms; Alan Owston.*—One specimen purple in color and resembling the specimens from Japan in the U. S. National Museum and in the Copenhagen Museum.

2. *Misaki, Japan; 30-50 fathoms; Alan Owston.*—One specimen, slightly smaller than the preceding.

I am now convinced that I was wrong in placing Hara's *macrodiscus* under the synonymy of Hartlaub's *afra; macrodiscus* is a stouter and larger form than *afra* with longer and heavier cirri and longer brachials. A glance at the cirri alone is sufficient to distinguish them.

TROPIOMETRA PICTA (Gay)

Antedon carinata (part) 1882. P. H. Carpenter, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 502 (5).

1. *Santos, Brazil.*—Ten specimens.
2. *Rio de Janeiro, Brazil.*—One large specimen.

3. *Off the mouth of the Amazons (0° 25′ S. lat., 46° 44′ W. long.)*.—Eleven specimens.

4. *Among the Baleiro Islands, off the harbor of Victoria, province of Espirito Santo, Brazil.*—Seven fine specimens.

5. *No Locality.*—Two specimens.

TROPIOMETRA CARINATA (Lamarck)

Antedon carinata (part) 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 502 (1).

1. *Mauritius.*—Two dry specimens.

TROPIOMETRA ? ENCRINUS (A. H. Clark)

Antedon carinata (part) 1882. P. H. CARPENTER, Journ. Linn. Soc. (Zoöl.), vol. 16, p. 502 (1).

1. *Java.*—Four specimens. Unfortunately I overlooked these specimens while at Hamburg. They probably belong to *T. encrinus*, though there is a possibility that they may be referable to *T. indica*. At any rate they cannot belong either to *T. picta* or to *T. carinata*, or to the larger forms of the *T. afra* group.

Family CALOMETRIDÆ

NEOMETRA MULTICOLOR (A. H. Clark)

1. *Okinose, Japan; 55 fathoms; Alan Owston, October 27, 1901.*—One typical specimen with twelve arms, and one small twelve armed example.

Family ANTEDONIDÆ

Subfamily ANTEDONINÆ

ANTEDON PETASUS (Danielssen and Koren)

1. *Tromsø, Norway.*—Two specimens.

2. *Norway.*—Two specimens.

ANTEDON BIFIDA (Pennant)

1. *White Island, Scilly Islands.*—Two specimens.

2. *Spain.*—Two specimens.

3. *Cezimba, Portugal; A. Greeff, January 18, 1880.*—Three specimens; one of these has the arms about 80 mm. long and the cirri about XXX, 11-13, distally flattened and curved; another is similar, the cirri having 13 segments; the third is small.

In the perisomic areas between the IBr_1 there are prominent rhombic groups of rather solid perisomic plates resembling those figured for Scottish specimens by W. B. Carpenter.

ANTEDON HUPFERI (Hartlaub)

Antedon hupferi 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai 1890, p. 171 (1).—1891. Nova Acta Acad. German., vol. 58, No. 1, p. 88, pl. 5, figs. 53, 59 (1).

1. *Wapu, Ivory Coast (West Africa); 21 fathoms; blue mud; Capt. Hupfer, December 5, 1887.*—One specimen, the type of the species; this may be described as follows:

The centrodorsal is thin, with a rather broad dorsal pole 1 mm. in diameter, very slightly concave; the cirrus sockets are arranged in two irregular rows.

The cirri are XXVI, 14-16, 12 mm. to 14 mm. long, intermediate in character between those of *Antedon bifida* and those of *A. mediterranea,* though slightly nearer the former; on the short outer segments the dorsal profile is perfectly straight, on the longer centrally constricted segments very slightly concave; the longest proximal segments are from two to two and one-half times as long as the proximal diameter; the short outer segments are usually half again as long as broad, becoming slightly longer on the last three; the opposing spine is minute, terminal, and sharp; the longer earlier segments are moderately constricted so that the outer, which are slightly flattened laterally, appear broader in lateral view; but the difference is comparatively slight.

The arm structure resembles that of *A. bifida.*

The perisomic areas between the IBr series are occupied by triangular masses of rather solid perisomic plates.

P_1 has eighteen segments of which the first is about as broad as long, the second slightly longer than broad, the third slightly over twice as long as broad, and the remainder three times as long as broad; the third and following have very slightly produced and very finely spinous distal edges; the pinnule is very long, though not especially stout; P_2 and the following pinnules are very much shorter.

The disk bears a very few small calcareous nodules, more numerous on the base of the anal tube than elsewhere.

2. *Gorée, Ivory Coast; 13 fathoms; Capt. Hupfer, May, 1891.*—One small specimen.

ANTEDON MEDITERRANEA (Lamarck)

Antedon roseum Hamburg Mus., MS. (4).

1. *Nice.*—One specimen.
2. *Naples.*—One specimen.
3. *Sicily; Krohn.*—One specimen.
4. *Mediterranean Sea.*—One specimen.

EUANTEDON, new genus

Centrodorsal low hemispherical, resembling that of *Antedon mediterranea* or *A. adriatica,* bearing about thirty cirri.

Cirri long, rather slender, all the segments longer than broad, the earlier two to four times as long as broad, the outer slightly longer than broad; in general resembling those of the Mediterranean species of *Antedon.*

Arm structure as in the Mediterranean species of *Antedon;* synarthrial tubercles may be moderately developed.

P_1 slender with less than twenty-five segments, shorter than the cirri, somewhat stiffened; all the segments except the basal are elongated; P_2 about half as long as P_1, but longer than P_3, resembling P_1.

Genotype.—*Antedon moluccana* A. H. Clark, 1912.

Euantedon differs from *Antedon* in having P_2 resembling P_1 and intermediate in size between P_1 and P_3; and in having P_1 composed of much longer segments than the corresponding pinnule in *Antedon.* It differs from *Mastigometra* in having P_1 shorter than instead of much longer than the cirri, stiffened instead of flagellate, and composed of fewer segments.

EUANTEDON SINENSIS, new species

1. *? Coast of China* (labeled, in Chinese characters, "very deep water").—One specimen, which may be described as follows:

Cirri about XXX, 15-17, the longest probably 13 mm. to 15 mm. long; the longest segments in the proximal portion are from two to two and one-half times as long as broad; the outer segments are only very slightly shorter; the cirri resemble those of *Antedon adriatica* in general appearance; the dorsal proximal and distal edges of the segments are slightly thickened in the outer segments as in *Antedon mediterranea* and in *A. adriatica.*

The arm structure resembles that of *A. adriatica;* the distal intersyzygial interval is three oblique muscular articulations. The arms are about 60 mm. long.

P_1 is broken in all cases; but it is longer and stouter than P_2; the first segment is short, the second slightly longer than broad, the third slightly over twice as long as broad, and the following about three times as long as broad; the distal edges of the third and following segments are slightly produced; P_2 is from 6 mm. to 6.5 mm. long with nine or ten segments of which the second is about as long as broad, the third nearly twice as long as broad, and the following increase in length so that the outer are about four times as long as the median diameter; the third and following have slightly produced finely spinous distal edges; the following pinnules are small and weak.

This species is closely related to *Euantedon moluccana;* it is somewhat larger than the type (and only known specimen) of that form, and shows the following differences; the cirrus segments are proportionately only about half as long, with both the proximal and distal dorsal edges thickened and prominent, the entire dorsal surface in *E. moluccana* being straight and smooth; there is much less difference in proportions between the proximal and terminal cirrus segments than in *E. moluccana;* the proximal pinnules are essentially the same in the two forms, but in *E. moluccana* the component segments are longer and the distal edges are smooth and not produced; the synarthrial tubercles are less prominent than in *E. moluccana.*

IRIDOMETRA NANA (Hartlaub)

Antedon nana 1890. HARTLAUB, Nachr. Ges. Göttingen, Mai 1890, p. 170 (1). —1891. Nova Acta Acad. German., vol. 58, No. 1, p. 89 (1).

1. *Tonga Islands.*—One specimen.

Subfamily ZENOMETRINÆ

LEPTOMETRA CELTICA (Barrett and McAndrew)

1. *"Porcupine" Station No. 13.*—Three specimens.

LEPTOMETRA PHALANGIUM (J. Müller)

1. *Naples.*—Three specimens.
2. *Tunis, 50-100 fathoms.*—Three specimens.

Subfamily HELIOMETRINÆ

HELIOMETRA GLACIALIS (Leach)

1. *Greenland.*—Two large and handsome specimens.
2. *East Spitzbergen; W. Kükenthal.*—Twelve specimens.

SOLANOMETRA MAGELLANICA (Bell)

Antedon eschrichtii var. *magellanica* 1882. BELL, Proc. Zoöl. Soc. London, 1882, p. 651.

Antedon rhomboidea 1888. P. H. CARPENTER, "Challenger" Report, Comatulæ, p. 148.—1895. HARTLAUB, Bull. Mus. Comp. Zoöl., vol. 27, No. 4, p. 138 (1).

Heliometra magellanica 1911. A. H. CLARK, Bull. du mus. d'hist. nat., No. 4, 1911, p. 257.

1. *Smyth Channel, Straits of Magellan; Dr. H. Rehberg.*—One specimen, resembling others at hand from the vicinity of Cape Horn.

2. *Puerto Bueno, Smyth Channel; Capt. R. Paessler, October 25, 1893.*—One specimen.

HATHROMETRA PROLIXA (Sladen)

1. *East Spitzbergen; Römer and Schaudinn dredging stations 23-24, 32, 126-130.*—Six specimens.

Family PENTACRINITIDÆ

ISOCRINUS DECORUS (Wyville Thomson)

1. *Barbados.*—One specimen.

METACRINUS ROTUNDUS P. H. Carpenter

1. *Japan.*—One specimen.
2. *Sagami Bay, Japan.*—One specimen.

LIST OF THE PUBLISHED PAPERS DEALING WHOLLY OR IN PART WITH THE CRINOIDS IN THE COLLECTION OF THE HAMBURG MUSEUM.

1868. Lovén, Sven, Om *Hyponome sarsi.* Förhandl. Skand. Naturf. Christiania, 1868, vol. 10, pp. 159-160.

1869. Lütken, C. F., *Hyponome sarsi*, a recent Australian Echinoderm closely allied to the palæozoic Cystidea, described by Professor Lovén; with some Remarks on the Mouth and Anus in the Crinoidea and Cystidea. Canadian Naturalist (N. S.), vol. 4, pp. 267-270.*

1882. Carpenter, Philip Herbert, The Comatulæ of the Hamburg Museum. Journal of the Linnean Society (Zoölogy), vol. 16, pp. 501-526.

1888. Carpenter, Philip Herbert, "Challenger" Report, Comatulæ. Zoology, vol. 26 (Part 60).

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1891. Hartlaub, Clemens, Beitrag zur Kenntniss der Comatuliden-Fauna des Indischen Archipels. Nova Acta der Ksl. Leop.-Carol. Deutschen Akademie der Naturforscher, vol. 58, No. 1, pp. 1-120.

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* For references to additional papers on the subject of this supposed recent Cystidean, see the synonymy under *Zygometra microdiscus*, p. 11.

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A FOSSIL TOOTHED CETACEAN FROM CALIFORNIA, REPRESENTING A NEW GENUS AND SPECIES

WITH TWO PLATES

BY
FREDERICK W. TRUE

(PUBLICATION 2151)

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A FOSSIL TOOTHED CETACEAN FROM CALIFORNIA, REPRESENTING A NEW GENUS AND SPECIES.

(WITH TWO PLATES)

By FREDERICK W. TRUE

A portion of the mandible of a fossil cetacean belonging to the museum of the University of California, has recently been sent me by Prof. J. C. Merriam and proves on examination to represent an undescribed form. With the jaw are four detached teeth. This material, which is recorded as No. 1352 Mus. Univ. Cal., was obtained from Upper San Pablo, near Rodeo, California. Rodeo is a town about 16 miles northeast of San Francisco on San Pablo Bay. Although so small a part of the skeleton is available for study, yet as it represents a quite distinct form, it seems to require a name. It is, therefore, described below under the designation of *Hesperocetus californicus.*

The portion of the symphyseal region of the mandible preserved consists of three fragments which, when placed in line, measure 196 mm. It is probable, however, that the anterior and middle portions should be separated by an interval of about 30 mm. The posterior portion is probably from near the posterior end of the symphysis. The greatest breadth posteriorly is 41 mm. and the greatest depth, 29 mm. In section, the mandible is triangular or cordate, the sides being convex and the upper surface nearly flat. When viewed from above, the jaw appears at first to present a series of ten or eleven pairs of alveoli closely approximated, but upon careful examination it is seen that every second pair in reality consists of two shallow depressions in the surface of the jaw, while the alveoli themselves are widely separated. There are, in fact, only six pairs of alveoli represented in the fragment preserved, unless the anterior pair is to be regarded as consisting of two or three pairs of small alveoli closely approximated. Further reference will be made to this question below. Aside from this anterior pair, the alveoli are large and elliptical, the largest posterior one having a longitudinal diameter of 20 mm. and a transverse diameter of 9.5 mm. They decrease in size anteriorly, the pair immediately following the anterior ones having a length of 12.5 mm. The two alveoli constituting the pair nearest the posterior end of the fragment are separated in the median line by a distance of 9 mm., while the two constituting the pair nearest the anterior one are separated by 4 mm. As already mentioned, the space between the different pairs of alveoli is occupied by a series of elliptical depressions of similar form, but only a few millimeters deep. These depressions are deepest at the middle of the series, the posterior ones being shallower and longer, and the anterior ones shallower and shorter.

The alveoli constituting the anterior pair, as already mentioned, differ from the others in that they are divided by one or two rudimentary transverse septa. These septa are convex backward and emarginate above, so that they do not reach the level of the upper surface of the jaw, except where they join the sides of the same and the median longitudinal ridge. The anterior one is not visible on the right half of the jaw, and on the left it is developed on the side nearest the outer margin of the jaw. It is supposable that the teeth belonging in these alveoli had a partially divided root, such as sometimes occurs in *Platanista*, *Inia* and other recent genera, but this is by no means certain. The fragment in which they are situated has been broken transversely into two pieces, and it is possible that the two parts do not belong together. As the fracture is behind the anterior pair of alveoli, however, this does not explain their conformation, though it may be that the anterior piece belongs farther forward, and that the mandible was a little expanded at the extremity.

The upper margins of the jaw are rounded, and the lateral borders of the median ridge are sinuous, owing to the fact that it expands opposite the points at which the pairs of alveoli and of elliptical depressions join. Along the center, it appears to have been as high as the outer borders of the jaw and flat above.

The sides of the jaw are convex and meet in a rounded angle in the median line below. On each side are several rather large foramina from which more or less distinct channels extend forward toward the extremity of the jaw. There is, however, no continuous longitudinal furrow such as is found in *Stenodelphis*, *Schizodelphis*, etc.

The four teeth which accompany the mandible lack the greater part of the root and the crowns are worn in a peculiar manner, as will be noted more in detail below. They seem too large for the alveoli, but when placed in them it is observed that they fit quite accurately and there is little doubt that they belong to the jaw already described.

The crowns of the teeth, which are of a very dark brown color, are short and conical, and elliptical in section at the base. They are strongly curved inward, or a little backward, from about the middle of the height. The enamel is distinctly rugose and there is a clearly-defined, longitudinal postero-internal ridge, and also an antero-external ridge. The latter is bifurcated in the lower half. The cingulum is represented only by a small tubercle at the base of the internal ridge. The crown is slightly constricted below this point. The base of the crown appears oblique owing to wear or splintering of the enamel on the outer side, but was probably not so originally. The apex of the crown in two of the teeth is obliquely truncate as a result of attrition, the upper exposed surface being quite flat. In the other two teeth only the extreme tip is abraded and the exposed worn surface is nearly at right angles with the longitudinal axis of the crown. The dimensions of the teeth are as follows:

Measurements.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Length of crown	11	12	11	11
Antero-posterior diameter of crown at base	8	10	9	8.5
Transverse diameter of crown at base	8	8	8.5	8

The four teeth, of which measurements are given above, differ somewhat in their characteristics when compared with each other. Tooth No. 1 is from the left side, if a lower tooth. It is the smallest of the four and the crown is most strongly recurved. The antero-external ridge of the crown is nearly obliterated, but appears to be widely bifurcated at the base. On this account and because of the curvature of the crown it may be a posterior tooth, and belong behind the other three. The anterior side of the crown is worn away by abrasion, leaving a large, flat, elliptical and nearly vertical surface devoid of enamel. Tooth No. 2 has the largest crown of the four and the crown is also more compressed than in the other teeth. The bifurcation of the anterior ridge extends upward only a little way from the base. This tooth is only slightly curved inward and backward. Teeth Nos. 3 and 4 are almost identical in form and size. They are perceptibly larger in diameter than No. 1, and the crown is somewhat gibbous near the base. The apex is worn away, leaving a large, oblique, elliptical surface devoid of enamel, but was originally strongly curved inward and backward. The anterior ridge is bifurcated upward to a point about half way between the base of the crown and the apex (when complete).

The dimensions of the portion of the mandible which is preserved are as follows:

	mm.
Length of the three parts when in line and touching........	196
Greatest breadth of median portion posteriorly	41
Least breadth of anterior portion anteriorly	26
Breadth at middle of median portion......................	34
Length of posterior alveolus...............................	20
Breadth of the same..	9.5
Length of alveolus next to the anterior one................	12.5
Breadth of the same..	9
Length of anterior alveolus	22.5
Breadth of anterior alveolus...............................	12
Length of the posterior depression........................	18
Breadth of the same..	11.5
Length of one of the middle depressions...................	16
Breadth of the same..	10
Length of the depression next to the anterior alveolus......	8
Breadth of the same	10
Least breadth of median ridge between alveoli posteriorly....	9
Least breadth of median ridge between alveoli anteriorly....	4
Depth of mandibular fragment posteriorly..................	29
Least depth of mandibular fragment anteriorly..............	23

From the foregoing description it will be gathered that *Hesperocetus californicus* is a toothed cetacean, or porpoise, of moderate size, with a rather long beak and teeth in both jaws. The teeth were separated by wide interspaces, those of the lower jaw fitting in between those of the upper jaw and *vice versa* when the mouth was closed, but probably the teeth of neither set touched those of the other in front or behind, except in a few instances. The tips of the upper teeth probably rested on the upper surface of the lower jaw in the depressions which intervene between the alveoli, and, similarly, the mandibular teeth probably rested against the roof of the mouth.

What the affinities of the species are is difficult to determine. The peculiar setting of the teeth just mentioned reminds one, to a certain extent, of the South American genus *Ischyrorhynchus* Ameghino. The original description of the type-mandible of *Ischyrorhynchus vanbenedeni* is as follows:

" Mandibular rami anchylosed together throughout the length of the tooth-row as in *Saurocetes* [=*Pontoplanodes*]. Mandible less compressed, with a flat and rugose space between the two tooth-rows, one or two centimeters broad in its posterior part. Perpendicular diameter of the mandible a little greater than the largest transverse diameter. The upper part terminates in a rounded longitudinal eminence (*quilla*). Roots of the teeth less compressed than in *Saurocetes* [=*Pontoplanodes*], frequently imperfect at the termination below, with the two points, anterior and posterior, less distinct. Crowns of the teeth conical and low, with the apex turned a little backward and the enamel strongly rugose. Teeth implanted in an alternating order, each of those of the right side opposite the space which intervenes between two of the left side, and *vice versa* with each of the teeth of the left side in relation to those of the right side. Average diameter of each of the posterior molars at the level of the alveolar border: antero-posterior, 13 millimeters, transverse, 8. Diameter, antero-posterior, of the crown of a detached tooth, 9 millimeters; transverse, 9 millimeters. Height of crown, 11 millimeters. Transverse diameter of the beak at the anterior end of the part figured, 31 millimeters; vertical diameter, 38 millimeters."[1]

In *Hesperocetus* the teeth of the two sides are opposite, but this might be, and probably was, so in the anterior part of the mandible of *Ischyrorhynchus*. Displacements of the teeth similar to that occurring in the latter genus are common in various recent genera of Delphinidæ. In *Ischyrorhynchus* the teeth are close together, or even in contact, on each side at the posterior end of the series figured by Ameghino, but the anterior ones are separated by interspaces which increase in length forward. It is not improbable, therefore, that near the anterior end of the complete jaw they were quite as widely spaced as in *Hesperocetus*.

There is also some indication of depressions in the interspaces between the teeth in the fragment figured by Ameghino, but they are quite indistinct, and are somewhat external to the alveoli, rather than in line with them, as in *Hesperocetus*.

Although the dimensions of the teeth in the two forms are nearly identical, the proportions of the jaw do not agree. The fragment on which *Ischyrorhynchus* is based, if it were from the same species as that on which *Hesperocetus* is based, should be from nearer the posterior end of the symphysis, on account of the close approximation of the teeth in the former. It should, therefore, be broader. The type-fragment of *Ischyrorhynchus* is, however, narrower at the posterior end than the Californian specimen. From this circumstance, it seems reasonable to suppose that the latter, when complete,

[1] Revista Argent. Hist. Nat., Buenos Aires, vol. 1, 1891, pp. 163-165.

had the teeth widely spaced throughout. This idea is strengthened by the fact that the interspaces in the fragment preserved increase in length toward the posterior end of the jaw, or maintain a constant length, the length of each from in front backward being as follows: 13, (hiatus), 20, 23, 23, 23 mm. In the type of *Ischyrorhynchus* the same intervals are about 10, 8, 4.5, 1, 0, 0 mm. The mandible in the latter form is deeper than wide, while in *Hesperocetus,* it is wider than deep, but this difference is rather specific than generic.

On account of the differences mentioned above, the assignment of the Californian specimen to the genus *Ischyrorhynchus* does not seem warranted.

It is possible that *Hesperocetus* is related to the South American genus *Saurodelphis* Burmeister, which belongs to the family Iniidæ, but as the mandible of the latter genus is not known this cannot be determined at present.

The genus *Pontoplanodes* Ameghino, which has already been alluded to, presents some of the characteristics of *Hesperocetus.* The mandibular teeth have conical, recurved crowns, with rugose enamel, and in the anterior ones the root is more or less distinctly divided into two or three branches at the extremity. The upper borders of the jaw are sinuous in outline, and there are depressions between the teeth. These depressions, however, are of small size and are situated outside of the alveoli instead of in line with them, as they are in *Hesperocetus.* The teeth are quite close together, especially at the posterior end of the series. The mandible has a distinct channel or sulcus, along the outer side of the symphyseal portion, as in *Platanista,* etc.

While *Pontoplanodes* presents some resemblances to *Hesperocetus* they are not sufficient, in my opinion, to warrant a close association of the two genera.

Hesperocetus may be provisionally assigned to the family Iniidæ, but it should be remarked that the teeth, though much larger, resemble those of *Delphinodon* which I have recently proposed to transfer to the Delphinidæ. No known genus of that family, however, presents mandibular characteristics similar to those of *Hesperocetus.*

EXPLANATION OF PLATES

Hesperocetus californicus, new genus and species. Type.

PLATE 1

FIG. 1. Mandible. Superior aspect.
2. Mandible. Inferior aspect.

Both figures natural size.

PLATE 2

FIG. 1. Mandible. Lateral aspect. Left side. Natural size. (The inferior margin is complete below the posterior foramen.)
2. Tooth No. 1. Postero-internal surface.
3. The same. Anterior surface.
4. Tooth No. 2. Internal surface.
5. The same. Anterior surface.
6. Tooth No. 3. Postero-internal surface.
7. The same. Antero-external surface.

All the figures of teeth twice natural size.

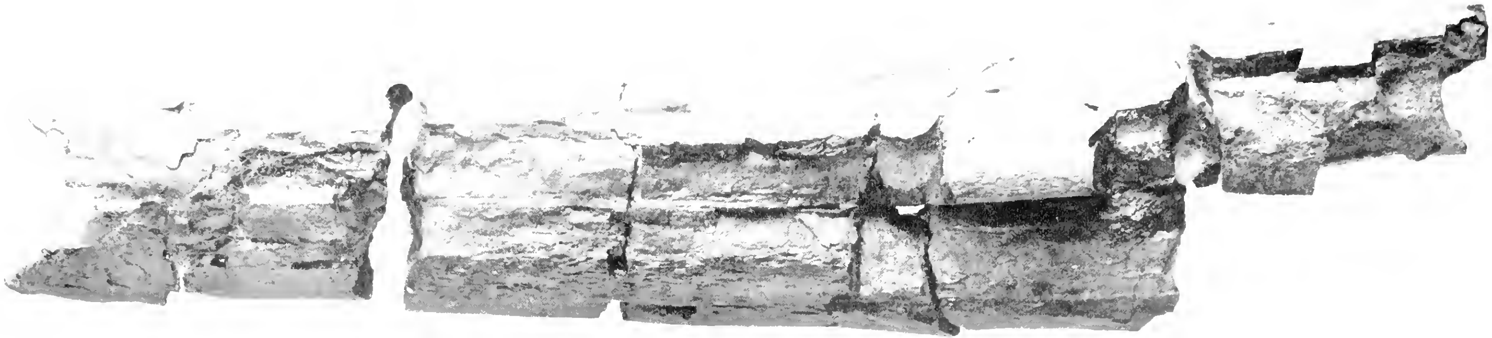

Fig. 2

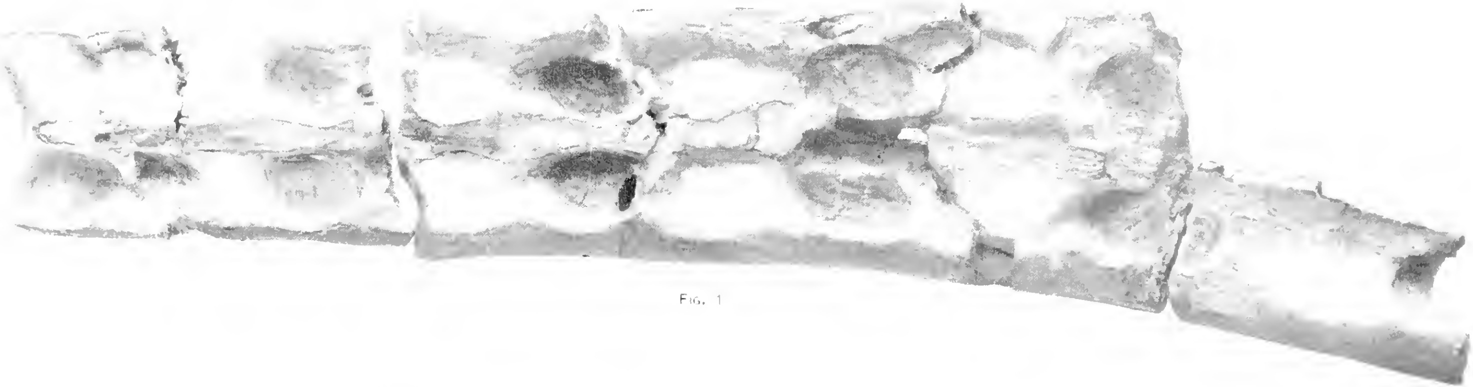

Fig. 1

MANDIBLE OF HESPEROCETUS CALIFORNICUS, NEW GENUS AND SPECIES. TYPE

FIG. 1

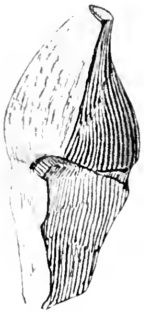

FIG. 2

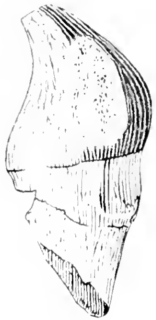

FIG. 3

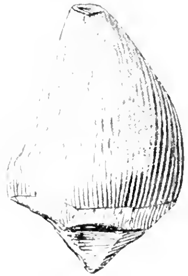

FIG. 4

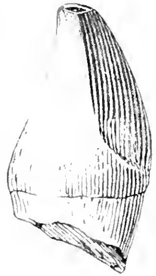

FIG. 5

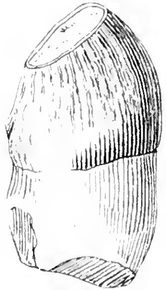

FIG. 6

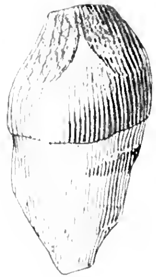

FIG. 7

MANDIBLE AND TEETH OF HESPEROCETUS CALIFORNICUS, NEW GENUS AND SPECIES. TYPE

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NEW RACES OF INSECTIVORES, BATS, AND LEMURS FROM BRITISH EAST AFRICA

BY

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(Publication 2152)

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NEW RACES OF INSECTIVORES, BATS, AND LEMURS FROM BRITISH EAST AFRICA

By EDMUND HELLER

NATURALIST, SMITHSONIAN AFRICAN EXPEDITION

Further study of the collection of East African mammals in the U. S. National Museum has resulted in the discovery of several new races of insectivores, bats, and lemurs which are described in the present paper.

Nearly all of these new forms have been detected in the collection recently made under the direction of Mr. Paul J. Rainey in British East Africa.

The new races described are chiefly from the summits of isolated mountains situated either in the northern desert of British East Africa near the Abyssinian border, or else in the Taru Desert near the coast.

The material has been compared directly with the types of the described species in the British Museum. For the privilege of examining the specimens in the British Museum and for facilities in the working out of the collection the writer is indebted to Mr. Oldfield Thomas, the curator of mammals.

GALAGO MOHOLI COCOS, new subspecies

Type from Mazeras, British East Africa; adult male; No. 181810, U. S. Nat. Mus.; collected by Edmund Heller, December 16, 1911; original number, 4870.

Characters.—Coloration very similar to *gallarum,* but differing by the cinnamon tone to the upper parts and tail and the plumbeous bases to the hair of the underparts. From *nyasæ,* this race differs by lighter dorsal coloration, darker hind feet and longer pelage. The last molar is distinctly larger than in either *gallarum* or *nyasæ.*

Coloration.—Dorsal surface of body cinnamon; the limbs to the toes and the sides lighter, buffy-yellow; tail purer cinnamon deepening toward the tip; head on occiput darker than body, umber-brown; snout with a broad white stripe from nose to middle of forehead, bordered on each side by broccoli-brown which color is continuous on sides of snout to the whitish lips; cheeks grayish-buffy; ears naked, blackish; chin, throat, and sides of neck blackish; underparts buffy-yellow, the hairs everywhere plumbeous at the base; chest more highly colored, ochraceous.

Measurements.—Head and body, 150 mm.; tail, 203; hind foot, 55; ear, 38.

Skull: Occipito-nasal length, 41; condylo-basal length, 37; zygomatic breadth, 28; interorbital width, 4.5; intertemporal width, 16.5; nasals, 10.8 x 3.2; upper cheek teeth, 12.3; width of palate at m^2, 7; m^3 length, 3.2; m^3 width, 3.2; width mesopterygoid fossa, 6.2; length palate, 13.2; mandible length, 25; mandible height at coronoid, 12.6.

This race is intermediate between *gallarum* of Somaliland and *nyasæ* of Nyasaland, except in the distinct character of the last molar. *Gallarum* differs chiefly by the pure buffy or whitish hair of the underparts which is white to the roots, and also by the dark hair-brown tail, with a blackish tip. The collection contains six specimens from the type-locality all of which agree in the cinnamon coloration and the large size of the last upper molar. Some fifteen miles farther inland from Mazeras at Maji-ya-chumvi a series of four specimens of *Galago* were obtained. These are all *baccatus,* being ashy-gray in color without any cinnamon suffusion. The Mazeras specimens were all obtained on the brushy borders of the cocoa-palm groves. These groves are the dominant feature in the landscape of the coast belt, and extend almost unbroken from the sea beaches inland a distance of ten or fifteen miles. They mark the tropical littoral zone more precisely than any other plant growth.

MINIOPTERUS NATALENSIS ARENARIUS, new subspecies

Æquatorial Broad Winged Bat

Type from the Guaso Nyuki, Northern Guaso Nyiro River, British East Africa; adult female; No. 181811, U. S. Nat. Mus.; collected by Edmund Heller, October 4, 1911; original number, 4413.

Characters.—Size of *natalensis,* but color paler, pelage shorter; the skull with broader brain-case and with inner incisor greatly exceeding outer in size.

Coloration.—Dorsal color seal-brown, the head darker, clove-brown, and the rump lighter walnut-brown, the hair only slightly darker at the base; underparts washed with drab-gray, the hair basally dark slaty; ears and membranes blackish, the latter narrowly white bordered.

Measurements.—Head and body, 55 mm.; tail, 47; hind foot, 9; ear, 11; forearm, 45.

Skull: Greatest length, 14.8; condylo-incisive length, 14.3; basilar length, 11; zygomatic length, 5.6; upper cheek teeth, 4.8; condylo-incisive length of mandible, 10.9; coronoid-angular depth of mandible, 3.5.

The type was secured in a large crevice among granite boulders on the summit of a small kopje. One other specimen was shot at dusk among some acacia trees in the same vicinity.

PIPISTRELLUS AERO, new species

Uaragess Pipistrelle

Type from summit of Mount Garguez, Mathews Range, altitude 7,000 ft., British East Africa, adult male; No. 181812, U. S. Nat. Mus.; collected by Edmund Heller, August 26, 1911; original number, 4110.

Characters.—Similar to *fuscatus* in color and in the position of the first upper premolar which is placed well inside of the tooth-row, but size of body much less, equal to that of *nanus,* which differs from it in the position of the minute first upper premolar which is in the tooth-row and can be seen from the outside. Skull larger than in *nanus.*

Coloration.—Dorsal coloration uniform vandyke-brown; underparts lighter wood-brown, the hair everywhere slate-black at base; membranes, feet, ears, and tail black.

Measurements.—Head and body, 42 mm.; tail, 32; foot, 6; ear, 10.5; forearm, 31.5.

Skull: Condylo-incisive length, 12; zygomatic breadth, 8.5; mastoid breadth, 7; length upper tooth series to outer edge of canine, 4.8; condylo-incisive length of mandible, 9.

Two additional specimens from the summit of Mt. Garguez are in the collection. They agree with the type in color, size, and dental characters. This species was seen only in the heavy forest on the summit of the mountain. Numbers of them were seen at dusk every evening but no other species was noted at so high an altitude.

PIPISTRELLUS HELIOS, new species

Samburr Pipistrelle

Type from Merelle Water, 30 miles south of Mt. Marsabit, British East Arica; adult male; No. 181813, U. S. Nat. Mus.; collected by Edmund Heller, July 22, 1911; original number, 3065.

Characters.—Related most closely to *nanus* but size much less and coloration much paler; size of *culex,* but inner upper incisors broad and bifid at tip; from *ariel* it differs in bifid inner upper incisor and large size of first upper premolar.

Coloration.—Dorsal haired area ochraceous-buff; the hair at extreme base deep black; underparts lighter, buff in color, the hair deep black on the basal two-thirds of its length; ears naked, clay color; membranes blackish, narrowly edged by white.

Measurements.—Head and body, 45 mm.; tail, 31; hind foot, 5; ear, 9; forearm, 27.5.

Skull: Greatest length, 11; condylo-incisive length, 10.6; basilar length, 8.3; zygomatic breadth, 7; interorbital constriction, 3.2; palatilar length (nasal notch), 4.1; upper cheek teeth, 2.9; condylo-incisive length of mandible, 7.7; coronoid-angular depth of mandible, 2.8.

Three specimens of this diminutive Pipistrelle are in the collection. All were collected in the Northern Guaso Nyiro watershed.

PACHYURA LIXA ÆQUATORIA, new subspecies

Æquatorial Pachyura

Type from the summit of Mt. Sagalla, Taita Hills, British East Africa, altitude 4,000 ft.; adult male; No. 181814, U. S. Nat. Mus.; collected by Edmund Heller, November 19, 1911; original number, 4815.

Characters.—Most closely allied to *lixa* but differing by larger size, darker coloration and dark colored tail; fourth upper unicuspid large and placed in tooth row so that it is visible from the side, the relative size of the unicuspids agrees with *lixa* and is distinctly different from *leucura* in which species the fourth is minute and shoved inside the tooth row in the angle between the third and the large premolar, differs further from *leucura,* its nearest geographical ally, by much smaller size and dark tail.

Coloration.—Dorsal color uniform slate-gray, underparts distinctly lighter, gray 8 of Ridgway, the two colors rather sharply defined on sides; lateral gland conspicuously marked by an elliptical patch of short white hair; hair everywhere plumbeous at base; feet white; ears and tail slate-gray the latter whitish only on underside for the basal one-half.

Measurements.—Head and body, 75 mm.; tail, 56; hind foot, 12.5.

Skull: Post glenoid process to outside edge of incisors, 12; breadth of brain-case, 9.5; length of upper tooth row, 8.8; condylo-incisive length of mandible, 12.5; depth of coronoid process, 5.

Type unique. Skull broken posteriorly, the whole occipital, auditory and sphenoidal portion missing. The third upper unicuspid about twice the size of the second which is scarcely twice the size of the fourth. The species is closely related to *lixa* of Nyasaland and rather distantly to the large *leucura* which occurs on Zanzibar Island and on the coast at Lamu and Witu.

PACHYURA INFINITESIMA, new species

Pygmy Pachyura

Type from Rumruti, Laikipia Plateau, British East Africa; altitude 7,000 ft.; adult male; No. 11.4.6.5, Brit. Mus.; collected by Robin Kemp, October 27, 1910; original number, 1431.

Characters.—Most closely allied to *nanilla* of South Africa, but size considerably smaller and color of upper parts broccoli-brown, not variegated-gray; fourth upper unicuspid large, one-third size of second and placed in tooth row, there being a slight diastema between it and the following tooth; second unicuspid only about one-half size of third; relative sizes of unicuspids agreeing with *nanilla*.

Coloration.—Dorsal color uniform broccoli-brown, underparts much lighter silvery, gray 10 of Ridgway, fairly sharply defined on sides; hair everywhere plumbeous at base, except on chin where it is white to the roots; position of lateral glands marked by a conspicuous patch of white hair; feet white; ears and tail dorsally broccoli-brown, the underside of the latter whitish for the basal one-half.

Measurements.—Head and body, 57.5 mm.; tail, 26; hind foot, 8.5.

Skull: Condylo-incisive length, 14.5; breadth of brain-case, 6.5; length of upper tooth row, 5.8; condylo-incisive length of mandible, 8.9; depth at coronoid process, 3.8.

Type unique. This species is somewhat smaller than *nanilla* and is the smallest African race, but is less minute than *madagascarensis*. *Crocidura nanilla*, which resembles this species in size and color, is a true *Crocidura*. The fourth unicuspid, which the type skull shows on its right side, is a mere compressed ridge of dentine crowded in between the third unicuspid and the large premolar and has no resemblance to the low circular cuspid tooth of *Pachyura* which represents the fourth upper unicuspid. The left side of *nanilla* lacks any adventitious tooth of this sort and is of the normal *Crocidura* type. In *nanilla* the third unicuspid is scarcely larger than the second while in *Pachyura* this tooth is usually double the size of the second. There is in the collection among a large series of *Crocidura suahelæ* one specimen which shows a similar compressed ridge-like fourth upper unicuspid on each side. These adventitious teeth have peculiar compressed knife-like crowns which are wedged in between the normal teeth much like the blade of a knife might be inserted in the tooth row.

CROCIDURA SUAHELÆ, new species

Strand Shrew

Type from Mazeras, British East Africa; adult male; No. 181815, U. S. Nat. Mus.; collected by Edmund Heller, December 17, 1911; original number, 4875.

Characters.—Agreeing with *voi* in the enlarged character of the second unicuspid in comparison to the third, but size of body much larger and coloration broccoli-brown, not slaty.

Coloration.—Dorsal coloration uniform broccoli-brown not sharply defined against the drab-gray of the underparts; hair everywhere slate-gray at base; lateral glands defined by a conspicuous line of white hairs; feet somewhat lighter than body, drab in color; tail uniform in color with the dorsum and clothed by short brown hair and scattered long white hairs on the basal two-thirds.

Measurements.—Head and body, 110 mm.; tail, 69; hind foot, 16.

Skull: Condylo-incisive length, 26.5; width of brain-case, 10.5; interorbital width, 4.8; upper tooth row (crowns), 11.8; condylo-incisive length of mandible, 16; depth (coronoid process to ramus), 7.3.

Dentition crowded, causing the second unicuspid to appear decidedly larger than the third from the side. When viewed from below they are seen to be actually the same in size.

This species although possessing the dental characters of *voi* does not seem to intergrade with it in size or coloration. It is a decidedly larger species approaching very closely *flavescens* in actual size of body and teeth, but differing by the enlarged second unicuspid from the members of that group.

A series of twenty from the type locality are in the collection. The color variation is almost nil, except in very immature specimens which are uniform grayish.

CROCIDURA TURBA LAKIUNDÆ, new subspecies

Lakiunda Swamp Shrew

Type from the Lakiundu River, near its junction with the Northern Guaso Nyiro River, British East Africa; adult female; No. 181816, U. S. Nat. Mus.; collected by Edmund Heller, July 12, 1911; original number, 1986.

Characters.—Most closely allied to *provocax* of which it is the low country representative; differs by very much browner coloration, shorter pelage and longer tail; third unicuspid very slightly larger than the second as in *turba* and its allies; skull similar to *provocax* but smaller.

Coloration.—Dorsal coloration uniform vandyke-brown, the underparts but slightly lighter in color, broccoli-brown; the color on the sides merging imperceptibly into the underparts; feet and ears drab; tail uniform in color, vandyke-brown; hair everywhere plumbeous at base.

Measurements.—Head and body, 95 mm.; tail, 57; hind foot, 15.5.

Skull: Condylo-incisive length, 23; width of brain-case, 10; length of upper tooth row, 10.4; condylo-incisive length of mandible, 14.5; depth at coronoid process, 5.5.

This is a lighter, more brownish race of *provocax* which occurs at the rather low elevation of 2,000 ft. on a stream, Northern Guaso Nyiro, which rises in the Aberdare Range in the territory inhabited by *provocax*. It has the second and third unicuspids of about equal size, the latter never attaining twice the size of the second as in *fumosa*. The second unicuspid viewed from the side looks distinctly larger than the third but when viewed from below where the whole tooth can be seen its real relative size is seen to be equal or slightly larger than the second.

A series of nine specimens is in the collection, seven of these are topotypes and the others are from neighboring localities on the Isiola River and Northern Guaso Nyiro at the Government post. Some of the specimens are rather darker than the type and are quite intermediate in color with *provocax*. The specimens were all secured in marshes or along the reedy borders of streams.

CROCIDURA RAINEYI, new species

Rainey Shrew

Type from Mt. Garguez, Mathews Range, British East Africa, altitude 6,000 ft.; adult male; No. 181817, U. S. Nat. Mus.; collected by Edmund Heller, September, 1911; original number, 4195.

Characters.—Most closely allied to *fumosa montis* from which it differs by larger size and decidedly more grayish coloration. Agrees with the *fumosa* group in having the third upper unicuspid twice the size of the second, but skull decidedly larger than in any other member of the group.

Coloration.—Dorsal coloration slate-gray with a broccoli-brown suffusion and fine silvery ticking when viewed from behind, underparts scarcely different in shade from the dorsal, but without the silvery ticking; hair everywhere plumbeous at base, hands and feet whitish; ears naked, whitish; tail indistinctly bicolor, drab above, whitish below; lateral glands marked by short grayish hairs which are not noticeably different from the sides in color.

Measurements.—Head and body, 90 mm.; tail, 61; hind foot, 15.5.

Skull: Condylo-incisive length, 23.3; breadth of brain-case, 10.7; length upper tooth row, 11; condylo-incisive length of mandible, 15.8; depth of mandible at coronoid process, 6.

This species is a close ally of *fumosa,* but differs more in color from the typical form from Mt. Kenia, than from the Mt. Ruwenzori race, *montis.* The series of eight specimens from the type locality show absolutely no color variation from the type and no intergradation takes place with the Kenia species. This is in agreement with the isolated habitat. The species is confined to the extreme forested summit of Mount Garguez which is isolated from the Kenia forest by low bush covered desert in which no representative of the *fumosa* group is known to occur. *Fumosa* and its allies are all forest species known only from the highlands with the exception of *schisticea* of the high veldt of the Athi Plains. On Mt. Garguez this race was found from the lower edge of the forest at 5,000 feet to the summit, 7,000 feet.

CROCIDURA LUTREOLA, new species

Mbololo Brown Shrew

Type from the summit of Mt. Mbololo, Taita Hills, British East Africa, altitude 5,000 ft.; adult female; No. 181818, U. S. Nat. Mus.; collected by Edmund Heller, November 6, 1911; original number, 4635.

Characters.—Allied most closely to *jacksoni,* but distinguishable by the darker coloration and narrower smaller skull; third unicuspid decidedly larger than second, almost twice as large while in *jacksoni* the relative difference in size is slightly less.

Coloration.—Dorsal color seal-brown, uniform in color to lower sides; underparts broccoli-brown; hair everywhere plumbeous at base; feet and ears broccoli-brown, tail seal-brown above and somewhat lighter below but not distinctly bicolor.

Measurements.—Head and body, 70 mm.; tail, 52; hind foot, 12.5.

Skull: Condylo-incisive length, 19; width of brain-case, 8.7; length of upper tooth row, 8; condylo-incisive length of mandible, 11.5; depth at coronoid process, 4.5.

This is one of the *jacksoni* group which are chiefly distinguishable from *hildegardeæ* by the marked enlargement of the third unicuspid in comparison to the second which is only about half its size. The skull of the type of *hildegardeæ* has lost both its second upper unicuspids but the third is much smaller than the same tooth in the type of *jacksoni* and could not have been any larger than the missing second unicuspid. The specimens of *jacksoni* in the British Museum are only two, both of which are from alcoholic material. These two appear considerably lighter and their skulls are decidedly larger.

From Mt. Mbololo we have eight skins of this new race and two also from the forest on Mt. Umengo, a neighboring mountain. From the summit of Mt. Sagalla, also one of the Taiti Hills, there is a series of much lighter specimens which no doubt represent *parvipes* although their tails are much longer than that of the typical specimen which came from the base of this mountain. Mt. Sagalla is a lower mountain than Mbololo and lacks the forest covering on its summit chiefly on account of its lack of moisture, to which environmental difference the lighter color of its shrews seems to be due.

CROCIDURA HILDEGARDEÆ ALTÆ, new subspecies

Uaragess Brown Shrew

Type from Mt. Garguez, Mathews Range, British East Africa, altitude 6,000 ft.; adult male; No. 181819, U. S. Nat. Mus.; collected by Edmund Heller, August 31, 1911; original number, 4190.

Characters.—Like *hildegardeæ* but tail longer and coloration darker, third unicuspid equal to size of second as in typical *hildegardeæ.*

Coloration.—Dorsal coloration vandyke-brown merging imperceptibly on sides into the slightly lighter drab colored underparts, hair everywhere plumbeous at base; feet drab; ears darker, hair-brown; tail almost uniform vandyke-brown, only lighter on underside basally.

Measurements.—Head and body, 74 mm.; tail, 62; hind foot, 13.5.

Skull: Condylo-incisive length, 19.8; breadth of brain-case, 9.2; length of upper tooth row, 8.7; condylo-incisive length of mandible, 12; depth at coronoid process, 4.8.

This race is confined to the forested summit of Mt. Garguez ranging from 5,000 to 6,000 ft. The lower slopes of the mountain are inhabited by the shorter tailed and lighter colored race *procera.* A series of six topotypes are in the collection. These show very little variation in the coloration or in length of tail.

CROCIDURA HILDEGARDEÆ PROCERA, new subspecies

Juniper Brown Shrew

Type from the summit of Mt. Lololokui, Northern Guaso Nyiro district, British East Africa; altitude 6,000 ft.; adult female; No. 181820, U. S. Nat. Mus.; collected by Edmund Heller, September 9, 1911; original number, 4274.

Characters.—Allied closely to *hildegardeæ* and having the same proportions, but lighter colored, especially the underparts, and slightly larger sized; differs from its nearer geographical ally *altæ* by lighter, whitish underparts and shorter tail; second and third unicuspids equal in size, the third not appreciably larger.

Coloration.—Dorsal color broccoli-brown the color uniform to lower sides where it is fairly well defined against the light gray underparts; hair everywhere plumbeous at base; feet white; ears drab; tail indistinctly bicolor, broccoli-brown above, drab-gray below.

Measurements.—Head and body, 72 mm.; tail, 51; hind foot, 12.

Skull: Condylo-incisive length, 20; breadth of brain-case, 9; length of upper tooth row, 8.8; condylo-incisive length of mandible, 12.7; depth at coronoid process, 4.8.

This shrew was found abundantly in the dry juniper forest which grows on the broad summit of Mt. Lololokui. A series of eleven skins is in the collection from the type locality besides three others from the lower slopes of Mt. Garguez. On Mt. Garguez the juniper, *Juniperus procera,* grows as a fringing forest below the dense forest proper on the dryer slopes of the mountain and it is in this zone that the present race occurs abundantly. They are not known however, to inhabit the dry arid plains from which these two mountains rise nor are they known from the Northern Guaso Nyiro River. The whitish underparts at once distinguish it from any of the other races of *hildegardeæ.*

ELEPHANTULUS RUFESCENS MARIAKANÆ, new subspecies

Coast Elephant Shrew

Type from Mariakani, British East Africa; adult female; No. 181821, U. S. Nat. Mus.; collected by Edmund Heller, December 31, 1911; original number, 5072.

Characters.—Intermediate in coloration between the dark race, *pulcher,* and the reddish *rufescens;* median dorsal coloration wood-brown, much lighter than the prout-brown of *pulcher* and much less reddish than the russet of *rufescens;* size and skull about as in *rufescens.*

Coloration.—Median dorsal color from snout to base of tail wood-brown, sides of head and body lighter, olive-buff, the color sharply defined below against the silky white underparts; fore and hind feet white; tail bicolor hair-brown above, white below, the two colors sharply defined on sides, tail covered by short hairs which hide the annulations; eye bordered below by a wide white band, and another above, which latter is continuous as a wide postocular stripe to base of ear; this stripe bordered below by a large patch of cinnamon which reaches the orbit; rest of cheeks olive-buff like sides, ears naked and blackish with a tuft of white hairs at base in front and a fulvus patch at posterior border; underparts pure silky white, the hair everywhere slate at base, except on chin where it is white to the roots; chest gland bordered by a patch of vinaceous-cinnamon hair.

Measurements.—Head and body, 130 mm.; tail, 108; hind foot, 30; ear, 22.

Skull: Occipito-nasal length, 35.5; zygomatic breadth, 19.5; interorbital breadth, 6.3; nasals, 13.5 x 2.8; upper molar series, 6.3; width of palate at m^2, 6.8; length of mandible, 25.5; height at coronoid, 10.5.

Five specimens are in the collection from the type locality. One of these is a mature male which is slightly darker than the type. There is also an immature male and two nursing young. These young examples are quite like the adult in color but much longer haired and woollier in appearance. This race is a coast form and its darker coloration is no doubt due to the moister climate to which it is subject. *Pulcher* which is an inland and highland race is also a dark form and differs from this race only in degree of color. Between the two areas of these races is found the russet colored desert form *rufescens.* The moist conditions of the immediate coast strip and the highlands of the interior produce a similar dark coloration in this species while the climate of the intervening desert region produces a decidedly reddish type of coloration.

All of the species of the *rufescens* group have a large chest gland covered thickly by short white hair in both sexes. This chest gland only occurs in specimens from northern German East Africa northward to Somaliland and Abyssinia. In the north, however, we find *revoili* and its allies without the chest gland and a similar condition is found in all the *rupestris* allies of the Zambesia and South African region. The forms called *pulcher, somalicus, boranus, dundasi,* and *peasei* are all races of *rufescens* and of only subspecific value. These appear to be very well separated as a group from the other members of the genus by the possession of the peculiar chest gland.

PETRODROMUS SULTANI SANGI, new subspecies

Taita Giant Elephant Shrew

Type from the summit of Mt. Mbololo, 4,000 ft. altitude, Taiti Hills, British East Africa; adult male; No. 181822, U. S. Nat. Mus.; collected by Edmund Heller, November 9, 1911; original number, 4698.

Characters.—Differs from *sultani* of the coast district by lighter coloration, the median dorsal region being raw umber rather than bister and the lowerparts cream-white instead of ochraceous-buff as in *sultani.* Skull, smaller, with the posterior ends of the nasal bones deeply sunk between the raised borders of the maxillary bones.

Coloration.—Median dorsal area, from interorbital region to base of tail, raw umber bordered on sides of body by olive-gray which gradually merges into buff along lower sides of body; hind limbs buffy like the sides, the feet cinnamon; fore legs buffy like sides, the feet ochraceous-buff. Tail black, at base on lower side for a short distance buff; armed along its lower margin by a row of long stiff-knobbed bristles; crown of head raw umber, the same color continued as a median stripe to the tip of the proboscis, a broad stripe of same color through eye from base of whiskers to behind ear, eye bordered above and below by a wide line of cream-buff, and base of ears encircled by a border of same color; cheeks olive-gray; ears blackish, covered by a few short tawny hairs; underparts white, on sides somewhat cream-buff but everywhere sharply defined against the buff of the lower sides; hair everywhere slate at base except on chin and forethroat where it is uniform cream-buff to the roots.

Measurements.—Head and body, 190 mm.; tail, 123 (tip missing); hind foot, 56; ear, 34.

Skull: Occipito-nasal length, 53; condylo-basal length, 52.5; zygomatic breadth, 29.5; interorbital width, 8; nasals, 21 x 4; upper molar series, 10; width of palate at m^2, 10.3; mandible length, 42; height from angle to coronoid process, 18.3.

Only the type was secured in the Taita Hills, but three specimens from the same region secured by R. Kemp and now in the British Museum agree well with the type in coloration. A large series from Mazeras are also of the same light color while the type and the specimens from the Shimba Hills in the British Museum collection are quite dark. The large series of specimens examined demonstrate conclusively that the female is distinctly darker bellied than the male, being quite ochraceous-buff below while the male is whitish or at most cream-buff.

This large insectivore is known to the Duruma tribe as sangi. They are an article of diet with these negroes who catch them in snares set along their runways in the forests.

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A STUDY OF THE SALINITY OF THE SURFACE WATER IN THE NORTH PACIFIC OCEAN AND IN THE ADJACENT ENCLOSED SEAS

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PREFACE

During the 1906 cruise of the United States Fisheries steamer "Albatross" in the North Pacific Ocean and in the Bering, Okhotsk, Japan, and Eastern Seas, I devoted considerable attention to the question of the salinity of the water through which the ship passed. Though much has been accomplished, thanks chiefly to the activity of the Russian Admiralty, in the working out of the conditions along the Asiatic shores and, thanks to the ships of the German merchant marine, both steam and sail, in the elucidation of the conditions from Seattle southward, very little has been done on the American side north of Puget Sound and in the Bering Sea; therefore particular pains were taken to make the records for this area especially complete.

Water specimens were taken by the quartermaster at 8 a. m. and at 8 p. m., and at once put into 18 oz. crown glass bottles which were tightly corked. As a rule samples of the surface water were also taken whenever the ship was stopped for dredging.

On account of the motion of the ship and because of the great amount of other more pressing work to be done it was not possible to work out the density of the water specimens at sea. They were therefore allowed to accumulate in the laboratory until a harbor or quiet anchorage was reached when the accumulation was disposed of.

The variation in the reading of my salinometers resulting from changes in temperature was not known. But any error arising from such variation was eliminated so far as possible by taking the readings always in approximately the same temperature, the water samples being stored in a room in which the temperature was at all times fairly constant.

There are three important sources of error involved in the method of storing water samples in cork stoppered soft glass bottles until such time as determination is possible. The water will dissolve a certain amount of the glass, thus increasing the density; irregularities from this source, however, are probably negligible so far as my results are concerned, because of the large probable error involved in the method used. Again the date and time of day, or the station number, were written on paper labels and placed in the water; of course the sizing and certain other of the constituents of the paper and of the pencil lead dissolved out, increasing the salt content of the water; but the labels used were of uniform size and composition, and the amount of writing was always the same so that approximately the same error is involved in each reading and may be considered as compensated in the general correction applied. The third source of error lies in the evaporation through and around the corks; occasionally there is an evident discrepancy due to this cause (as for instance in Nos. 9 and 12), but ordinarily the error was probably so small as to be, in view of the probable error as calculated, negligible. In the rough northern waters it was often necessary to retain water samples for several days; but here it was cold and damp and evaporation was reduced to a minimum; in the south determinations could be made much more frequently, and this source of error was largely eliminated.

The apparatus used in determining the specific gravity of the water was Hilgard's ocean salinometer, and the specific gravities were all reduced to the standard temperature of 60° Fahr. (15°.56 C.). The tables employed in this reduction are given in the Report of the Commissioner of Fish and Fisheries for 1883 (1885), p. 78.

The standard used by Makaroff in his work was $S\frac{17.5°}{17.5°}$, he having been induced to recalculate his observations to this standard because of its very general use among oceanographers of other nations, especially by the Germans. In his monograph he includes the salinity records for the Pacific determined by the "Challenger" and other ships recalculated to $S\frac{17.5°}{17.5°}$ from the original figures.

The standard used by the Bureau of Fisheries has generally been $S\frac{15.56°}{15.56°}$, though on one or two of the earlier cruises it appears to have been $S\frac{15.56°}{4°}$, corresponding to that of the "Challenger."

In the following calculation of an empirical correction for my figures no account is taken of the difference between $S\frac{15.56°}{15.56°}$ and $S\frac{17.5°}{17.5°}$ for the reason that such slight differences as exist (Professor Krümmel gives an average of -0.00013 for the difference between $S\frac{15.56°}{15.56°}$ and $S\frac{17.5°}{17.5°}$) are pracitically constant between the extremes recorded on this cruise.

In this paper I have employed figures representing the specific gravity of the water rather than the amount of dissolved salts expressed in grammes per liter for the reason that almost all of the previous records for the area under consideration are so given, and therefore the use of the older method renders my figures more readily comparable with those of previous observers.

Absolute accuracy is not claimed for the figures representing the specific gravities herein recorded; indeed the author is well aware that absolute accuracy cannot possibly be secured by the method used under the limitations imposed by a voyage of this character. Nansen has shown the difficulties in the way of salinity determination by salinometer, even with the precautions taken by him, and in the case of my determinations and subsequent calculations the taking of any but the most obvious precautions meant the expenditure of a considerable amount of time and thus became impossible. But the figures have a distinct comparative value and, in the absence of other data for much of the region covered, may be taken as affording an approximate index of the conditions in the seas traversed by the ship.

As my time was too fully occupied in other work to permit of my devoting my personal attention to it, the greater part of the actual determination of the densities was done by Mr. Leonard M. Tongue, the clerk of the ship, under my supervision. Mr. Tongue's familiarity with the instruments and his conscientious devotion to the scientific work of the ship combined to make his calculations reliable within a comparatively small limit of personal error.

In addition to surface specimens, samples of water were, so far as possible, taken at the same time from the circulating pump the intake of which is about four feet below the surface. This water was drawn from the tap in the laboratory, enough water being first allowed to run off entirely to clear the pipe from the laboratory to the sea. It was not believed that the modification of the water on its passage through this pipe, which was constantly in use, could be sufficient to be detected by the method used in the determination of the specific gravities.

Many of the salinity determinations taken at the surface during this cruise are included, without correction or comment, in the dredging and hydrographic records of the cruise (Bureau of Fisheries Document No. 621, 1907, pp. 1-50). It was necessary in distributing our zoölogical material for study to provide each of our collaborators at the same time with the data of each dredge haul. Immediately upon our return to San Francisco, therefore, Mr. Tongue compiled these records from our undigested notes taken at sea.

THE LIMITS OF ERROR IN THE OBSERVATIONS

There were fifty observations taken on the water from the circulating pump; in three instances these readings were identical with those taken from water dipped from the surface (Nos. 24, 64 and 73); in twenty-four instances they were greater, as follows:

No. 1:	0.00044	No. 57:	0.00005
(No. 9:	0.00286)	No. 60:	0.00030
No. 18:	0.00020	No. 62:	0.00010
No. 19:	0.00003	No. 66:	0.00016
No. 25:	0.00006	No. 81:	0.00003
No. 27:	0.00018	No. 91:	0.00004
No. 28:	0.00023	No. 93:	0.00008
No. 29:	0.00003	No. 94:	0.00056
No. 32:	0.00014	No. 97:	0.00092
No. 40:	0.00009	(No. 99:	0.00207)
No. 46:	0.00005	No. 124:	0.00008
No. 51:	0.00003	No. 129:	0.00021

and in twenty-three instances less, as follows:

No. 2:	0.00042	No. 42:	0.00011
No. 4:	0.00030	No. 43:	0.00015
(No. 5:	0.00119)	No. 50:	0.00003
No. 7:	0.00035	No. 61:	0.00005
No. 10:	0.00041	No. 72:	0.00016
No. 11:	0.00065	No. 83:	0.00010
(No. 12:	0.00385)	No. 84:	0.00006
No. 13:	0.00023	No. 86:	0.00006
No. 22:	0.00019	No. 92:	0.00019
No. 30:	0.00009	No. 110:	0.00023
No. 41:	0.00041	No. 115:	0.00038
		No. 120:	0.00018

In the cases in which the reading from the circulating pump was greater than that from the surface water (excluding No. 9 in which the surface reading, from rain or some other cause, is obviously abnormally low; and No. 99 in which the reading from the circulating pump, probably because of evaporation, is obviously too high) we find a variation between 0.00092 (No. 97) and 0.00003 (Nos. 19, 29, 51 and 81), with a mean of 0.00018.

In the cases in which the reading from the circulating pump was less than that from the surface water (excluding Nos. 5 and 12 in which the surface reading is obviously too high) we find a variation between 0.00065 (No. 11) and 0.00003 (No. 50), with a mean of 0.00022.

The fact that the variation was plus in twenty-four instances and minus in twenty-three with no variation in three, that there is no correlation between the variation and the latitude, and that the average of all the variation (+0.00018−0.00022) is −0.00004, a quantity altogether too small to be detected by the instruments used, shows that in reality the difference in the water at the surface and a few feet below it is entirely negligible, not falling within the scope of possible detection by the instruments used.

This being so we have a personal and fortuitous error of 0.00018+0.00022=0.00040 to take into consideration so that, under the best of conditions we must admit of a possible variation of ±0.00020 from the truth. This shows graphically the absolute insignificance of the figures in the fifth decimal place and their entire dependence upon chance.

THE REJECTION OF INACCURATE READINGS.

Assuming that the readings from the surface and from the circulating pump are, so far as lies within the power of our instruments to detect, the same, we are able to compare the two readings and in many cases to reject one of them as probably less accurate than the other. Where two readings were taken those which are probably the most nearly correct are (discarding the insignificant fifth decimal) as follows:

No. 1:	1.0212	No. 50:	1.0253
No. 2:	1.0257	No. 51:	1.0253
No. 4:	1.0259	No. 57:	1.0253
No. 5:	1.0256	No. 60:	1.0254
No. 7:	1.0257	No. 61:	1.0253
No. 9:	1.0251	No. 62:	1.0253
No. 10:	1.0252	No. 64:	1.0253
No. 11:	1.0218	No. 66:	1.0253
No. 12:	1.0252	No. 72:	1.0252
No. 13:	1.0243	No. 73:	1.0252
No. 18:	1.0244	No. 81:	1.0248
No. 19:	1.0250	No. 83:	1.0251
No. 22:	1.0250	No. 84:	1.0252
No. 24:	1.0250	No. 86:	1.0253
No. 25:	1.0250	No. 91:	1.0253
No. 27:	1.0254	No. 92:	1.0253
No. 28:	1.0253	No. 93:	1.0253
No. 29:	1.0252	No. 94:	1.0254
No. 30:	1.0252	No. 97:	1.0260
No. 32:	1.0247	No. 99:	1.0263
No. 40:	1.0253	No. 110:	1.0261
No. 41:	1.0254	No. 115:	1.0261
No. 42:	1.0254	No. 120:	1.0257
No. 43:	1.0253	No. 124:	1.0258
No. 46:	1.0253	No. 129:	1.0260

CALCULATION OF THE CONSTANT REPRESENTING THE INSTRUMENTAL ERROR

During the cruise of the "Albatross" among the Philippine Islands two hundred and twenty-one observations of the surface density were taken, with the instruments which I myself had used in 1906; these observations show considerable variation, but the average is 1.024533.

There were also taken on the same cruise eighty observations of the salinity below 100 fathoms; these likewise exhibit a considerable amount of variation, and give an average of 1.025048.

The records for the eighty-four observations taken among the Philippine Islands below the surface are in detail as follows:

34	fms.	1.02386
50	"	1.02523
78	"	1.02516
96	"	1.02551
102	"	1.02451
105	"	1.02496
108	"	1.02476
118	"	1.02496
122	"	1.02526
140	"	1.02482
148	"	1.02597
148	"	1.02506
150	"	1.02513
150	"	1.02513
155	"	1.02509
159	"	1.02517
162	"	1.02421
170	"	1.02489
172	"	1.02359
173	"	1.02468
174	"	1.02513
177	"	1.02496
178	"	1.02523
178	"	1.02496
180	"	1.02510
186	"	1.02510
191	"	1.02489
193	"	1.02517
193	"	1.02467
195	"	1.02447
198	"	1.02468
201	"	1.02538
208	"	1.02456
212	"	1.02593
214	"	1.02354
215	"	1.02465
218	"	1.02485
218	"	1.02468
220	"	1.02509
220	"	1.02500
224	"	1.02525
225	"	1.02492

230	fms.	1.02490
231	"	1.02513
234	"	1.02484
244	"	1.02482
248	"	1.02517
249	"	1.02482
258	"	1.02516
265	"	1.02430
272	"	1.02421
280	"	1.02517
295	"	1.02482
299	"	1.02502
300	"	1.02495
310	"	1.02543
312	"	1.02484
340	"	1.02454
375	"	1.02576
379	"	1.02521
380	"	1.02459
393	"	1.02480
394	"	1.02468
411	"	1.02475
422	"	1.02566
450	"	1.02556
494	"	1.02522
502	"	1.02457
515	"	1.02523
524	"	1.02538
525	"	1.02577
530	"	1.02467
554	"	1.02497
564	"	1.02533
565	"	1.02505
584	"	1.02535
604	"	1.02441
612	"	1.02516
638	"	1.02492
730	"	1.02564
745	"	1.02548
775	"	1.02606
958	"	1.02516
1804	"	1.02574

The averages are:

0-100	fms.	1.02494
100-150	"	1.02505
150-200	"	1.02482
200-250	"	1.02487
250-300	"	1.02480
300-350	"	1.02494
350- 400	fms.	1.02501
400- 450	"	1.02532
450- 500	"	1.02522
500- 600	"	1.02514
600- 700	"	1.02483
700-1804	"	1.02561

Comparing the known average density of the surface water of the Philippine archipelago, about 1.02675, with the average of the observations taken by the "Albatross," 1.02453, we find the latter to be 0.00222 too low. Possibly part of the difference is due to the excess of salinities taken near the shore in the "Albatross" records.

Comparing the known average density of the deep water of the Pacific, 1.02650, with the average of the eighty observations taken by the "Albatross" below 100 fathoms, 1.025048, we find the latter to be 0.00145 too low. A glance at the records suggests that the difference really is somewhat greater, for the water bottles evidently did not always contain water from the depth to which they were submerged.

A similar comparison of the densities as given by Makaroff, and as determined by myself in the same localities at six well separated places show my observations as calculated to be too low by 0.00136, 0.00184, 0.00215, 0.00210, 0.00115 and 0.00175.

If we average these differences between the observations taken on the "Albatross" and those taken by the British, German, Swedish and Russian ships we will get a correction which, when applied to the former, will make them comparable to the latter, or at any rate nearly enough so for the purposes of the present study. The average of these eight differences is 0.00175, which is the correction which will be used throughout this paper. The average of my six observations which are comparable to those of Makaroff, all of which were calculated by the same observer, is 0.00173.

On plotting my observations, corrected by comparison with the determinations of Makaroff on the western side of the Pacific upon a chart, I found that one of my stations was almost on the exact spot occupied by a station recorded by Lenz, in the Gulf of Alaska, and I was gratified to find that the salinity given by Lenz, and my own determination of the salinity with the empirical correction added, were identical.

It will be noticed that all of the salinity records published by Mr. Alexander Agassiz for the mid-Pacific region which were taken on board the "Albatross" are in need of about the same correction to make them comparable with those of the ships of other nations.

The necessity for this correction arises from the fact that the instruments were not standardized before being used.

BRIEF RESUMÉ OF THE CONDITIONS FOUND IN THE NORTH PACIFIC

For our knowledge of the water densities and of the temperatures of the North Pacific we are chiefly indebted to the late Vice-Admiral S. O. Makaroff of the Russian Navy. Not only did he take an enormous number of observations of his own, beginning in 1866 as a naval cadet and from that time almost constantly until his death on the "Variag," but in an exhaustive monograph published in 1894,[1] he summarized and digested all the work of the others who had taken observations in that area, republishing, often with certain corrections calculated by himself, all their data.

The following account of the conditions in the Pacific is chiefly a summary of that given by Makaroff.

Speaking broadly, there is found in the trade wind belt of the western part of the Pacific, a zone of warm water with a high salinity; water with a density of more than 1.0270 is only found in this zone and along the equator; beyond this area as far as the Philippines and Japan, and approaching the equator in a broad curve around it to the eastward, we find water having a density of from 1.0265 to 1.0270. Corresponding to latitude 42° to 46° N. we find water with a density of from 1.0255 to 1.0260; this approaches the coast of California where it mingles with the coast water and, taking a direction toward the southsouthwest, forms a cuneiform area within the area of water of higher salinity. It is probable that this area of low salinity (which lies to the southward of the Hawaiian Islands) is narrower in August than in March, and also that it is then situated more to the southward. This zone corresponds to the so-called California current.

The surface water to the northward of the zone with density ranging from 1.0255 to 1.0260 has a density of from 1.0250 to 1.0255, and Makaroff believed it probable that the larger part of the surface water of the Bering Sea lies within these extremes (see beyond, p. 17).

The mean specific gravity of the surface water of the Pacific (excluding the enclosed seas) is 1.0264.

The specific gravity of the lower levels over the entire Pacific is everywhere the same; the average is 1.0265.

The "Challenger" found near the antarctic ice at 50 fathoms a specific gravity of 1.0265, or the same as the mean for the deep water

[1] "Vitiaz" i Tikhii Okean; Le "Vitiaz" et l'Océan Pacifique. St. Pétersbourg, 1894.

of the Pacific; Makaroff believes that the water of the deeper layers in the Pacific comes originally from the Antarctic Ocean, an hypothesis which finds much support in the zoögeography of the Pacific region.

The specific gravity of the water of the Philippines and of the Sulu and Celebes Seas is much less than that of the adjacent parts of the Pacific.

In order to appreciate the significance of the varying salinities in the North Pacific and in the enclosed seas bordering upon it some attention must be given to the circulation of the water in the region and to the course and interrelationships of the various currents found there.

The largest of these currents, and by far the most important, is the warm current from the south carrying water of high salinity, known as the Kuro-Siwo or Japanese current, and corresponding in a general way to the so-called Gulf Stream of the western Atlantic. On reaching the coasts of Japan and the peninsula of Korea the Kuro-Siwo divides into three parts; the principal part advances along the southern coast of Japan; the second enters the Sea of Japan through the straits of Korea and forms the so-called Tsu-Shima current; the third turns to the westward and resembles in its general characteristics a similar branch which is given off from the Kuro-Siwo south of Formosa. It is not yet definitely known just what direction this branch takes; but as Makaroff found in running from the Chu-San archipelago to Nagasaki a water with a very high specific gravity it seems probable that this branch, after describing a broad curve, turns toward the south in the same manner as does the branch given off south of Formosa.

The Tsu-Shima current does not occupy the entire width of the Korean Straits, for there is a zone of cold water with a low specific gravity along the Korean Coast which is part of a similar zone occupying the entire western part of the sea of Japan. On entering the Sea of Japan through the Korean Straits the Tsu-Shima current turns to the right and runs northeastward along the Japanese coast. It is probable that this current influences the salinity of the entire southeastern part of the Sea of Japan.

Observations have shown that near Dajelet Island at a depth of 100 meters the cold water is sharply separated from the warm water which here is shoved downward, forming a deep current beneath the superficial water of low salinity flowing southward from the north.

The Tsu-Shima current, advancing toward the northeast, reaches the Strait of Tsugaru, through which a large amount of water flows to the eastward from the Sea of Japan to the Pacific. Continuing further toward the northeast the greater part of what remains of the Tsu-Shima current flows through the Strait of La Pérouse into the Sea of Okhotsk, and a comparatively small portion continues northward along the west coast of Sakhalin.

The salinity of the surface water in the Strait of La Pérouse is greatly diminished by an admixture of fresh water from rain and snow, but at depths greater than 25 meters it is found to be the same as that of the water passing through the Korean Strait.

The principal branch of the Kuro-Siwo which follows the southern coast of Japan passes with great swiftness through van Dieman Strait, and thence runs parallel to the coast only touching the extremities of the capes which extend furthest outward from the southern shore, Siwo-Misaki, Kawatsu, etc. It does not enter any of the gulfs or bays. In winter its limits are readily recognized by the high temperature and the high specific gravity, but in summer they can be determined only by the latter.

The salinity of the water of the Inland Sea is much less than that of the neighboring parts of the Pacific or of the Sea of Japan; Makaroff found it to be in January 1.02527, in May 1.02544 and in June 1.02632, the average being 1.0252; the "Challenger" found the average salinity of the eastern part in May to be 1.02375.

The Kuro-Siwo only follows the coast of Japan as far as Cape Inaboïe Saki, at that point turning to the east. Many observations made on vessels running between Kamchatka and Japan have proved that in the later summer months the warm water extends much further to the northward than the parallel of Cape Inaboïe Saki though, judging from the specific gravities, the northern limit of the Kuro-Siwo scarcely passes 40° N. At that latitude the surface water of the Kuro-Siwo turns to the eastward, and has a specific gravity of less than 1.0260. However, water with a specific gravity of 1.0260 is found in the deeps of the Bering Sea and reaches to within 200 meters of the surface. It is to be noticed that in the Bering Sea the isotherms rise toward the east, so that we are justified in believing that the warm water approaches nearer the surface in the eastern than in the western part.

In the Sea of Japan the heavy water, which is borne by the Tsu-Shima current, turns to the eastward; but it does not at all points touch the island of Nipon as it is deflected by a moderately strong current of small salinity which comes from the Inland Sea, entering the Sea of Japan by the Straits of Shimonoseki. This heavy water in flowing northward along the coasts of Nipon, Yezo and Sakhalin very gradually becomes less and less saline.

Near the Siberian coast, water with a specific gravity of from 1.0250 to 1.0255 descends from north to south, washing the whole coast of the western part of the Sea of Japan and making itself felt even in the Korean Strait.

The specific gravity of the water in the Sea of Japan is higher than that in corresponding latitudes in the Pacific; in going from Hakodate to Vladivostok the specific gravity diminishes rapidly west of 134° and near Vladivostok is about 0.0011 less than in the Strait of Tsugaru.

The mean specific gravity of the water of the Sea of Japan, both at the surface and in the deeper portions, is 1.0260.

Tracing a line from the Bay of St. Olga to the middle of the Korean Strait we find that in the western part the specific gravity, both at the surface and below, does not pass 1.0260. The heavy water which enters the Strait of Korea occupies in width more than half the strait, and its entire depth; further northward, however, the thickness of the heavy layer does not exceed 100 meters. Water with a specific gravity of more than 1.0262 is only found in the eastern part of the sea.

The Strait of La Pérouse includes two zones of water of different salinities and temperatures. In the southern part there is a warm current which descends toward the east near the coast of Yezo, and in the northern part, near the coast of Sakhalin, there is a cold current running toward the westward out of the Sea of Okhotsk. The line of separation between these two currents is not vertical but strongly inclined; the water from the Sea of Okhotsk, lighter and colder, advances in a mass having a cuneiform section over the warmer, but also heavier, water of the eastern part of the Sea of Japan which passes downward and, turning to the right on account of the rotation of the earth, extends far toward the northeast under the cold water. This water from the Sea of Japan has a specific gravity of 1.0260, and a temperature of 19° C. in August; it is probable that in winter the temperature does not fall below 3° C.

The surface water of Aniva Bay, in southern Sakhalin, has a specific gravity of 1.0245; for a while in August its temperature may be as much as 17° C., but the rest of the year it is much lower.

Under the upper layer of comparatively warm water is a cold layer with a specific gravity of 1.0254.

On account of the quantity of water which flows through the Korean Strait and raises the surface of the Sea of Japan and that of the Gulf of Tartary above that of the surrounding seas the bulk of the water from the Amur River, instead of turning to the right and flowing to the southward as would naturally be expected, turns to the north, though part of it comes southward along the western shore of the Gulf of Tartary where it causes a considerable diminution of the salinity. In this gulf the water of the lower layers near Sakhalin, below 40 meters, has a higher specific gravity than that near the continent. In the upper layers there is no regularity in the variations so that they are probably the result of the action of winds, local currents, tides, etc.

Almost the entire central portion of the Sea of Okhotsk has a specific gravity between 1.0245 and 1.0250; near the coasts the water is in general less saline. In the Bay of Oudsk and near Sakhalin the specific gravity is less than 1.0230, showing the influence of small rivers which empty into the southwestern part of the Sea of Okhotsk, and especially of the Amur. Krusenshtern found near the northern end of Sakhalin water with a specific gravity of 1.0130.

The deeper water of the Sea of Okhotsk is more dense than that nearer the surface; at a depth of 800 meters it has a specific gravity of 1.0261, or the same as that of the water which enters through the Strait of La Pérouse. As in the Bering Sea this lower stratum of warm water with high salinity is found at a greater depth in the west than in the east, for in both seas there is, along the western coast, a cold current of low salinity which submerges to a great depth the warm water with high salinity. Makaroff believed that the water of the Sea of Okhotsk enters that sea by way of the Strait of La Pérouse and not from the Pacific.

The mean density of the water of the Sea of Okhotsk and of all its bays is 1.0242.

Among the Kuril Islands the surface water is mixed with heavier and much colder water than that occurring on the coast of Kamchatka, the greatest degrees of salinity and cold being midway between Kamchatka and Japan and not at the northern end of the chain; this heavy and cold water forms a broader belt on the Pacific than on the Okhotsk Sea side of the islands; it was supposed by Makaroff to be in reality water from the great depths of the Okhotsk

Sea which is here forced to the surface through the pressure of the deep current of warm heavy water which enters the Okhotsk Sea through the Strait of La Pérouse. It may be, however, that this explanation is not quite correct, and that the presence of this abyssal water among the Kuril Islands is to be accounted for rather by the application of Ekmann's hypothesis.

Relatively warm water with a specific gravity of 1.0260 is found in the depths of the Bering Sea, reaching to within 200 meters of the surface; it is found much nearer the surface at the Commander Islands than along the coast of Kamchatka, a phenomenon similar to that observed in the Sea of Okhotsk. It is to be remarked that in the Bering Sea the isotherms rise toward the eastward as one leaves the Kamchatkan coast so that we are justified in believing that the warm water approaches nearer the surface in the eastern part than in the western, though there is no evidence that the specific gravity is higher in the former.

The layer of warm surface water along the coast of Kamchatka is very shallow, and observations on this coast prove the existence of an intermediate zone of cold water, just as in the western part of the Sea of Okhotsk; determinations made in latitude 60°-62° N. show that the specific gravity is still low at a depth of 150 meters which induces us to suppose that here the water is influenced by the water of the Arctic Ocean and is not directly connected with the warm water of the more southern latitudes.

At Port Clarence, Alaska, the specific gravity of the deeper water is from 1.0136 to 1.0216, much less than in the middle of the Bering Strait or in the Arctic Ocean. The "Vega," on her course across the Bering Strait from Port Clarence to Simavine, found that the specific gravity rose a little, the value being the same from the surface to the bottom; beyond longitude 171° W. the specific gravity of the surface water became much less than that of the deeper layers, while the temperature was also lower at all depths.

In the Bering Strait the more saline water occurs on the western side; the comparatively warm water which enters the Arctic Ocean on the eastern side is strongly mixed with the water from the Alaskan rivers and shows no trace at any depth of the water of the Kuro-Siwo which apparently does not reach this point.

Observations made near the coast of Asia in latitude 63° 16′ N. showed the presence of an intermediate layer of cold water similar to that observed near the coast of Kamchatka.

A water of low salinity descends to the southward near the coast of Kamchatka, and apparently continues down the Kuril chain; further from the coast the water of the Bering Sea has a salinity of about 1.0250, corresponding to the latitude.

METEOROLOGICAL CONDITIONS TENDING TO LOWER THE COMPARATIVE SALINITY OF THE PACIFIC

Professor Krümmel has shown that the Pacific is less saline than the Atlantic, the difference between them being comparatively slight in the southern hemisphere, but very considerable in the northern. A preliminary examination of the data available for the portion of the north Pacific north of Puget Sound shows that the low salinity of this area is much more marked on the eastern than on the western side. Professor Woekoff has explained the increased salinity of the Atlantic by the constant loss of water from the Atlantic and from the Atlantic water sheds through the operation of constant westerly winds which, passing across Europe, Asia and Africa, charged with Atlantic water, deposit it in the interior basins of those continents which have no connection with the oceans, and even in the Asiatic water shed of the Pacific itself. The Pacific loses no water in this way on account of the high mountains which form an almost unbroken barrier along its eastern shores.

THE SEASONAL VARIATION IN THE SALINITY OF THE WATER OFF THE CALIFORNIAN COAST

A preliminary examination of the salinity records obtained by the "Albatross" off the Californian coast, with the necessary corrections applied, shows a most interesting condition. In the summer the isohalines, upon reaching the vicinity of the Californian coast, bend abruptly to the northward and run more or less parallel with the shore, this effect being noticeable nearly to Puget Sound. In the winter this distortion of the isohalines disappears, and they then run to the coast almost exactly along the parallels of latitude.

Dr. Thorade has worked out in great detail the seasonal variation in temperature for the Californian coast, and he finds that the isotherms near the coast bend downward and run far to the southward in summer, but become more or less coincident with the parallels of latitude in winter. He has explained the phenomenon as resulting from the upwelling of abyssal water along the Californian coast in summer, this upwelling decreasing and practically disappearing in winter. His explanation of the coldness of the coast strip as a result of the upwelling of abyssal water presumes that this cold water should also be exceptionally saline, and therefore that the isohalines should bend abruptly to the northward just as the isotherms bend abruptly to the southward, while in the winter both isotherms and isohalines should follow courses more nearly agreeing with the parallels of the latitude. My observations on the seasonal variations in the salinity of this coast agree absolutely with his on the temperature.

The charts published by Makaroff show that in the mid-Pacific, between 170° and 180° W. long. the mean isohaline of 1.0255 runs approximately along the 46th parallel, and the isohaline of 1.0260 is approximately in 42° 50′ N.; the 1.0250 isohaline is far up in the Gulf of Alaska where it runs parallel to the coast, crossing the meridian of 140° W. in about 56° N. From these positions there is a slight southerly movement in winter, and in a corresponding northerly movement in summer.

In the summer the isohaline of 1.0250, running in a generally southerly direction, turns northward at about 42° 15′ N. lat., 127° W. long., joining the coast of Cape Moares, in 45° 30′ N. lat. The isohaline of 1.0255 turns northward at 37° N. lat., 127° W. long., and runs thence almost directly north between the meridians of 125° 30′ W. and 125° 00′ W. (practically coinciding with the latter north of 41° N. lat.) for a considerable distance, eventually turning eastward and reaching the coast at Cape Blanco. The isohaline of 1.0257 rises in a broad curve from 34° 40′ N. lat., 133° W. long. to 36° 30′ N. lat., 123° 30′ W. long., and then turns rather abruptly northward and northwestward, running parallel to the coast to 39° N., when it gradually turns northward again, reaching the coast at Cape Mendocino. The noticeable feature of this isohaline is the broad seaward bend which, considered in its relation to the coast line, reaches its maximum in the latitude of San Francisco, and its actual maximum westerly extension in 39° N. lat. In the San Francisco region there is a small area with a salinity of less than 1.0255 bounded by a curve of large radius extending from Point Arena (just south of 39° N. lat.) on the north to Pescadero Point (about 37° 15′ N. lat.) on the south. This curve crosses 38° N. in 123° 30′ W., and 123° W. in 37° 30′ N., its course being almost parallel to that of the 1.0257 line further off shore. The isohaline of 1.0260 turns northward at 33° N., 125° W., and runs in a broad curve northnortheast to Monterey Bay.

In the winter the isohalines east of 133° W. run approximately along the parallels of latitude, rising only slightly near the coast; the isohaline of 1.0255 rises from 33° 50′ N. lat., 124° W. long to Point Sal, north of Point Conception; the isohaline of 1.0257 runs from 33° N. 123° W. to Santa Barbara; and the isohaline of 1.0260 run from 32° 20′ N. 121° W. to Encinitas, just north of San Diego.

THE BERING SEA

A preliminary examination of the American records available for the Bering Sea shows a rather interesting condition, though one which is essentially what would be predicated from a survey of the land and submarine contours and of the drainage systems.

Makaroff showed the isohaline of 1.0250 running from 45° N. lat. 150° E. long. nearly in a straight line (with a slight regular convexity toward the east) to Bering Island, then turning more to the eastward and running (again with a slight convexity toward the southeast) to about lat. 61° N., long. 180° WE.; from this point he was unable to trace it further owing to an absence of data. It appears from the records at hand that here it turns abruptly to the southward running as far as lat. 55° N. which it crosses in long. 179° 20′ W., then making a broad sweep toward the east, crossing lat. 54° N. at long. 177° 30′ W., reaching lat. 53° 35′ N. in long. 174° 30′ W., and, continuing the same curve, crossing lat. 55° N. again in long. 171° 25′ W.; here it turns abruptly toward the NNW., crossing lat. 55° N. in long. 171° 55′ W., and reaching lat. 55° 50′ in long. 171° 55′ W., curving sharply about and coming southward again in a course parallel to that taken going north and about thirty miles to the eastward (forming a long narrow finger toward the NNW., lying chiefly between long. 171° W. and long. 172° W.) as far as lat. 54° 25′ N. long. 170° 30′ W. where it gradually turns eastward, after long. 169° W. running between lat. 54° 05′ N, and lat. 54° 10′ N. to long. 167° 05′ W. where it turns abruptly south and then west, running WSW. nearly in a straight line to Uliaga in the Islands of Four Mountains.

We thus see that the water with a specific gravity of 1.0250 or more is entirely confined to that part of the Bering Sea west of long. 167° W., while except for a narrow strip just north of the Andreanof Islands, the Islands of Four Mountains, Unmak and western Unalaska, it lies to the west of long. 179°. It therefore lies entirely in the deep western part of the sea, its southeastern extremity showing a curious approximate coincidence with the 1000 fathom line.

The westerly position of this water of comparatively high salinity which enters the Bering Sea from the southward is evidently governed by the breadth and depth of the channels. Between Kamchatka and the Commander Islands it lies beneath the colder and less saline water flowing southward along the Kamchatkan coast, this superficial layer progressively decreasing in thickness toward the east and allowing the heavier and warmer water to reach the surface at Bering Island. The broad deep channel between the Commander and western Aleutian Islands allows of the passage of great quantities of Pacific water, but the large Andreanof Islands with the narrow channels between them form a barrier so that little is able to flow by them. Between the Andreanof Islands and Umnak, however, there are again broad open channels, inluding the Amukta Pass, and these allow of the passage of enough water to form to the northward the long finger above described, and the somewhat similar finger stretching toward the east nearly to long. 167° W.

The general configuration of the area of high salinity in the western part of the Bering Sea suggests that it is not a constant, but rather an intermittent flow, for were it constant, one would scarcely expect to find it extending itself by such long and narrow processes as occur north, and again east, of the Amukta Pass, or failing to reach the shores of islands upon which the precipitation is not by any means sufficient to keep it away.

It is quite possible that we have in the Bering Sea a condition comparable to that shown by Cleve, Ekmann and Pettersson to exist in the Norwegian Sea, and that there is a yearly pulsation due to a variation in the height of the level of the north Pacific, reaching the maximum in November and the minimum in March, by which the flowing of the surface water of the Pacific through the Aleutian channels is increased during the late spring, summer and early autumn, decreasing in the winter and early spring. While the flow of water of comparatively high salinity from the Pacific into the Bering Sea is undoubtedly constant, and toward the western part of the sea always strong, its eastward extension is probably governed by an annual variation, expanding and contracting with more or less regularity.

Toward the eastern part of the Bering Sea the density decreases very slowly; the 1.0240 line crosses long. 164° W. in lat. 57° 30′ N., running toward the southeast; crossing long. 163° W. in lat. 55° 15′ N. it turns south running to a point fifteen miles north of Point Blaine on the Alaska peninsula, then turns southwest and follows the coast to Cape Mordvinof on Unimak where it reaches its southwestern limit.

South of the Alaska peninsula the 1.0250 line runs in a northeast-southwest direction slightly to the northwest of lat. 54° N. long. 158° W.

SYNOPSIS OF THE SALINITIES OBSERVED DURING THE 1906 CRUISE OF THE "ALBATROSS"

Locality	Observation No.	Density
Near San Francisco Bay	(1)	1.0212
From San Francisco to the Columbia River	(2-10)	1.0255
Off the Columbia River	(11)	1.0218
Off Clearwater, Washington	(12)	1.0252
Strait of Juan de Fuca	(13)	1.0243
At Tacoma	(14)	1.0211
Strait of Georgia	(15)	1.0214
Union Bay, Vancouver Island	(16-17)	1.0221
Queen Charlotte Sound	(18)	1.0224
Provost I. to long. 145° W.	(19-26)	1.0250
Long. 145° W. to long. 158° W.	(27-30)	1.0253
South of the Shumagin Is.	(31)	1.0240
Eastern end of the Aleutian Is.	(32-33)	1.0247
Near Bogosloff	(34)	1.0250
Unimak to Seguam	(35-38)	1.02525
Atka to Semisopochnoi	(39-42)	1.0254
South Central Bering Sea	(43-52)	1.0253
Vicinity of Semisopochnoi Is.	(53-55)	1.0254
South of Amchitka	(56)	1.0250
Kyska to Copper (Myedni) Island	(57-68)	1.0253
Copper I. to and about Bering I.	(69-76)	1.0252
Between Bering I. and Kamchatka	(77-78)	1.0250
Near Starichkof I.	(79-80)	1.0246
Off Cape Asacha, Kamchatka	(81)	1.0248
About southern Kamchatka	(82-86)	1.0252
Vicinity of Simushir, Kurils	(87-90)	1.0255
Urupp, Kurils, to Cape Yerimo, Yezo	(91-95)	1.0253
Strait of Tsugaru	(96)	1.0255
Eastern part of the Sea of Japan	(97-104)	1.0260

Locality	Observation No.	Density
Toyama Bay (1.0216-1.0261)	(105-114)	1.0253
Near Waijima	(115)	1.0261
Komatsu to Kioga Saki	(116-124)	1.0256
Oki Is.	(125-126)	1.0255
Between Oki Is. and Hornet I. (Liancourt Rocks)	(127)	1.0252
Between Oki Is. and Hornet I.	(128)	1.0258
South of Hornet I. and Matsushima I.	(129-131)	1.0261
Coast of Korea, and the Korean Straits to Tsu-Shima and Ikki-Shima	(132-139)	1.0248
South of Hirado I. and near Nagasaki	(140-141)	1.0253
South of Goto Is.	(142)	1.0252
South of Goto Is. and West of Koshiki I.	(143-148)	1.0247
West of Uji-Shima and South of Kusakaki-Shima	(149-151)	1.0252
South of Tanega-Shima	(152-153)	1.0262
West of Tanega-Shima	(154)	1.0257
Off Kagoshima Gulf	(155)	1.0251
In Kagoshima Gulf	(156)	1.0239
Van Dieman Strait, and eastward to the Inland Sea	(157-162)	1.0261
Inland Sea	(163-164)	1.0241
South of the Kii Channel	(165)	1.0259
In Oshima-Ko	(166)	1.0238
Off Oshima-Ko and South of Hamamatsu	(167-172)	1.0257
Near No-Shima	(173)	1.0259
Northeast of Choshi	(174)	1.0254
From Choshi to Tsugaru Strait	(175-179)	1.0255
From Iwanai Bay to Rebunshiri I., and west of Southern Sakhalin	(180-183)	1.0258
Eastern part of the Gulf of Tartary	(184-185)	1.0256
Aniva Bay, Sakhalin Island	(186)	1.0245
Near Cape Siretoko	(187)	1.0243
Southeastern Sakhalin to Cape Patience	(188-191)	1.0235
Sea of Okhotsk	(192)	1.0239
Sea of Okhotsk	(193)	1.0245
Sea of Okhotsk	(194)	1.0247
Sea of Okhotsk	(195)	1.0256
Sea of Okhotsk	(196)	1.0255
South of Kunashir and Otsu Saki	(197-198)	1.0253
Near Cape Yerimo, Yezo	(199)	1.0252
Off Urakawa and west of Urakawa	(200-201)	1.0258
From southeast of Mororan to Sendai	(202-204)	1.0254
Off Sendai	(205)	1.0259
Northeast of Choshi	(206)	1.0249
Vicinity of No-Shima	(207-208)	1.0255
Suruga Gulf	(209-215)	1.0250
Off Suruga Gulf	(216-218)	1.0256
West of Nii Jima	(219)	1.0254
Sagami Bay	(220-221)	1.0253

NARRATIVE

Our first observation, made not long after leaving San Francisco Bay, showed water of a comparatively low density (1.0212), possibly indicating the influence of the bay water. From Marin county to the mouth of the Columbia River we passed through water varying in density from 1.0251 to 1.0259, with an average of 1.0255; this variation was probably due to our crossing closely approximated isohalines running more or less parallel to the shore line, though possibly part of it was due to the effect upon the surface water of the various rivers which enter the ocean along this coast. Off the mouth of the Columbia River the density was, as would naturally be expected, very low (1.0218); it rose to 1.0252 further north and fell to 1.0243 in the Straits of Fuca.

At Tacoma, in the Straits of Georgia, and at Union Bay, Vancouver Island, the density was low, ranging between 1.0211 (at Tacoma) and 1.0221 (at Union Bay), on account of the drainage from the land; but in Queen Charlotte Sound we found it to be again about the same (1.0244) as it was in the Straits of Fuca.

From the Queen Charlotte Sound as far as long. 145° W. the density was very uniform (1.0250); at that point a slight rise was noted (1.0253) which was maintained to long. 158° W., beyond which locality, in the vicinity of the Shumagin Islands, it dropped to 1.0240, rising again south of the eastern end of the Aleutian chain to 1.0247.

Near Bogosloff the density was slightly greater (1.0250), and on the course from Unimak to Siguam a further slight increase was noticed, which was augmented between Atka and Semisopochnoi. In the south central part of the Bering Sea the density was very slightly less, but on returning to the vicinity of Semisopochnoi we found the same figure which we had previously observed between Atka and Semisopochnoi. Our observation south of Amchitka is rather low, and may possibly be incorrect. Between Kyska and Copper Island the readings were the same as those in the south central Bering Sea (1.0253), and slightly less than those between Atka and Semisopochnoi. From Copper Island to and about Bering Island a slightly lessened density (1.0252) was noted, and a further decrease was observed between Bering Island and Kamchatka (1.0250).

Near Starichkof Island a comparatively low density was found (1.0246), which rose off Cape Asacha (1.0248) and again about the southern extremity of Kamchatka where, both in the Pacific and in the Okhotsk Sea, it was again the same as between Copper and Bering Islands (1.0252).

In the vicinity of Simushir the salinity was notably high (1.0255), falling again on the course between Urupp and Cape Yerimo, Yezo, to the same figure we had observed in the south central Bering Sea and between Kyska and Copper Islands (1.0253).

In the Strait of Tsugaru the same density was observed as in the vicinity of Simushir (1.0255), but we found it greatly increased in the eastern part of the Sea of Japan (1.0260).

In Toyama Bay we determined salinities ranging from 1.0216 (in the southern part) to the normal salinity for the eastern part of the Sea of Japan, 1.0260 (in the more northern part). Near Waijima we found the same salinity as in the same general region further to the north (1.0261); but between Komatsu and the Oki Islands it was considerably less (1.0256), and we noted a further drop in the vicinity of the Oki Islands (1.0255).

Between the Oki Islands and Hornet Island (Liancourt Rocks), we determined two quite different readings, 1.0252 and 1.0258, while south of Hornet Island and south of Matsushima we found the high density characteristic of the east coast of the Sea of Japan (1.0261).

Along the Korean coast and in the Korean Strait about Tsu-Shima and Ikki-Shima we found water of a very low density (1.0248), which was the same as that previously observed off Cape Asacha, Kamchatka, and in general comparable to that along the east Kamchatka coast. South of Hirado Island and near Nagasaki the density was greater (1.0253), and was the same as that in the south central Bering Sea, between Kyska and Copper Islands and along the southern Kurils, and almost the same as that between the Oki Islands and Hornet Island. South of the Goto Islands and west of Koshiki Island (except in one spot in the former locality where we found a density of 1.0253, or practically the same as that south of Hirado Island and near Nagasaki) the density was 1.0247, or approximately the same as that along the Korean coast and about Tsu-Shima and Ikki-Shima. West of Uji-Shima and south of Kusakaki-Shima the density was about the same as that south of Hirado Island and near Nagasaki (1.0252), and the same as that about southern Kamchatka.

South of Tanega-Shima the salinity became much higher (1.0262), reaching about the same figure as in the eastern portion of the Sea of Japan. West of Tanega-Shima it was less (1.0257), and off Kagoshima Gulf much less, while within Kagoshima Gulf we found the water comparable to that in Toyama Bay, though only one observation (1.0239) was taken.

In van Dieman Strait and along the coast to the Inland Sea the same density (1.0261) was found as near Waijima and generally in the eastern part of the Sea of Japan.

The two observations in the Inland Sea showed a water of low salinity (1.0241); but south of the Kii channel we found again approximately the same salinity as that normal for the Japanese current (1.0259).

In the little land-locked harbor of Oshima-Ko the water was quite fresh (1.0238), while in the vicinity of that harbor and south of Hamamatsu we found it somewhat less saline than in the Japanese current (1.0257).

Near No-Shima the salinity rose to 1.0259, and on our journey northward along the east coast of Japan to the Strait of Tsugaru we found the density varying between 1.0252 and 1.0258, with an average of 1.0255.

In Iwanai Bay and in Ishikan Bay on the west coast of Yezo, and west of Rebunshiri Island and southern Sakhalin, the salinity was comparatively high (1.0258), dropping further to the northward in the eastern part of the Gulf of Tartary to 1.0256. Our single observation in Aniva Bay in southern Sakhalin gave 1.0245, while off Cape Siretoko we found 1.0243. Between Cape Siretoko and Cape Patience the salinity varied between 1.0243 and 1.0227, the average being 1.0235, and on our course between Cape Patience and the southeastern corner of the Sea of Okhotsk it rose regularly through 1.0239, 1.0245 and 1.0247 to 1.0256 and 1.0255, falling to 1.0253 south of Kunashir and south of Otsu-Saki, and to 1.0252 off Cape Yerimo. Off Urakawa and west of Urakawa we found a salinity of 1.0258, southeast of Mororan to Sendai a salinity of 1.0254, while another observation off Sendai gave 1.0259. Northeast of Choshi we found a salinity of 1.0249, and in the vicinity of No-Shima a salinity of 1.0255.

As was to be expected the water in Suruga Gulf proved to be less saline than that of the open sea, especially in the more remote portions, varying from 1.0236 to 1.0256, with an average of 1.0250; off shore in this region we found 1.0256.

West of Nii Jima we found a salinity of 1.0254, and in Sagami Bay our two observations gave 1.0253.

AN OBSERVATION ON THE INTERMINGLING OF RIVER AND OCEAN WATER

It has long been known that the water from a shallow river upon entering the sea spreads out fan-like over the surface of the salt water for a very considerable distance with little intermingling. While dredging one day in Suruga Gulf we had striking optical evidence of the truth of this. Though the day was clear there had been during the preceding night heavy rains over the land and the rivers were all swollen and very muddy. It happened that one of the localities in which we wished to work was within the area covered by the extremely muddy water from a small river. The water was so muddy that small objects disappeared from view at a depth of a few inches. On hauling up the trawl a dark hole of clear black water was made through the muddy surface layer, which was then seen to be but a few feet in thickness.

COMPARISON OF OUR FIGURES WITH THOSE PREVIOUSLY PUBLISHED

As far as southern Kamchatka our figures agree very well with those of "Vega," "Vitiaz," "Variag" and "Predpriatie" for the same region. From this point our course was through territory for which there are no previous records, though the "Vitiaz" established a line of observations somewhat further to the eastward. We found the specific gravity of the water in the Kuril chain higher than would be expected, reaching a maximum in the middle of the group; these comparatively high figures undoubtedly represent a purely local condition, the result, as explained by Makároff, of the upthrust of the abyssal water of the Okhotsk Sea (or of the Pacific, or of both) to the surface.

About Yezo our figures again agree with those previously published. There are no records for the west coast of Nipon, and here our observations seem to indicate a belt of water of comparatively low salinity near the coast, probably a very thin and superficial layer resulting from the drainage from the land, intervening between the heavy water of the eastern part of the Sea of Japan and the shore line.

In the region of the Korean Straits and off the Korean coast our figures do not quite agree with those of Makaroff, though, generally speaking there is but little difference; our figures for southern and eastern Japan more nearly coincide with his.

On the west coast of Yezo, where no previous observations have been taken, we found water of a somewhat lesser density than is indicated for the region further off shore; this would naturally be expected, and agrees with the conditions found on the west coast of Nipon.

Along the coasts of Sakhalin our observations agree with those of the Russian investigators.

For the southern and southeastern part of the Sea of Okhotsk there are no previous records; we found conditions approximately what would be expected and, agreeing with our observations further to the northward, found a local area of comparatively high salinity near the Kuril chain.

TABLE SHOWING THE SPECIFIC GRAVITIES OF THE SEA WATER AS OBSERVED DURING THE 1906 CRUISE OF THE "ALBATROSS."

Serial No.	Date (1906)	Time of day	Latitude (N)	Longitude	General location	Specific gravity at surface	Specific gravity below surface	Specific gravity corrected by the addition of 0.00175		Accept'd specific gravity
								At surface	Below surface	
			° ′ ″	° ′ ″						
1	May 3	8.00 p. m.	37 54 30	122 51 40 W	Off Marin County, California.	1.01904	1.01946	1.02079	1.02121	1.0212
2	4	8.00 a. m.	....	....	....	1.02446	1.02404	1.02621	1.02579	1.0257
3	4	10.02 a. m.	39 18 00	123 58 00 W	About 20 miles off coast of Cal.	1.02387	....	1.02562	....	1.0256
4	4	8.00 p. m.	40 18 30	124 27 00 W	Off Point Gorda. Cal.........	1.02454	1.02424	1.02629	1.02599	1.0259
5	5	8.00 a. m.	41 09 00	124 50 00 W	Off Trinidad Head Cal......	1.02504	1.02385	1.02679	1.02560	1.0256
6	5	8.00 p. m.	41 50 30	124 42 40 W	Off Crescent City, Cal........	....	1.02406	....	1.02581	1.0258
7	6	8.00 a. m.	42 30 00	124 55 00 W	Off Goldbeach, Oreg.........	1.02395	1.02360	1.02570	1.02535	1.0257
8	6	8.00 p. m.	42 50 15	124 52 00 W	Off Cape Blanco, Oreg.......	1.02360	....	1.02535	....	1.0254
9	7	8.00 a. m.	43 35 00	124 35 00 W	Off Empire, Oreg............	1.02050	1.02336	1.02225	1.02511	1.0251
10	7	8.00 p. m.	44 47 50	124 08 20 W	Off Yaquina Head, Oreg.....	1.02389	1.02348	1.02564	1.02523	1.0252
11	8	8.00 a. m.	46 10 00	124 07 30 W	Off the Columbia River......	1.02007	1.01942	1.02182	1.02117	1.0218
12	8	8.00 p. m.	47 35 30	124 31 00 W	Off Clearwater, Wash........	1.02352	1.01967	1.02527	1.02142	1.0252
13	9	8.00 a. m.	48 17 30	123 53 50 W	Strait of Juan de Fuca.......	1.02264	1.02241	1.02439	1.02416	1.0243
14	10	8.00 a. m.	....	....	Tacoma, Wash..............	....	1.01937	....	1.02112	1.0211
15	13	8.00 p. m.	48 52 30	123 06 30 W	Strait of Georgia............	....	1.01963	....	1.02138	1.0214
16	14	8.00 a. m.	....	....	Union Bay, Vancouver Island.	....	1.02038	....	1.02213	1.0221
17	14	8.00 p. m.	....	....	....do......................	....	1.02030	....	1.02205	1.0220
18	18	8.00 p. m.	51 15 00	129 32 00 W	Queen Charlotte Sound.......	1.02250	1.02270	1.02425	1.02445	1.0244
19	19	8.00 a. m.	51 54 00	132 23 30 W	Off Prevost Island...........	1.02327	1.02330	1.02502	1.02505	1.0250
20	19	10.21 a. m.	52 02 00	132 53 00 W	70 m. W. of Queen Charlotte I.	1.02310	....	1.02485	....	1.0249
21	19	8.00 p. m.	52 32 00	135 06 00 W	Off Moresby Island..........	1.02337	....	1.02512	....	1.0251
22	20	8.00 a. m.	53 01 00	138 01 30 W	Off Graham Island...........	1.02345	1.02326	1.02520	1.02501	1.0250
23	20	10.15 a. m.	53 05 00	138 31 00 W	....	1.02330	....	1.02505	....	1.0250
24	20	8.00 p. m.	53 28 00	141 02 00 W	W. of Queen Charlotte Islands	1.02330	1.02330	1.02505	1.02505	1.0250

25	May	21	8.00 a. m.	53 50 00	144 19 00 W	W. of Queen Charlotte Islands	1.02324	1.02330	1.02499	1.02505	1.0250
26		21	10.20 a. m.	53 53 00	144 53 00 W	....do......................	1.02333	....	1.02508	....	1.0250
27		21	8.00 p. m.	54 09 00	147 42 00 W	Gulf of Alaska..............	1.02370	1.02388	1.02545	1.02563	1.0254
28		22	8.00 a. m.	54 15 00	150 56 15 W	....do......................	1.02340	1.02363	1.02515	1.02538	1.0253
29		22	8.00 p. m.	54 10 00	154 41 00 W	S. of Kodiak Island, Alaska..	1.02347	1.02350	1.02522	1.02525	1.0252
30		23	8.00 a. m.	53 54 00	157 59 00 W	S. of Semidi Islands.........	1.02350	1.02341	1.02525	1.02516	1.0252
31		23	8.00 p. m.	53 56 00	160 24 00 W	S. of Shumagin Islands......	1.02225	....	1.02400	....	1.0240
32		24	8.00 a. m.	53 44 00	164 12 00 W	S. of Unimak................	1.02296	1.02310	1.02471	1.02485	1.0247
33		28	8.00 a. m.	54 03 30	166 44 00 W	Near Unalaska...............	1.02302	....	1.02477	....	1.0247
34		28	4.19 p. m.	53 57 00	168 06 00 W	Near Bogosloff Islands.......	1.02330	....	1.02505	....	1.0250
35		28	8.00 p. m.	53 52 00	168 33 00 W	N. of Unimak................	1.02359	....	1.02534	....	1.0253
36		29	8.00 a. m.	53 20 00	171 00 00 W	N. of Amukta Island.........	1.02350	....	1.02525	....	1.0252
37		29	2.22 p. m.	53 12 00	171 37 00 W	....	1.02350	....	1.02525	....	1.0252
38		29	8.00 p. m.	52 58 00	172 24 00 W	N. of Siguam Island.........	1.02357	....	1.02532	....	1.0253
39		31	8.00 a. m.	52 22 00	173 58 00 W	Near Atka...................	1.02365	....	1.02540	....	1.0254
40		31	8.00 p. m.	52 55 00	175 25 00 W	....do......................	1.02355	1.02364	1.02530	1.02539	1.0253
41	June	1	8.00 a. m.	52 32 00	177 35 00 W	N. of Kanaga................	1.02370	1.02329	1.02545	1.02504	1.0254
42		1	8.00 p. m.	53 58 30	179 43 00 W	N. of Semisopochnoi Islands.	1.02370	1.02359	1.02545	1.02534	1.0254
43		3	8.00 a. m.	54 07 30	179 02 30 E	South Central Bering Sea....	1.02355	1.02340	1.02530	1.02515	1.0253
44		3	9.54 a. m.	54 12 00	179 07 30 E	....do......................	1.02346	....	1.02521	....	1.0252
45		3	1.58 p. m.	54 20 30	179 09 30 E	....do......................	1.02361	....	1.02536	....	1.0253
46		3	8.00 p. m.	54 32 30	179 16 00 E	....do......................	1.02352	1.02357	1.02527	1.02532	1.0253
47		4	7.02 a. m.	54 30 00	179 17 00 E	....do......................	1.02361	....	1.02536	....	1.0253
48		4	8.00 a. m.	54 30 00	179 16 00 E	....do......................	1.02355	....	1.02530	....	1.0253
49		4	3.53 p. m.	54 33 30	178 44 00 E	....do......................	1.02355	....	1.02530	....	1.0253
50		4	8.00 p. m.	54 18 00	178 47 00 E	....do......................	1.02355	1.02352	1.02530	1.02527	1.0253
51		5	8.00 a. m.	52 44 00	179 29 00 E	N. of Semisopochnoi Islands.	1.02352	1.02355	1.02527	1.02530	1.0253
52		5	1.04 p. m.	52 11 00	179 43 00 E	Near Semisopochnoi Islands..	1.02359	....	1.02534	....	1.0253
53		5	1.35 p. m.	52 11 00	179 49 00 E	....do......................	1.02369	....	1.02544	....	1.0254
54		5	4.31 p. m.	52 11 00	179 57 00 W	....do......................	1.02375	....	1.02550	....	1.0255
55		5	8.00 p. m.	51 53 20	179 44 00 W	....do......................	1.02369	....	1.02544	....	1.0254
56		6	8.00 a. m.	51 11 00	179 02 00 E	S. of Amchitka Island........	1.02330	....	1.02505	....	1.0250
57		6	8.00 p. m.	51 30 00	177 00 00 E	S. of Kyska Island..........	1.02355	1.02360	1.02530	1.02535	1.0253
58		7	8.00 a. m.	51 51 00	174 39 00 E	SE. of Agattu Island........	1.02355	....	1.02530	....	1.0253
59		7	11.17 a. m.	52 01 00	174 39 00 E	....do......................	1.02350	....	1.02525	....	1.0253

TABLE SHOWING THE SPECIFIC GRAVITIES OF THE SEA WATER AS OBSERVED DURING THE 1906 CRUISE OF THE "ALBATROSS."—CONTINUED.

Serial No.	Date (1906)	Time of day	Latitude (N)	Longitude	General location	Specific gravity at surface	Specific gravity below surface	Specific gravity corrected by the addition of 0.00175		Accept'd specific gravity
								At surface	Below surface	
			° ′ ″	° ′ ″						
60	June 8	8.00 p. m.	52 25 00	173 49 00 E	E. of Agattu Island..........	1.02335	1.02365	1.02510	1.02540	1.0254
61	9	8.00 a. m.	52 33 00	173 58 00 E	S. of Semichi Islands	1.02359	1.02354	1.02534	1.02529	1.0253
62	11	8.00 p. m.	52 44 00	173 35 00 E	E. of Attu Island...........	1.02354	1.02364	1.02529	1.02539	1.0253
63	11	5.47 p. m.	52 55 40	173 26 00 E	....do......................	1.02354	....	1.02529	....	1.0253
64	12	8.00 a. m.	52 40 00	171 41 00 E	SW. of Attu Island..........	1.02354	1.02354	1.02529	1.02529	1.0253
65	12	4.18 p. m.	53 20 00	170 33 00 E	Off Attu Island.............	1.02354	....	1.02529	....	1.0253
66	12	8.00 p. m.	53 39 00	170 02 00 E	Between Attu and Copper I..	1.02354	1.02370	1.02529	1.02545	1.0253
67	13	8.00 a. m.	54 44 00	167 52 30 E	Near Copper Island..........	1.02357	....	1.02532	....	1.0253
68	14	8.00 a. m.	54 54 00	167 28 00 E	....do......................	1.02354	....	1.02529	....	1.0253
69	14	11.12 a. m.	54 49 45	167 12 30 E	....do......................	1.02340	....	1.02515	....	1.0251
70	14	2.52 p. m.	54 36 15	166 58 15 E	Near Bering Island..........	1.02354	....	1.02529	....	1.0252
71	14	3.30 p. m.	54 36 15	166 57 15 E	....do......................	1.02354	....	1.02529	....	1.0252
72	14	8.00 p. m.	54 39 30	166 36 30 E	Near Cape Manati, Bering I..	1.02364	1.02348	1.02539	1.02523	1.0252
73	15	8.00 a. m.	55 09 45	165 47 00 E	W. of Bering Island.........	1.02352	1.02352	1.02527	1.02527	1.0252
74	15	8.00 p. m.	....	....	Nikolskoi Bay, Bering Island.	....	1.02345	....	1.02520	1.0252
75	16	8.00 a. m.	54 58 00	165 21 00 E	W. of Bering Island.........	1.02352	....	1.02527	....	1.0252
76	16	10.14 a. m.	54 48 00	164 54 00 E	Nikolskoi Harbor, Bering I...	1.02364	....	1.02539	....	1.0253
77	16	8.00 p. m.	54 01 00	162 56 00 E	Bet. Bering I. and Avacha Bay	1.02325	....	1.02500	....	1.0250
78	17	8.00 a. m.	53 02 00	160 36 00 E	Off C. Chipunski, Kamchatka	1.02344	....	1.02519	....	1.0251
79	20	11.25 a. m.	52 47 00	158 43 00 E	Near Starichkof Island	1.02303	....	1.02478	....	1.0247
80	20	2.57 p. m.	52 37 30	158 50 00 E	....do......................	1.02293	....	1.02468	....	1.0246
81	20	8.00 p. m.	52 08 00	158 53 00 E	Off Cape Asacha, Kamchatka	1.02310	1.02313	1.02485	1.02488	1.0248
82	21	8.00 a. m.	50 52 00	156 46 00 E	E. of northern Paramushir...	....	1.02335	....	1.02510	1.0251
83	21	8.00 p. m.	51 27 00	155 56 00 E	W. of Kurile Lake, Kamchatka	1.02354	1.02344	1.02529	1.02519	1.0251

84	June	22	8.00 a. m.	50 04 00	154 03 00 E	W. of southern Paramushir..	1.02350	1.02344	1.02525	1.02519	1.0252
85		22	4.12 p. m.	49 06 00	153 06 00 E	Near Chirinkotan Island......	1.02354	....	1.02529	....	1.0252
86		22	8.00 p. m.	....	....	....	1.02360	1.02354	1.02535	1.02529	1.0253
87		23	8.00 a. m.	....	....	Off Milne Bay, Simushir.....	1.02364	....	1.02539	....	1.0254
88		24	10.37 a. m.	46 46 40	151 41 00 E	Near Simushir..............	1.02382	....	1.02557	....	1.0256
89		24	1.07 p. m.	46 42 00	151 45 00 E	....do.....................	1.02384	....	1.02559	....	1.0256
90		24	2.09 p. m.	46 42 00	151 47 00 E	....do.....................	1.02374	....	1.02549	....	1.0255
91		24	8.00 p. m.	46 10 00	150 58 00 E	E. of Urupp................	1.02348	1.02352	1.02523	1.02527	1.0253
92		25	8.00 a. m.	44 50 00	149 19 00 E	E. of Iturup................	1.02379	1.02360	1.02554	1.02535	1.0253
93		25	8.00 p. m.	43 41 00	147 43 00 E	E. of Shikotan..............	1.02354	1.02362	1.02529	1.02537	1.0253
94		26	8.00 a. m.	42 55 00	145 47 00 E	E. of Yezo..................	1.02316	1.02372	1.02491	1.02547	1.0254
95		26	8.00 p. m.	41 58 00	143 48 00 E	Near Cape Yerimo, Yezo.....	1.02359	....	1.02534	....	1.0253
96		27	8.00 a. m.	41 40 40	141 19 20 E	Tsugaru Strait..............	1.02379	....	1.02554	....	1.0255
97	July	17	8.00 a. m.	40 51 00	139 58 00 E	Near Aomori................	1.02418	1.02510	1.02593	1.02685	1.0260
98		17	8.00 p. m.	39 26 00	139 20 30 E	Near Tobi Shima............	1.02406	....	1.02581	....	1.0260
99		18	8.00 a. m.	38 33 00	138 40 00 E	N. of Sado Island...........	1.02458	1.02665	1.02633	1.02840	1.0263
100		18	9.29 a. m.	38 35 00	138 41 00 E	Near Sado Island...........	1.02447	....	1.02622	....	1.0262
101		18	11.07 a. m.	38 32 00	138 43 00 E	....do.....................	1.02385	....	1.02560	....	1.0256
102		18	3.59 p. m.	38 12 00	138 52 00 E	Near Niigata	1.02403	....	1.02578	....	1.0257
103		19	3.43 p. m.	37 37 00	138 19 00 E	Near Sado Island...........	1.02444	....	1.02619	....	1.0261
104		19	8.00 p. m.	37 33 00	138 12 00 E	S. of Sado Island...........	1.02443	....	1.02618	....	1.0261
105		20	8.00 a. m.	37 08 20	137 10 00 E	Toyama Bay.................	1.01989	....	1.02164	....	1.0216
106		21	10.04 a. m.	37 08 35	137 10 05 E	....do.....................	1.02199	....	1.02374	....	1.0237
107		21	4.11 p. m.	37 27 30	137 32 20 E	....do.....................	1.02413	....	1.02588	....	1.0258
108		21	4.53 p. m.	37 25 00	137 32 00 E	....do.....................	1.02403	....	1.02578	....	1.0257
109		21	8.00 p. m.	37 24 00	137 43 00 E	....do.....................	1.02437	....	1.02612	....	1.0261
110		22	8.00 a. m.	37 23 00	137 36 00 E	....do.....................	1.02441	1.02418	1.02616	1.02593	1.0261
111		22	8.06 a. m.	37 23 00	137 36 00 E	....do.....................	1.02420	....	1.02595	....	1.0259
112		22	9.54 a. m.	37 20 00	137 41 30 E	....do.....................	1.02427	....	1.02602	....	1.0260
113		22	11.13 a. m.	37 16 00	137 40 00 E	....do.....................	1.02413	....	1.02588	....	1.0258
114		22	1.47 p. m.	37 22 30	137 47 00 E	....do.....................	1.02431	....	1.02606	....	1.0260
115		22	8.00 p. m.	37 31 00	137 04 10 E	Near Waijima...............	1.02444	1.02406	1.02619	1.02581	1.0261
116		23	8.32 a. m.	36 14 30	135 56 30 E	Near Komatsu...............	1.02365	....	1.02540	....	1.0254
117		23	9.12 a. m.	36 13 40	135 56 30 E	....do.....................	1.02410	....	1.02585	....	1.0258
118		23	11.15 a. m.	36 03 30	135 54 00 E	Near Takefu................	1.02395	....	1.02570	....	1.0257

TABLE SHOWING THE SPECIFIC GRAVITIES OF THE SEA WATER AS OBSERVED DURING THE 1906 CRUISE OF THE "ALBATROSS."—CONTINUED.

Serial No.	Date (1906)	Time of day	Latitude (N)	Longitude	General location	Specific gravity at surface	Specific gravity below surface	Specific gravity corrected by the addition of 0.00175		Accept'd specific gravity
								At surface	Below surface	
			° ′ ″	° ′ ″						
119	July 23	1.06 p. m.	36 03 30	135 52 30 E	Near Takefu	1.02410	....	1.02585	....	1.0258
120	23	8.00 a. m.	36 14 40	135 56 30 E	Near Fukui	1.02400	1.02382	1.02575	1.02557	1.0257
121	23	1.21 p. m.	35 56 30	135 39 15 E	Wakasa Bay	1.02385	....	1.02560	....	1.0256
122	24	2.44 p. m.	35 57 45	135 34 00 E	....do	1.02392	....	1.02567	....	1.0256
123	24	4.09 p. m.	36 02 00	135 30 00 E	....do	1.02395	....	1.02570	....	1.0257
124	24	8.00 p. m.	36 04 00	135 02 30 E	Off Kioga Saki	1.02410	1.02418	1.02585	1.02593	1.0258
125	25	8.00 a. m.	36 11 00	133 24 30 E	Oki Islands	1.02375	....	1.02550	....	1.0255
126	26	9.30 a. m.	36 13 00	133 27 00 E	Near Dogo Island	1.02375	....	1.02550	....	1.0255
127	26	8.00 p. m.	36 43 30	132 23 30 E	Between Oki I. and Hornet I.	1.02347	....	1.02522	....	1.0252
128	27	8.00 a. m.	36 40 30	132 30 00 E	....do	1.02407	....	1.02582	....	1.0258
129	27	8.00 p. m.	36 56 00	132 00 00 E	S. of Hornet Island	1.02423	1.02444	1.02598	1.02619	1.0260
130	28	8.00 a. m.	37 29 00	131 13 00 E	S. of Matsushima	1.02448	....	1.02623	....	1.0262
131	29	8.00 p. m.	37 13 00	130 45 00 E	....do	1.02427	....	1.02602	....	1.0260
132	30	8.00 a. m.	36 06 30	129 50 00 E	Off Unkofski Bay, Korea	1.02340	....	1.02515	....	1.0251
133	30	8.00 p. m.	36 08 00	129 46 00 E	....do	1.02310	....	1.02485	....	1.0248
134	31	8.00 a. m.	36 17 00	129 40 00 E	....do	1.02335	....	1.02510	....	1.0251
135	31	8.00 p. m.	36 23 00	129 58 00 E	Off Yeng-hai, Korea	1.02310	....	1.02485	....	1.0248
136	Aug. 1	8.00 a. m.	36 32 00	129 58 00 E	....do	1.02299	....	1.02474	....	1.0247
137	1	8.00 p. m.	36 06 00	130 45 00 E	Between Korea and Oki I.	1.02302	....	1.02477	....	1.0247
138	2	8.00 a. m.	34 32 30	129 59 00 E	E. of Tsu-Shima	1.02320	....	1.02495	....	1.0249
139	2	8.00 p. m.	34 09 00	130 05 00 E	NE. of Iki-Shima	1.02237	....	1.02412	....	1.0241
140	3	8.00 a. m.	33 03 20	129 22 30 E	S. of Hirado I.	1.02372	....	1.02547	....	1.0254
141	8	8.00 p. m.	32 26 00	129 22 00 E	Near Nagasaki	1.02365	....	1.02530	....	1.0253
142	9	8.00 a. m.	32 26 30	128 36 30 E	S. of Goto Islands	1.02347	....	1.02522	....	1.0252

143	Aug.	9	8.00 p. m.	32 32 30	128 30 00 E	S. of Goto Islands	1.02313	......	1.02488	......	1.0248
144		10	8.00 a. m.	32 33 00	128 19 00 E	....do.	1.02293	......	1.02468	......	1.0246
145		10	8.00 p. m.	32 22 30	128 41 00 E	....do.	1.02300	......	1.02475	......	1.0247
146		11	8.00 a. m.	31 39 30	129 19 00 E	W. of Koshiki Island	1.02272	......	1.02447	......	1.0244
147		11	8.00 p. m.	31 38 00	129 26 00 E	....do.	1.02303	......	1.02478	......	1.0247
148		12	8.00 a. m.	31 38 30	129 19 00 E	....do.	1.02313	......	1.02488	......	1.0248
149		12	8.00 p. m.	31 13 20	129 21 40 E	W. of Uju-Shima	1.02347	......	1.02522	......	1.0252
150		13	8.00 a. m.	30 25 00	129 06 40 E	S. of Kusakaki-Shima	1.02351	......	1.02526	......	1.0252
151		13	8.00 p. m.	30 23 30	129 36 30 E	....do.	1.02351	......	1.02526	......	1.0252
152		14	8.00 p. m.	29 57 00	130 41 00 E	S. of Tanega-Shima	1.02454	......	1.02629	......	1.0262
153		15	8.00 a. m.	29 51 00	131 02 00 E	....do.	1.02464	......	1.02639	......	1.0263
154		15	8.00 p. m.	30 31 00	130 45 00 E	W. of Tanega-Shima	1.02402	......	1.02577	......	1.0257
155		16	8.00 a. m.	30 59 00	130 29 50 E	Off Kagoshima Gulf	1.02343	......	1.02518	......	1.0251
156		16	8.00 p. m.	....	....	Off Chirin Jima, Kagoshima G.	1.02216	......	1.02391	......	1.0239
157		21	8.00 a. m.	31 19 00	131 22 00 E	In van Dieman Strait	1.02437	......	1.02612	......	1.0261
158		21	8.00 p. m.	31 19 30	132 14 30 E	E. of van Dieman Strait	1.02432	......	1.02607	......	1.0260
159		22	8.00 a. m.	31 39 00	132 54 30 E	S. of Shikoku Island	1.02467	......	1.02642	......	1.0264
160		22	8.00 p. m.	32 32 00	132 39 00 E	S. Entrance, Bungo Channel	1.02425	......	1.02600	......	1.0260
161		23	8.00 a. m.	32 32 00	132 25 00 E	....do.	1.02415	......	1.02590	......	1.0259
162		23	8.00 p. m.	32 58 00	132 10 40 E	Bungo Channel	1.02428	......	1.02603	......	1.0260
163		24	8.00 a. m.	34 09 00	132 56 50 E	Inland Sea	1.02212	......	1.02387	......	1.0238
164		24	8.00 p. m.	34 17 30	133 33 45 E	....do.	1.02266	......	1.02441	......	1.0244
165		28	8.00 a. m.	33 51 45	135 02 45 E	S. of the Kii Channel	1.02419	......	1.02594	......	1.0259
166		28	....	....	....	In Oshima-Ko	1.02212	......	1.02387	......	1.0238
167		29	8.00 a. m.	33 25 00	135 42 10 E	Off Oshima-Ko	1.02396	......	1.02571	......	1.0257
168		30	8.00 a. m.	33 24 20	135 42 00 E	....do.	1.02385	......	1.02560	......	1.0256
169		31	8.00 a. m.	33 21 00	135 43 00 E	....do.	1.02408	......	1.02583	......	1.0258
170		31	8.00 p. m.	33 24 50	135 57 00 E	....do.	1.02402	......	1.02577	......	1.0257
171	Sept.	1	8.00 a. m.	34 04 30	137 48 00 E	S. of Hamamatsu	1.02412	......	1.02587	......	1.0258
172		1	8.00 p. m.	33 25 30	138 35 00 E	....do.	1.02395	......	1.02570	......	1.0257
173		14	8.00 p. m.	34 59 30	140 16 00 E	Near No-Shima	1.02424	......	1.02599	......	1.0259
174		15	8.00 a. m.	36 11 00	141 03 00 E	NE. of Choshi	1.02371	......	1.02546	......	1.0254
175		15	8.00 p. m.	37 33 30	141 28 30 E	S. of Sendai	1.02353	......	1.02528	......	1.0252
176		16	8.00 a. m.	38 49 00	142 02 00 E	Off Kesennuma	1.02374	......	1.02549	......	1.0254
177		16	8.00 p. m.	39 37 30	142 09 00 E	Off Nambu Minato	1.02394	......	1.02569	......	1.0256

TABLE SHOWING THE SPECIFIC GRAVITIES OF THE SEA WATER AS OBSERVED DURING THE 1906 CRUISE OF THE "ALBATROSS."—CONTINUED.

Serial No.	Date (1906)	Time of day	Latitude (N)	Longitude	General location	Specific gravity at surface	Specific gravity below surface	Specific gravity corrected by the addition of 0.00175		Accept'd specific gravity
								At surface	Below surface	
			° ′ ″	° ′ ″						
178	Sept. 17	8.00 a. m.	41 14 00	141 44 00 E	Off Idzuto	1.02414	......	1.02589	......	1.0258
179	18	8.00 p. m.	41 55 00	139 49 00 E	Off E. Entrance, Tsugaru St.	1.02398	......	1.02573	......	1.0257
180	20	8.00 a. m.	43 05 50	140 23 50 E	Iwanai Bay	1.02414	......	1.02589	......	1.0258
181	21	8.00 p. m.	43 43 30	140 57 00 E	Ishikari Bay	1.02414	......	1.02589	......	1.0258
182	22	8.00 a. m.	45 23 00	140 48 00 E	W. of Rebunshiri I.	1.02417	......	1.02592	......	1.0259
183	22	8.00 p. m.	46 02 30	141 29 00 E	W. of South'rn end of Sakhalin	1.02411	......	1.02586	......	1.0258
184	23	8.00 a. m.	47 39 00	141 24 00 E	......	1.02391	......	1.02566	......	1.0256
185	23	8.00 p. m.	47 05 30	141 40 40 E	......	1.02385	......	1.02560	......	1.0256
186	24	8.00 a. m.	46 03 20	142 24 30 E	Aniva Bay, Sakhalin	1.02275	......	1.02450	......	1.0245
187	25	8.00 p. m.	46 00 30	143 31 20 E	Near Cape Siretoko	1.02262	......	1.02437	......	1.0243
188	26	8.00 a. m.	46 46 00	144 00 00 E	......	1.02232	......	1.02407	......	1.0240
189	26	8.00 p. m.	47 00 00	144 10 40 E	......	1.02259	......	1.02434	......	1.0243
190	27	8.00 a. m.	48 33 00	145 05 30 E	......	1.02102	......	1.02277	......	1.0227
191	28	8.00 a. m.	48 41 30	144 57 30 E	......	1.02140	......	1.02315	......	1.0231
192	28	8.00 p. m.	47 52 00	145 36 30 E	......	1.02221	......	1.02396	......	1.0239
193	29	8.00 a. m.	46 24 00	145 42 00 E	......	1.02282	......	1.02457	......	1.0245
194	29	8.00 p. m.	45 52 50	145 50 00 E	......	1.02303	......	1.02478	......	1.0247
195	30	8.00 a. m.	44 30 00	145 35 00 E	......	1.02394	......	1.02569	......	1.0256
196	30	8.00 p. m.	44 26 00	145 52 00 E	S. part of Sea of Okhotsk	1.02384	......	1.02559	......	1.0255
197	Oct. 1	8.00 a. m.	43 38 40	145 57 00 E	S. of Kunashir	1.02361	......	1.02536	......	1.0253
198	1	8.00 p. m.	42 48 30	145 26 30 E	S. of Otsu Saki	1.02359	......	1.02534	......	1.0253
199	2	8.00 a. m.	41 53 00	143 20 00 E	Near Cape Yerimo	1.02354	......	1.02529	......	1.0252
200	2	8.00 p. m.	42 01 50	142 32 00 E	Off Urakawa	1.02411	......	1.02586	......	1.0258
201	3	8.00 a. m.	42 11 00	141 57 00 E	W. of Urakawa	1.02410	......	1.02585	......	1.0258

202	Oct.	3	8.00 p. m.	42 10 00	141 33 30 E	SE. of Mororan	1.02371	......	1.02546	......	1.0254
203		9	8.00 a. m.	38 51 30	142 02 00 E	E. of Kesennuma	1.02369	......	1.02544	......	1.0254
204		10	8.00 a. m.	38 15 15	141 38 30 E	Off Sendai	1.02365	......	1.02540	......	1.0254
205		10	8.00 p. m.	37 55 00	142 02 30 E	....do	1.02422	......	1.02597	......	1.0259
206		11	8.00 a. m.	36 14 30	141 15 00 E	NE. of Choshi	1.02316	......	1.02491	......	1.0249
207		11	8.00 p. m.	34 49 30	139 59 00 E	Off No-Shima	1.02382	......	1.02557	......	1.0255
208		12	8.00 a. m.	34 49 30	138 40 15 E	Near O-Shima	1.02390	......	1.02565	......	1.0256
209		13	8.00 a. m.	35 02 10	138 57 50 E	Suruga Gulf	1.02232	......	1.02407	......	1.0240
210		15	8.00 a. m.	35 02 10	138 38 00 E	....do	1.02194	......	1.02369	......	1.0236
211		16	8.00 a. m.	34 47 15	138 24 15 E	....do	1.02369	......	1.02544	......	1.0254
212		17	8.00 a. m.	34 52 00	138 36 40 E	....do	1.02369	......	1.02544	......	1.0254
213		17	8.00 p. m.	34 27 50	138 14 30 E	....do	1.02370	......	1.02545	......	1.0254
214		18	8.00 a. m.	34 36 00	138 25 30 E	....do	1.02370	......	1.02545	......	1.0254
215		19	8.00 a. m.	34 48 00	138 26 30 E	....do	1.02387	......	1.02562	......	1.0256
216		19	8.00 p. m.	34 14 00	138 07 30 E	Off Suruga Gulf	1.02387	......	1.02562	......	1.0256
217		20	8.00 a. m.	34 05 00	137 59 00 E	....do	1.02399	......	1.02574	......	1.0257
218		20	8.00 p. m.	34 06 30	138 05 30 E	....do	1.02391	......	1.02566	......	1.0256
219		21	8.00 a. m.	34 36 50	139 02 40 E	W. of Nii Jima	1.02369	......	1.02544	......	1.0254
220		22	8.00 a. m.	35 07 30	139 15 00 E	Sagami Bay	1.02357	......	1.02532	......	1.0253
221		23	8.00 a. m.	35 07 40	139 15 40 E	....do	1.02354	......	1.02529	......	1.0253

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NEW MAMMALS FROM THE HIGHLANDS OF SIBERIA

BY

N. HOLLISTER

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NEW MAMMALS FROM THE HIGHLANDS OF SIBERIA

By N. HOLLISTER

Through the interest and liberality of Dr. Theodore Lyman, of Harvard University, the United States National Museum was invited to coöperate with the Museum of Comparative Zoölogy at Harvard, in an expedition to the Altai Mountains, Siberia and Mongolia, during the summer of 1912. The object of the expedition, which was under the personal direction of Doctor Lyman, was to collect the mammals and birds of this region for the institutions interested; with the wonderful wild sheep of the Altai as a special incentive. The results were far beyond the expectations, and among the mammals are several new species, diagnoses of which are here given.

MYOPUS MORULUS, sp. nov.

Type from Tapucha,[1] Altai Mountains, Siberia. No. 175197, United States National Museum; skin and skull; adult ♂. Collected August 6, 1912, by N. Hollister, Orig. No. 4437.

General characters.—Size of *Myopus schisticolor;* coloration darker, more blackish; rusty dorsal area duller and extending forward between ears to center of head; sides and underparts unicolor. Audital bullæ smaller and flatter.

Color of type.—Face between eyes, cheeks, sides, and underparts dark slate gray; nose slightly lighter. Upperparts with rusty stripe from head, forward of ears, extending backward to near base of tail; becoming more intense in color posteriorly, and broadening to cover lower back between hips. Hands like sides; feet and tail black.

Skull and teeth.—Skull like that of *Myopus schisticolor* but with audital bullæ smaller and much flatter. Upper and lower teeth compressed laterally; the enamel loops rounder, and the teeth slightly smaller, though of about same length as in *schisticolor.* Incisors weaker.

Measurements of type.—Head and body, 86 mm.; tail vertebræ, 14; hind foot, without claw, 16. Skull: Condylobasal length, 22.7; nasals, 6.6; upper tooth row, 6.6.

[1] Tapucha is 125 miles southeast of Biisk, and 50 miles northwest of Ongudai, on the post road to Kosh-Agatch. The exact locality is 5 miles south of Tapucha, at 6875 feet elevation.

Remarks.—Only a single specimen of this interesting new species was collected. It was caught under a log in a mountain nut-pine forest, in a region of heavy rainfall. The skull was broken by the trap, but has been repaired so that the length and tooth-row measurements are virtually accurate. The discovery of a species of *Myopus* in the Altai goes far toward the fulfillment of Middendorff's prophecy that these lemmings would be found eventually to range across the continent; and his excellent account of the specimen from the coast of the Okhotsk Sea (Sibirische Reise, bd. 2, p. 108) seems, in the light of this find, convincing.

SICISTA NAPAEA, sp. nov.

Type from Tapucha, Altai Mountains, Siberia. No. 175195, United States National Museum; skin and skull; adult ♂. Collected August 6, 1912, by N. Hollister. Orig. No. 4427.

General characters.—A yellowish, unstriped species, nearest to *S. flava;* but differing conspicuously in having the ears brown, not black; and with smaller hind foot and shorter tail.

Color of type.—Above yellowish-buff, finely mixed with brownish; ears brown, with rufous spot above and below the base. Underparts pure cream-buff, brighter on lower belly and anal region. Hands and feet grayish-white, a rufous spot above heel. Tail distinctly bicolor; brown above, gray below.

Skull and teeth.—Skull about the size of that of *S. flava;* but with shorter rostrum and more inflated, rounded braincase; zygomata more spreading; auditai bullæ larger. Teeth essentially as in *flava.*

Measurements of type, compared with an adult male of *flava*, the latter in parentheses; Head and body, 73 mm. (76); tail vertebræ, 84 (118); hind foot, without claws, 16 (21). Skull of type: Condylobasal length, 18.5; occipitonasal length, 20; zygomatic breadth, 10.5; upper tooth row, crowns, 3.0.

Remarks.—The single specimen of this jumping mouse was caught in a thicket in a very damp piñon forest at 6875 feet elevation. This is doubtless the animal recorded by Kastschenko, from the Little Altai, as *Sminthus concolor* Büchner. The species seems closely related only to *flava.*

ALLACTAGA GRISESCENS, sp. nov.

Type from Chuisaya Steppe (8 miles south of Kosh-Agatch), Siberia. No. 175404, United States National Museum; skin and skull; adult ♀. Collected July 28, 1912, by N. Hollister. Orig. No. 4395.

General characters.—Like *A. mongolica*, but smaller and grayer, with much smaller skull.

Color of type.—General color of upperparts pale drab gray, more brownish on rump; sides light gray; sides of face and underparts, and rump stripes, pure white. Legs gray outside, white inside; arms, hands, and feet white. Tail brownish above for two-thirds its length, then band of grayish-white, band of black, and tip of pure white; below grayish-white, with black sub-terminal band and white tip.

Skull and teeth.—Skull like that of *mongolica*, but very much smaller, with broader rostrum; teeth smaller.

Measurements of type.—Head and body, 143 mm.; tail vertebræ, 183; hind foot, 66. Skull compared with skull of adult female *A. m. longior*, the latter in parentheses: Greatest length, 36 (39.5); condylobasal length, 34 (37.5); zygomatic breadth, 23.5 (26); upper tooth row, alveoli, 7.5 (8.4).

Remarks.—This new jerboa seems related only to *A. mongolica* and *A. m. longior*. It is possibly confined to the isolated Chuisaya Steppe. Two specimens were collected.

PHODOPUS CREPIDATUS, sp. nov.

Type from Chuisaya Steppe (eight miles south of Kosh-Agatch), Altai District, Siberia; altitude 7300 feet. No. 175480 United States National Museum; skin and skull; adult ♂. Collected July 28, 1912, by N. Hollister. Orig. No. 4393.

General characters.—Palms and soles completely haired. Externally resembling *P. songarus* and *P. campbelli*. Differs from *songarus* in absence of shoulder stripes, faintness or lack of median stripe on crown and nape, strong suffusion of buffy on sides and underparts, and much smaller, slenderer skull, with large audital bullæ. Differs from *campbelli* in shortness of the dorsal stripe, which stops abruptly on rump fully an inch from base of tail; tail buffy, not silvery white; and skull long and slender, with large audital bullæ.

Color of type.—Upperparts grayish wood-brown, the hairs wood-brown tipped with blackish; underfur dark slate; a narrow blackish stripe from between shoulders to rump. Lips and cheeks creamy white; ears dark brown and buffy outside, white inside. Tail buffy near root, tip and lower side white. Shoulders bright buff, the three light areas on body and entire underparts whitish, with strong suffusion of buffy.

Skull.—Skull smaller and narrower than a skull of *songarus* from Akmolinsk, Siberia, with greater interorbital breadth and much larger bullæ; of quite different proportions than skull of *campbelli;* longer and narrower; audital bullæ large.

Measurements of type.—Head and body, 102 mm.; tail vertebræ, 13; hind foot, 13.5, without claws. Skull: Greatest length, 27; condylobasal length, 25; zygomatic breadth, 13; nasals, 11.1; interorbital breadth, 3.7; breadth of braincase, 11.1; upper tooth row, 4.0.

Remarks.—A series of seventeen specimens of *Phodopus crepidatus* was collected. The species seems to have no nearer known relative than *P. campbelli,* from northeastern Mongolia, which it resembles much more than it does *songarus* of the Siberian plains. It inhabits the isolated Chuisaya Steppe, near the Mongolian border, between the Kurai Mountains and the frontier range.

OCHOTONA NITIDA, sp. nov.

Type from Tchegan-Burgazi Pass, Altai Mountains, Siberia (near Mongolian border, south of Kosh-Agatch). No. 175390, United States National Museum; skin and skull; adult ♀. Collected July 8, 1912, by N. Hollister. Orig. No. 4257.

General characters.—Differs from *Ochotona alpina,* its nearest relative, in smaller size, smaller skull, and darker coloration; with more dark reddish-brown and blackish above, and less yellowish below, in fresh fall pelage. Lining of ear cream-buff, not black as in *alpina;* soles of feet considerably darker, almost black.

Color.—Fresh fall pelage: General color of upperparts dark mummy brown, a mixture of russet and black; nose, cheeks, and area behind ear lighter. Ears outside blackish-brown; inside pale cream buff, with no black, a faint narrow band of brownish bordering the rim of buffy. Sides bright cinnamon, with less blackish and brown than back, blending into the pure cinnamon of lower sides and underparts. Hands and feet grayish-buffy, the soles of feet blackish, not brown as in *alpina.* Summer specimens in the long left-over winter coat are much lighter, and lack most of the blackish and cinnamon color. The underfur is broadly dark slate; the individual hairs banded with cream buff and tipped with black. The type specimen shows both pelages, the animal having renewed the coat on the forward half of body.

Measurements of type.—Head and body, 208 mm.; hind foot, 30. Skull: Occipitonasal length, 47.6; condylobasal length, 43.6; greatest breadth, 22.4; length of nasals, 15; least interorbital constriction, 5.1; length of upper tooth row, 8.5; lower tooth row, 8.5.

Remarks.—Pallas described his *Lepus alpinus* from the Altai and Kolywan region, east to Kamchatka. The eastern forms have long since been separated, and inasmuch as two apparently distinct species are found in the region between Kolywan and the Mongolian border, it becomes necessary to further restrict the type locality of *alpina*. The animal described and figured by Pallas, and later by Waterhouse, is unquestionably the northern, large skulled form, represented in the United States National Museum by a single specimen from Barnaul. The pikas from the higher Altais to the southward are smaller, with much smaller skulls; and differ conspicuously in general color, without the striking black inner ear of the northern form. It seems necessary, therefore, to restrict the type locality of *alpina* to the Kolywan and Barnaul region, where the species doubtless inhabits the outlying ranges of the northern Altai, and to provide a name for the pika of the Little Altai to the southeast. True *alpina* may range to that higher part of the Altai system to the southwest of the region inhabited by *nitida*,[1] but the uniform series of thirty-one specimens taken by us in the Tchegan-Burgazi Pass near the Mongolian border and in the forested mountains near Tapucha, would seem to indicate that *nitida* is the only species found in this general region. Pikas of the very different *dauurica* and *ladacensis* groups have been described by Thomas from a comparatively short distance to the southeast, on the Mongolian side of the range.

MUSTELA LYMANI, sp. nov.

Type from Tapucha, Altai Mountains, Siberia. No. 175198, United States National Museum; skin and skull; adult ♂. Collected August 10, 1912, by N. Hollister. Orig. No. 4494.

General characters.—A stoat related to *Mustela erminea*, but with summer pelage very much paler, the reddish-brown color entirely wanting; no white spot behind eye; underparts with only the faintest tinge of very pale yellow; tail long.

Color of type, summer pelage.—Upperparts, including arms above to wrist, and legs above to middle of foot, Isabella color; slightly darker on head and center of back; no white spot behind eye and ear only faintly rimmed with lighter color. Hands above from wrist, and terminal half of feet above buffy-white. Anterior half of tail

[1] There are probably no pikas in the immediate vicinity of Kolywan and Barnaul, the country being much too flat. The specimens probably came from some one of the outlying ranges of the Altai back from the Obi and northward from the "Little Altai", the type locality of *nitida*.

above, darker than general tone of back; below buffy at root, then yellowish-buff, then with band of brown; terminal half black above and below. Underparts of body, limbs, and feet, white, with very faint tinge of pale straw on arm pits and lower belly. Lips white.

Skull and teeth.—Skull almost precisely like skulls of *Mustela erminea* from Sweden. Teeth, especially upper molar, lower carnassial, and last lower molar, smaller than in *erminea*.

Measurements of type.—Head and body, 275 mm.; tail vertebræ, 103; hind foot, without claws, 43. Skull: Condylobasal length, 47.6; palatal length, 20; least interorbital constriction, 10.6; upper molar-premolar row, 11; lower molar-premolar row, 12.5.

Remarks.—This new stoat differs conspicuously from *Mustela erminea* in the color of the upperparts, and appears to resemble in that character the *Mustela erminea ferghanæ* of Thomas from Ferghana. From the latter species it differs, however, in its much greater size, less yellow in coloration below, the absence of a white spot behind eye, and the much longer tail, as well as in other minor details.

MYOTIS PETAX, sp. nov.

Type from Kosh-Agatch, Chuisaya Steppe, Altai District, Siberia; Altitude 7300 feet. No. 175189, United States National Museum; skin and skull; adult ♀. Collected July 30, 1912, by N. Hollister. Orig. No. 4412.

General characters.—Like *Myotis daubentonii* but slightly larger and less reddish-brown; skull larger and teeth actually smaller.

Color of type.—Above sepia, lacking the reddish-brown tint of *daubentonii* in good coat. Below white, the bases of hairs seal brown. White of underparts extending on cheeks *to base of ears.* Wings blackish-brown; interfemoral membrane dark brown above, much lighter below.

Skull and teeth.—Skull larger than in *M. daubentonii* (longer and with broader braincase, rostrum, and palate). Teeth smaller than in *daubentonii;* narrower, but with tooth row of about same length.

Measurements of type.—Head and body, 55; tail vertebræ, 37; hind foot, without claw, 10; forearm, 39.5. Skull: Greatest length, 14.5; zygomatic breadth, 9.2; least interorbital constriction, 4.2; breadth of braincase, 7.6; upper tooth row, including incisors, 6.1.

Remarks.—While this form may be found eventually to intergrade with true *daubentonii*, the relative size of skull and teeth, and the marked differences of color pattern and tone, do not warrant considering it at present a geographical race of that species. The type was captured in a house in Kosh-Agatch; far from cliffs or trees, on the steppe.

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A NEW SUBSPECIES OF CROSSBILL FROM NEWFOUNDLAND

BY

A. C. BENT

(Publication 2158)

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A NEW SUBSPECIES OF CROSSBILL FROM NEWFOUNDLAND

By A. C. BENT

While visiting Dr. Leonard C. Sanford's camp, on the Fox Island River in Newfoundland, on June 10, 1912, I noticed two Crossbills, which he had just collected, which were very evidently different from any specimen of this species that I had ever seen from eastern North America. I advised him to collect as many more as possible for study and comparison. He succeeded in securing eleven specimens in all which he has kindly lent me for description. After comparing these birds with all the material available in the collections of the American Museum of Natural History in New York, the United States National Museum and Department of Agriculture Biological Survey in Washington, I have decided to describe and name the new form, which so far as we know at present is confined, in the breeding season at least, to Newfoundland.

LOXIA CURVIROSTRA PERCNA, new subspecies

Newfoundland Crossbill

Type.—Adult male, Cat. No. 233930, U. S. Nat. Mus., Flatbay River, Newfoundland, July 21, 1912, Dr. L. C. Sanford.

Subspecific characters.—Similar to *Loxia curvirostra minor* (Brehm) but considerably larger and with a much larger and heavier bill; slightly larger than *Loxia curvirostra bendirei*, Ridgway; but somewhat smaller than *Loxia curvirostra stricklandi*, Ridgway. In general coloration darker than any of the American subspecies of *Loxia curvirostra;* the reds deeper, richer and more brilliant and the greenish yellow shades richer and brighter than in similar plumages of the other forms. Whereas in the summer plumages of other American forms we find only a few of the most highly colored birds with reds equalling flame scarlet, and most of them show only orange chrome or duller shades of red, with less brilliant greens and yellows; we find in *Loxia curvirostra percna* scarlet, scarlet vermilion, vermilion, poppy red or even geranium red of the most brilliant, glossy shades, with various brilliant shades of greenish yellow.

The names of the colors referred to above are taken from Ridgway's Nomenclature of Colors, edition of 1886. The following measurements of *Loxia curvirostra percna* were kindly made by Mr. J. H. Riley, who also made the measurements of the other forms which I have copied directly from Ridgway's Birds of North and Middle America.

MEASUREMENTS OF LOXIA CURVIROSTRA PERCNA

Locality	Date	Wing	Tail	Culmen	Depth of Bill
Seven Adult Males	1912	*mm.*	*mm.*	*mm.*	*mm.*
Fox Island River, Newfoundland	June 10	93.0	56.0	19.0	12.0
" " " "	July 13	94.0	54.5	18.5	11.0
" " " "	" 15	96.5	54.0	19.5	11.0
" " " "	" 15	95.5	56.5	19.0	11.5
Flat Bay " "	" 18	93.0	54.0	18.5	10.0
" " " "	" 20	92.0	56.5	18.0	11.0
" " " " Type	" 21	96.5	57.0	19.0	11.5
Four Adult Females					
Fox Island River, Newfoundland	June 10	90.5	53.0	18.0	10.5
" " " "	July 9	89.0	50.5	18.5	11.0
Flat Bay " "	" 20	91.5	52.0	17.5	11.0
" " " "	" 20	89.5	53.5	18.5	11.0

MEASUREMENTS OF LOXIA CURVIROSTRA MINOR

Locality	Wing	Tail	Culmen	Depth of Bill
Averages of Adult Males	*mm.*	*mm.*	*mm.*	*mm.*
Eight from coast of Oregon to Alaska....	85.09	48.26	15.49	9.91
Six from Massachusetts to Maine.........	89.41	52.58	17.27	10.16
Six from Nebraska (Omaha)	83.82	49.78	15.49	9.40
Averages of Adult Females				
Four from coast of Washington to Alaska	83.57	47.50	14.73	9.40
Four from Massachusetts to Maine.......	86.36	50.04	17.27	10.41
Three from Nebraska (Omaha)...........	82.30	45.97	15.75	9.65

MEASUREMENTS OF LOXIA CURVIROSTRA BENDIREI

Locality	Wing	Tail	Culmen	Depth of Bill
Averages of Adult Males	*mm.*	*mm.*	*mm.*	*mm.*
Fifteen from eastern Oregon............	92.96	52.32	17.78	11.43
Fourteen from California	92.20	53.59	19.30	11.43
Nine from Colorado.....................	91.44	51.56	18.29	.....
Averages of Adult Females				
Three from eastern Oregon	89.41	52.07	17.78	11.43
Four from California	88.90	49.53	18.03	10.67
Six from Colorado......................	86.36	49.02	17.78	10.16

MEASUREMENTS OF LOXIA CURVIROSTRA STRICKLANDI

Locality	Wing	Tail	Culmen	Depth of Bill
Averages of Adult Males	*mm.*	*mm.*	*mm.*	*mm.*
One from Guatemala	93.47	55.88	20.07	11.43
Five from Mexico	100.33	56.39	19.81	12.95
Seven from Arizona	97.79	55.88	19.81	12.45
Averages of Adult Females				
Two from Guatemala	90.93	.....	19.56	11.94
Three from Mexica	96.27	52.07	19.56	12.45
Four from Arizona	90.93	50.80	18.80	10.41

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 60, NUMBER 16

REMAINS IN EASTERN ASIA OF THE RACE THAT PEOPLED AMERICA

(With Three Plates)

BY

Dr. A. HRDLIČKA
Curator of the Division of Physical Anthropology, U. S. National Museum

(Publication 2159)

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REMAINS IN EASTERN ASIA OF THE RACE THAT PEOPLED AMERICA

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By DR. A. HRDLIČKA

CURATOR OF THE DIVISION OF PHYSICAL ANTHROPOLOGY, U. S. NATIONAL MUSEUM

During the summer of 1912 the writer visited, partly under the auspices of the Smithsonian Institution and partly in the interest of the Panama-Californian Exposition of San Diego, certain portions of Siberia and Mongolia in search for possible remains of the race that peopled America, and whose home, according to all indications, was in eastern Asia. Upon the return of the writer from his journey in September this brief report was presented at the International Congress of Prehistoric Anthropology and Archeology at Geneva.

The journey extended to certain regions in southern Siberia, both west and east of Lake Baikal, and to Mongolia as far as Urga. It furnished an opportunity for a rapid survey, from the anthropological standpoint, of the field and conditions in those regions, and was made in connection with a prolonged research into the problems of the ethnic nature and origin of the American aborigines carried on by the writer on this continent.

The studies of American anthropologists and archeologists have for a long time been strengthening our opinion that the American native did not originate in America, but is the result of a comparatively recent, post-glacial, immigration into this country; that he is physically and otherwise most closely related to the yellow-brown peoples of eastern Asia and Polynesia; and that in all probability he represents, in the main at least, a gradual overflow from north-eastern Siberia.[1]

If our views concerning the origin of the Indian and his comparatively late coming into America be correct, then it seems there ought to exist to this day, in some parts of eastern Asia, archeological remains, and possibly even survivals, of the physical stock from which our aborigines resulted. For it could have been no small people that

[1] For a summary of these opinions see "The Problems of the Unity or Plurality and the Probable Place of Origin of the American Aborigines" in The American Anthropologist, Vol. 14, No. 1, January-March, 1912.

sent us in the course of several thousand years the various more pronounced sub-types of the American Indian, which according to all indications have developed outside of America. As a matter of fact, we have searched and watched for evidence concerning such remains for many years, and every publication that dealt with archeological exploration in eastern Asia or brought photographs of the natives, has in one way or another strengthened our expectations.

No archeologic work on an adequate scale, however, and no comprehensive anthropologic investigation of the natives of eastern Asia, have as yet been carried out, and in consequence many points on which light was needed remained uncertain.[1] Under these circumstances the writer was very desirous to visit personally at least a few of the more important parts of eastern Asia, to observe what was to be found there, and to determine what should be done in those regions by anthropologists and archeologists interested in the problem of the identity and origin of the American Indian.

An opportunity to undertake something in this direction came at last during the present year; but the means were limited and necessitated a restriction of the trip to the more important and at the same time more accessible territory. The choice was made of certain parts of south-eastern Siberia and of northern Mongolia, including Urga, the capital of outer Mongolia, which encloses two great monasteries and is constantly visited by a large number of the natives from all parts of the country. Besides the field observations a visit was also made to the various Siberian museums within the area covered, for the purpose of seeing their anthropological collections.

It will not be possible to enter here into details of the journey and I shall, therefore, restrict myself to mentioning in brief the main results. Thanks to the Russian men of science and the Russian political as well as military authorities, my journey was everywhere facilitated, I was spared delays, was shown freely the existing collections, and received much valuable information.

I have seen, or been told, of thousands upon thousands of as yet barely touched burial mounds or "kourgans", dating from the present time back to the period when nothing but stone implements were used by man in those regions. These kourgans dot the country about the Yenisei and its affluents, about the Selenga and its tributaries.

[1] It is only fair, however, that attention be called here to the Bogoraz and Jochelson work among the natives of Northern Siberia, as a part of the Jessup Expedition, for the American Museum of Natural History, New York City. Regrettably this work did not extend far enough to the south.

along the rivers in northern Mongolia, particularly the Kerulen, and in many other parts regarding which reliable information could be obtained. The little investigation that has been made of these remains is due, in the main, to Adrianov and his colleagues at Minusinsk, and especially to Professor Talko-Hryncewitz of Krakow, who was for many years the government physician at Kiachta. The mounds yield, according to their age, implements of iron, copper, bronze, or stone, occasionally some gold ornaments, and skeletons. The majority of these "kourgans" date doubtless from fairly recent times, corresponding to Ugrian or Turk or "Tatar[1]" elements, and to the modern Mongolian, and the skeletons found in them show mostly brachycephalic skulls, which occasionally resemble quite closely American crania of the same form. The older kourgans, on the other hand, particularly those in which no metal occurs, yield an increasing number of dolichocephalic crania, in which close resemblances with the dolichocephalic skulls of the American Indians are very frequent. To what people these older remains belong is as yet an unanswered question; but there are in certain localities, as for instance on the lower Yenisei, to this day remnants of native populations among whom dolichocephalic individuals are quite common, and these individuals often bear a most remarkable physical resemblance to the American Indian.

Besides mounds, the writer saw and learned of numerous large caverns, particularly in the mountains bordering the Yenisei River, which offer excellent opportunities for archeological investigation. Very little research work has thus far been done in these caverns, but some have yielded, to Jelieniev, stone implements that indicate old burials.

In regard to the living people, the writer had the opportunity of seeing numerous Buriats, representatives of a number of tribes on the Yenisei and Abacan Rivers, many thousands of Mongolians, a number of Tibetans, and many Chinese with a few Manchurians. On one occasion alone, that of an important religious ceremony, he had an opportunity to observe over 7,000 natives assembled from all parts of Mongolia. He has also seen photographs of members of some of the eastern Siberian tribes. Among all these people, but more especially among the Yenisei Ostiaks, the Abacan Katchinci and related groups, the Selenga Buriats, the eastern Mongolians, the Tibetans, the east Siberian Oroczi and the Sachalin Giliaks, there

[1] The term "Tatar" in Siberia is applied to large numbers of natives and covers a number of physically heterogeneous types.

are visible many and unmistakable traces of admixture or persistence of what appears to have been the older population of these regions, pre-Mongolian and especially pre-Chinese,[1] as we know these nations at the present day. Those representing these vestiges belong partly to the brachycephalic and in a smaller extent to the dolichocephalic type, and resemble to the point of identity American Indians of corresponding head form. These men, women and children are brown in color, have black straight hair, dark brown eyes, and facial as well as bodily features which remind one most forcibly of the native Americans. Many of these individuals, especially the women and children, who are individually less modified by the environment than the men, if introduced among the Indians and dressed to correspond, could by no means at the disposal of the anthropologist be distinguished apart. And the similarities extend to the mental make up of the people, as well as to numerous habits and customs which new contacts and religions have not as yet been able to efface.

The writer found much more in this direction than he had hoped for, and the physical resemblances between these numerous outcroppings of the older blood and types of north-eastern Asia and the American Indian, cannot be regarded as accidental, for they are numerous as well as important and cannot be found in parts of the world not peopled by the yellow-brown race; nor can they be taken as an indication of American migration to Asia, for emigration of man follows the laws of least resistance, or greatest advantage, and these conditions surely lay more in the direction from Asia to America than the reverse.

In conclusion, it may be said that from what he learned in eastern Asia, and weighing the evidence with due respect to other possible views, the writer feels justified in advancing the opinion that there exist to-day over large parts of eastern Siberia, and in Mongolia, Tibet, and other regions in that part of the world, numerous remains, which now form constituent parts of more modern tribes or nations, of a more ancient population (related in origin perhaps with the latest paleolithic European), which was physically identical with and in all probability gave rise to the American Indian.

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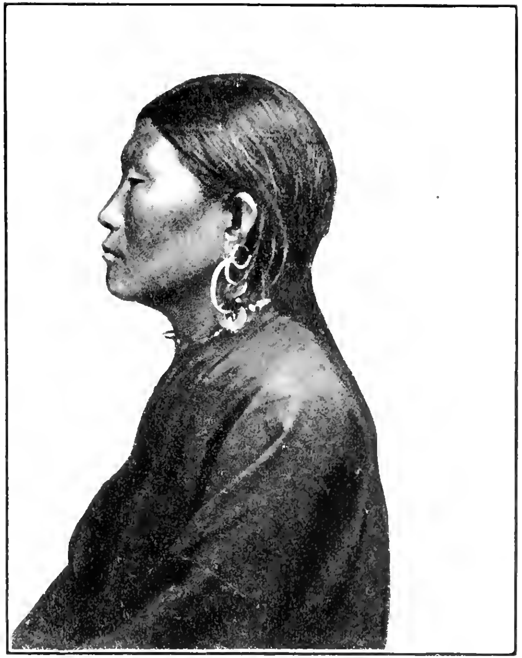
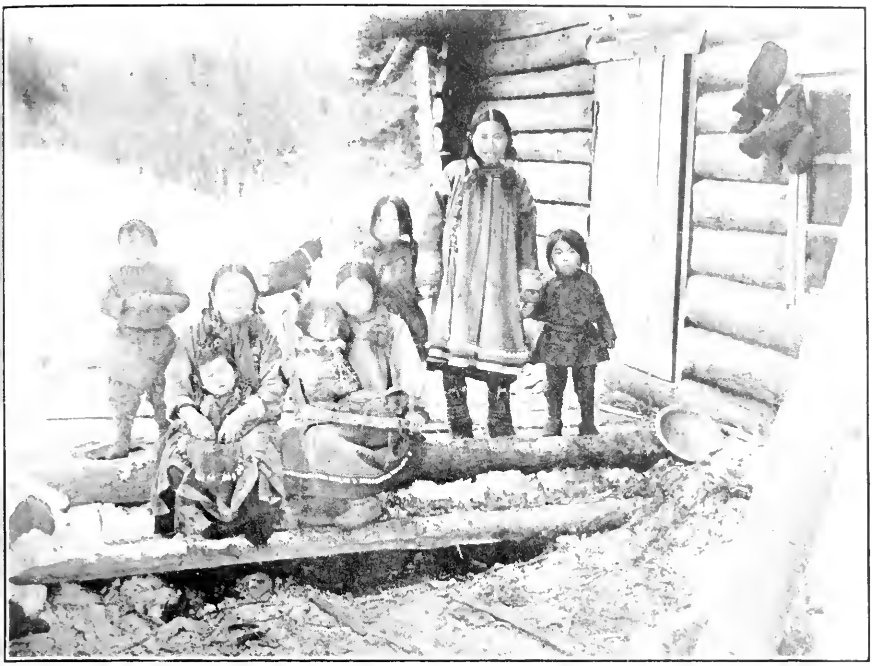
[1] The Mongolians of to-day are a mosaic or mixture of various local, southern and particularly western ethnic elements; while the Chinese present in the main a people that has undergone to a very perceptible degree its own differentiation, so as to constitute a veritable great subtype of the yellow-brown people.

The writer is able to merely touch on the great subject thus approached. The task of learning the exact truth remains for the future. In relation to opportunities for further investigation, he has satisfied himself that the field for anthropological and archeological research in eastern Asia is vast, rich, to a large extent still virginal, and probably not excessively complicated. It is surely a field which calls for close attention not only on the part of European students of the Far East, but especially on the part of the American investigator who deals with the problems of the origin and immigration of the American Indian.

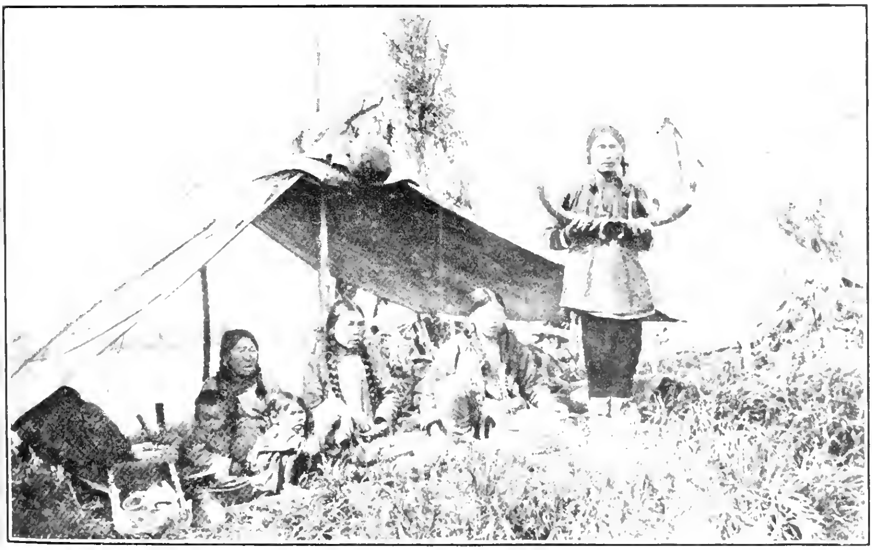


A GILIAK WOMAN FROM SACHALIN

(Photograph from the Antropologicny Instytut, Krakow; donated to the U. S. National Museum by Prof J. Talko-Hryncewicz)



OROCZI, ON THE STREAM KONI, EASTERN SIBERIA



OROCZI, ON THE RIVER IMAN, EASTERN SIBERIA

(Both photographs from the Antropologicny Instytut, Krakow; donated to the U. S. National Museum by Prof. J. Talko-Hryncewicz)

A FAMILY OF YENISEI OSTIAKS

(Photograph obtained by the U. S. National Museum through exchange, from the Ethnographical and Anthropological Museum of Peter the Great, St. Petersburg)

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NOTES ON AMERICAN SPECIES OF PERIPATUS, WITH A LIST OF KNOWN FORMS

BY

AUSTIN HOBART CLARK

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NOTES ON AMERICAN SPECIES OF PERIPATUS, WITH A LIST OF THE KNOWN FORMS

By AUSTIN HOBART CLARK

While engaged in entomological investigations on the Isthmus of Panamá, Mr. August Busck collected a single specimen of a species of *Peripatus*, which he found beneath a palm frond at La Chorrera; and in the course of their studies on the marine resources of Porto Rico the naturalists of the United States Bureau of Fisheries steamer "Fish Hawk" gathered two additional specimens at Vieques, a small island off the southeastern corner of Porto Rico, a locality where the genus was not previously known to occur.

Our knowledge of the species of this genus is in the highest degree fragmentary; many species are known, but of none of them do we know even approximately the geographical range. It thus becomes incumbent upon all to whom opportunity may offer immediately to record such specimens as may come under their notice in order to accumulate records from which, in time, the geographical distribution of the various forms may be accurately mapped.

At the same time everyone who records species of *Oroperipatus*, *Peripatus*, (with its various subgenera) or of the other genus occurring in America, *Metaperipatus*, should take care that his specimens are properly preserved and placed in some museum where they will be easily accessible for review, for the species of the various genera of this group, like the species of the king crabs, crinoids, and many other ancient types are all cast, as it were, in the same mould, and it is astonishingly easy to make mistakes in their determination.

PERIPATUS (PERIPATUS) JUANENSIS Bouvier

Peripatus juliformis (part) 1880. Peters, Sitszungsber. naturf. Freunde Berlin, 1880, pp. 29, 166.

Peripatus from Utuado 1880. Sedgwick, Quart. Journ. Micros. Sci., vol. 28, pp. 479, 488.

Peripatus dominicæ var. *juanensis* 1900. Bouvier, Bull. Soc. Ent. de France, 1900, pp. 394, 395.—1904. Bouvier, Nouv. Archives du Mus. d'Hist. nat. (4), vol. 3, pp. 7, 20.—1906. Bouvier, Ann. des Sci. Nat. (9), vol. 2 (zoologie), p. 266.

Vieques, near Porto Rico; "Fish Hawk" Porto Rican Expedition.—Two specimens, both females, agreeing well with Bouvier's description. The length of one is 35 mm., and the breadth 4 mm. There are 31 pairs of ambulatory legs. The coloration (in alcohol) is a deep, almost uniform, yellowish brown; the posterior portion of the body is slightly darker than the remainder, and there is a large lightish area just behind the anterior end. The primary papillæ are more yellowish than the general surface of the back. The ventral surface is somewhat lighter and more yellowish than the dorsal.

The other specimen, beautifully preserved, measures 45 mm. in length by 4 mm. in breadth. There are 31 pairs of ambulatory legs.

This species was heretofore known only from the island of Porto Rico, where it has been found at Utuado and Arecibo. A comparison between these specimens and others from various parts of the main island would be of interest, but no material for such a comparison is available.

PERIPATUS (MACROPERIPATUS) GEAYI Bouvier

Peripatus geayi 1899. Bouvier, Comptes Rendus Acad. des Sci., vol. 128, p. 1345.—1900. Bouvier, Ann. Soc. Ent. de France, vol. 68 (1899), pp. 389, 404-406.—1904. Bouvier, Bull. du Mus. d'Hist. Nat., 1904, p. 53.—1905. Bouvier, Annales des Sci. Nat. (9), vol. 2, p. 200.

La Chorrera, Panamá; from under a palm leaf; August Busck, May 17, 1912.—One specimen, agreeing well with Bouvier's description and figures. There are 32 pairs of ambulatory legs. The length is 45.5 mm. The color is a purplish brown, lighter beneath; the primary papillæ are darker than the rest of the back. Just behind the anterior extremity of the body is a broad transverse obscure yellow band, about 1.3 mm. wide, slightly constructed in the center.

This species was previously only known from French Guiana.

LIST OF THE AMERICAN SPECIES OF PERIPATUS, WITH THE ASCERTAINED RANGE OF EACH

The species belonging to the family Peripatidæ and to the subfamily Peripatinæ as now restricted, all but one of which are American, are as follows:

Genus OROPERIPATUS Cockerell

Oroperipatus ecuadoriensis (Bouvier).

Habitat.—Bulim, northwestern Equador.

Oroperipatus lankesteri (Bouvier).
Habitat.—Paramba, near Quito, Equador.

Oroperipatus tuberculatus (Bouvier).
Habitat.—Popayan, Colombia.

Oroperipatus quitensis (Schmarda).
Habitat.—High regions of Equador.

Oroperipatus cameranoi (Bouvier).
Habitat.—Cuenca and Sigsig, Equador.

Oroperipatus corradoi (Camerano).
Habitat.—Equador; known from Quito, Balzar and Guayaquil.

Oroperipatus eiseni (Wheeler).
Habitat.—Tepic, Mexico.

Oroperipatus belli (Bouvier).
Habitat.—Equador; Duran, on the Guayas river.

Oroperipatus goudoti (Bouvier).
Habitat.—Mexico.

Oroperipatus soratanus (Bouvier).
Habitat.—Bolivia; Sorata.

Oroperipatus balzani (Camerano).
Habitat.—Bolivia; states of Coroico and Chulumani.

Oroperipatus intermedius (Bouvier).
Habitat.—Bolivia; Sorata.

Genus PERIPATUS Guilding

Subgenus MACROPERIPATUS A. H. Clark

Peripatus (Macroperipatus) torquatus von Kennel.
Habitat.—Trinidad.

Peripatus (Macroperipatus) perrieri Bouvier.
Habitat.—Mexico; Vera Cruz.

Peripatus (Macroperipatus) geayi Bouvier.
Habitat.—Cayenne, on the French-Brazilian boundary; La Chorrera, Panamá.

Peripatus (Macroperipatus) ohausi Bouvier.
Habitat.—Brazil; Petropolis, near Rio de Janeiro.

Peripatus (Macroperipatus) guianensis Evans.
Habitat.—Demerara; east bank of the Demerara river.

Subgenus EPIPERIPATUS A. H. Clark

Peripatus (Epiperipatus) brasiliensis Bouvier.
Habitat.—Brazil; Santarem, probably also San Pablo, Panamá.

Peripatus (Epiperipatus) imthurmi Sclater.
Habitat.—Demerara; Maccasseema, on the Pomeroon river, Hoorubea, on the Demerara river, and other localities not specifically recorded; Essequibo; Surinam, Paramaribo; Cayenne, Haut Carsevenne.

Peripatus (Epiperipatus) evansi Bouvier.
Habitat.—East bank of the Demerara river.

Peripatus (Epiperipatus) edwardsii Blanchard.
HABITAT.—Cayenne; banks of the Approuague river, also the interior; Surinam, Paramaribo; ?Trinidad; Venezuela, Haute Sarare, Bas Sarare, Mérida and Caracas; ?Colombia, vicinity of Lake Valencia; Panamá, Panamá Station; Darien.

Peripatus (Epiperipatus) simoni Bouvier.
HABITAT.—Brazil, Breves, on the island of Marajo, at the mouth of the Amazons; Venezuela, Caracas.

Peripatus (Epiperipatus) biolleyi Bouvier.
HABITAT.—Costa Rica, San José and Surubres, near San Mateo; ?British Honduras, Benque Viejo.

Peripatus (Epiperipatus) nicaraguensis Bouvier.
HABITAT.—Nicaragua, Matagalpa and San Benito.

Peripatus (Epiperipatus) isthmicola Bouvier.
HABITAT.—Costa Rica, San José, Cachi, plains of Santa Clara.

Peripatus (Epiperipatus) trinidadensis Stuhlmann.
HABITAT.—Trinidad.

Peripatus (Epiperipatus) barbouri Brues.
HABITAT.—Grenada; Grand Etang.

Subgenus PERIPATUS Guilding

Peripatus (Peripatus) swainsonæ Cockerell.
HABITAT.—Jamaica, Bath, and near Savanna lo Mar.

Peripatus (Peripatus) juanensis Bouvier.
HABITAT.—Porto Rico, Arecibo and Utuado; Vieques.

Peripatus (Peripatus) danicus Bouvier.
HABITAT.—St. Thomas, Danish West Indies.

Peripatus (Peripatus) antiguensis Bouvier.
HABITAT.—Antigua, Barlar, near Warburton; also other localities not specifically recorded.

Peripatus (Peripatus) bavayi Bouvier.
HABITAT.—Guadeloupe, French West Indies.

Peripatus (Peripatus) dominicæ Pollard.
HABITAT.—Dominica, Laudat and Prince Rupert.

Peripatus (Peripatus) juliformis Guilding.
HABITAT.—St. Vincent.

Peripatus (Peripatus) brölemanni Bouvier.
HABITAT.—Venezuela, Tovar, Raxto Casselo and Puerto Cabello.

Peripatus (Peripatus) sedgwicki Bouvier.
HABITAT.—Venezuela, Caracas, San Esteban, La Moka, Las Trincheras and La Guayra.

Subgenus PLICATOPERIPATUS A. H. Clark

Peripatus (Plicatoperipatus) jamaicensis Grabham and Cockerell.
HABITAT.—Jamaica, Bath, and near Savanna lo Mar.*

* This species has two varieties, *gossei* Cockerell, and *bouvieri* Cockerell, with the same habitat as the type form.

Genus MESOPERIPATUS Evans

Mesoperipatus tholloni (Bouvier).
HABITAT.—French Congo.

The subfamily Peripatoidinæ of the family Peripatopsidæ is represented in America by the following species:

Genus METAPERIPATUS A. H. Clark

Metaperipatus blainvillei (Blanchard).
HABITAT.—Chile, San Carlos, Chiloe Island, Corral and Villa Rica.

In addition to the forms listed above, Grube described, under the name of *Peripatus peruanus,* a species from Peru which cannot be placed with certainty in any group.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

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SMITHSONIAN PYRHELIOMETRY REVISED

BY

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SMITHSONIAN PYRHELIOMETRY REVISED

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In a paper entitled "The Silver Disk Pyrheliometer"[1] it was stated that in order to promote pyrheliometric measurements of the solar radiation in other parts of the world with instruments whose indications are quite comparable, several copies of the Silver Disk Pyrheliometer have been sent out by the Smithsonian Institution. The number of these instruments which have now been sent out has reached about twenty. The present paper gives a revision of the constants of these instruments and a statement of their dependence on experiments to determine the standard scale of radiation.

Three copies of the Standard Water-flow Pyrheliometer[2] have been prepared at the shop of the Astrophysical Observatory. The principle of these instruments consists in receiving the solar radiation in a blackened chamber composing a perfect absorber or "absolutely black body" and in carrying away the heat developed as fast as formed by a current of water circulating around in the walls of the receiving chamber. The rate of flow of the water, the rise of temperature due to the solar heating and the aperture through which the solar rays enter being known, the heating due to the solar rays is determined in calories per square centimeter per minute. In test experiments heat may be introduced electrically within coils in the absorption chamber, and this may be measured as if it were solar heat. The complete recovery of such test quantities of heat serves to prove the accuracy of the instrument.

Quite recently a new standard pyrheliometer which we have called "Standard Water-stir Pyrheliometer No. 4" has been devised and tested by us. This instrument employs the ordinary method of calorimetry. A blackened tubular chamber for the absorption of the solar heat is provided as for the water-flow pyrheliometer. In the new instrument the absorption chamber is enclosed by a known quantity of water in a copper vessel, so that the whole apparatus comprises what is in effect a calorimeter for the method of mixtures.

[1] Smithsonian Miscellaneous Collections, Vol. 56, No. 19.

[2] See Annals, Astrophysical Observatory, Vol. 2, pp. 39 to 47, 1908. Also The Astrophysical Journal, Vol. 33, pp. 125 to 129, 1911.

The water in the instrument is vigorously stirred[1] by means of a stirring device run by an electric motor. A platinum resistance thermometer, fully bathed by the water of the pyrheliometer serves to determine its rate of rise of temperature due to the absorption of solar rays, and also its rates of change of temperature before and after exposure to these rays, due to the influence of the surroundings. In this manner we may determine the intensity of the radiation of the sun in terms of the rise of temperature per minute of a calorimeter of known water equivalent, and we may be assured that the solar rays are completely absorbed to produce heat, because they are absorbed by a blackened surface forming the inside of a deep chamber closely approximating to the "absolutely black body." In this new instrument, as in the water-flow pyrheliometers, means are provided for the introduction electrically of known quantities of heat to test the accuracy of the apparatus. A full description of the new water-stir pyrheliometer and of the water-flow pyrheliometers, Nos. 2 and 3, will appear in Vol. 3 of the Annals of the Astrophysical Observatory, now in preparation.

The following table is a summary of the experiments made with test quantities of electrical heating with standard pyrheliometers Nos. 2, 3 and 4:

Pyrheliometer.	Dates.	Number tests.	Heat recovered.	Average deviation.
			Per cent.	*Per cent.*
Water-flow 2 ..	1910—May 12, 16, 25, 26, 31; June 7.........	21	99.1	1.8
Water-flow 3 ..	1910—April 18, 22, 23.........................	16	99.85	0.63
Water-flow 3 ..	1911—Oct. 10, 11	12	100.66	1.4
Water-stir 4...	1912—Oct. 24, 25............................	6	100.05	0.53

From these experiments it appears that the test quantities of electrical heating were recovered by each instrument to within one per cent of the quantity introduced.

The results of comparisons of the standard pyrheliometers with secondary pyrheliometers are summarized in the following table:

Dates.	Number comparisons.	Standard used.	Secondary used.	Standard / secondary.	Probable error.
1910—May 10, 17, 28; June 4	16	2	A.P.O. 8	0.3772	0.0022
1910—Apr. 22	6	3	A.P.O. 8	0.3765	0.0009
1910—Oct. 31; Nov. 1..............	8	3	A.P.O. IV	0.5149	0.0013
1911—June 27......................	3	3	{ A.P.O. 8bis	0.3792	0.0018
			{ A.P.O IV	0.5094	0.0011
1911—Oct. 14, 15, 16, 22, 25, 31; Nov. 2, 6, 7................	21	3	A.P.O. 8bis	0.3770	0.0007
1912—Nov. 16, 19, 21..............	18	4	A.P.O. 9	0.3618	0.0012

[1] Successful use requires rapid stirring.

Intercomparisons between the secondary pyrheliometers named in the preceding table are as follows:

Dates.	Number comparisons.	Secondaries used. A.	Secondaries used. B.	Ratio $\frac{A}{B}$	Probable error.
1910—June 21	17	S.I. 5	A.P.O. 8	1.0242	0.0019
1911—Apr. 25	7	S.I. 5	A.P.O. 8bis	1.0389	0.0019
1912—Dec. 20	18	S.I. 5	A.P.O. 8bis	1.0281	0.0013
1909—Oct. 23, 31	9	A.P.O. 8	A.P.O. IV	1.3611	0.0021
1911—June 22, 28; Sept. 14	19	A.P.O. 8bis	A.P.O. IV	1.3518	0.0017
1910—July 28	6	A.P.O. 9	A.P.O. IV	1.3820	0.0008
1911—June 28	8	A.P.O. 9	A.P.O. IV	1.4102	0.0040
1911—June 28	8	A.P.O. 9	A.P.O. 8bis	1.0460	0.0010
1912—Feb. 6, 10	12	A.P.O. 9	A.P.O. 8bis	1.0328	0.0011
1912—Nov. 8	10	A.P.O. 9	A.P.O. 8bis	1.0470	0.0013
1912—Nov. 11	19	A.P.O. 9	A.P.O. 8bis	1.0445	0.0014

Combining the results of the two preceding tables we obtain the following constants which we now adopt for the secondary pyrheliometers named above. These constants and others which are derived from them in the remainder of this paper we designate as Smithsonian Revised Pyrheliometry of 1913:

From $\frac{\text{S.I. 5}}{\text{A.P.O. 8}}$ and $\frac{\text{S.I. 5}}{\text{A.P.O. 8}_{\text{bis}}}$ we find $\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}} = \frac{1.0311}{1.0242} = 1.0068$

From $\frac{\text{A.P.O. 8}}{\text{A.P.O. IV}}$ and $\frac{\text{A.P.O. 8}_{\text{bis}}}{\text{A.P.O. IV}}$ we find $\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}} = \frac{1.3611}{1.3518} = 1.0068$

From $\frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}}$ (49 values) we find $\frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}} = \ldots\ldots$ 1.0426

From $\frac{\text{A.P.O. 9}}{\text{A.P.O. IV}}$ and $\frac{\text{A.P.O. 8}_{\text{bis}}}{\text{A.P.O. IV}}$ we find $\frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}} = \frac{1.3981}{1.3518} = 1.0343$

From $\frac{\text{A.P.O. 8}_{\text{bis}}}{\text{A.P.O. IV}}$ (19 values) we find $\frac{\text{A.P.O. IV}}{\text{A.P.O. 8}_{\text{bis}}} = \ldots\ldots$ 0.7398

These results leave no choice as to the values to be adopted for $\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}}$ and $\frac{\text{A.P.O. IV}}{\text{A.P.O. 8}_{\text{bis}}}$, but are less satisfactory as regards $\frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}}$. However it will be seen that the discordance in this ratio almost wholly depends on the six comparisons $\frac{\text{A.P.O. 9}}{\text{A.P.O. IV}}$ of

July 28, 1910. It is possible that A.P.O. 9 was inadvertently not fully exposed at this time. We shall adopt:

$$\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}} = 1.0068. \quad \frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}} = 1.0426. \quad \frac{\text{A.P.O. IV}}{\text{A.P.O. 8}_{\text{bis}}} = 0.7398.$$

From $\frac{\text{Standard 2}}{\text{A.P.O. 8}}$ and $\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}}$ we find $\frac{\text{Standard 2}}{\text{A.P.O. 8}_{\text{bis}}} = 0.3772 \times 1.0068 = 0.3798.$

From $\frac{\text{Standard 3}}{\text{A.P.O. 8}}$ and $\frac{\text{A.P.O. 8}}{\text{A.P.O. 8}_{\text{bis}}}$ we find $\frac{\text{Standard 3}}{\text{A.P.O. 8}_{\text{bis}}} = 0.3765 \times 1.0068 = 0.3791.$

From $\frac{\text{Standard 3}}{\text{A.P.O. IV}}$ and $\frac{\text{A.P.O. IV}}{\text{A.P.O. 8}_{\text{bis}}}$ we find $\frac{\text{Standard 3}}{\text{A.P.O. 8}_{\text{bis}}} = 0.5149 \times 0.7398 = 0.3809.$

also $0.5094 \times 0.7398 = 0.3768.$

From $\frac{\text{Standard 4}}{\text{A.P.O. 9}}$ and $\frac{\text{A.P.O. 9}}{\text{A.P.O. 8}_{\text{bis}}}$ we find $\frac{\text{Standard 4}}{\text{A.P.O. 8}_{\text{bis}}} = 0.3618 \times 1.0426 = 0.3772.$

Besides these values we have given two direct comparisons of $\frac{\text{Standard 3}}{\text{A.P.O. 8}_{\text{bis}}}$.

In combining the results to obtain the best value of the constant of Secondary Pyrheliometer A. P. O. 8_{bis}, we have been guided by the view that a completely independent set-up of apparatus is a more weighty condition than is a small probable error. This amounts to saying that we have considered constant errors of more importance than accidental ones. But admitting this, we have also taken some notice of the number of observations made on different occasions, and of their accordance. These considerations have led us to the following values for Constant of Secondary Pyrheliometer A. P. O. 8_{bis}:

								Mean
Value	0.3798	0.3791	0.3809	0.3768	0.3792	0.3770	0.3772	0.3786
Weight	3	3	3	1	1	4	3	±0.0003
Standard at.	No. 2 Washn.	No. 3 Washn.	No. 3 Mt. Wilson	No. 3 Mt. Wilson	No. 3 Mt. Wilson	No. 3 Mt. Wilson	No. 4 Washn.	

The constants of the silver disk pyrheliometers sent out by the Smithsonian Institution to various observers are derived by comparisons of those silver disk pyrheliometers with one or the other of the pyrheliometers named above. The following table gives the results of these comparisons for determining the constants of the various Smithsonian pyrheliometers [1]:

Date.	Number comparisons.	Secondaries used. A.	Secondaries used. B.	Ratio $\frac{A}{B}$	Probable error.
1910—Apr 8	11	S.I. 1	A.P.O. 8	1.0182	0.0025
1911—Jan. 25	9	S.I. 1	A.P.O. 8bis	1.0357	0.0024
1911—Jan. 25	10	S.I. 1	A.P.O.VIII	1.3943	0.0031
1911—Dec. 6	7	S.I. 1	A.P.O. 8bis	1.0246	0.0060
1912—Feb. 10	8	S.I. 1	A.P.O. 8bis	1.0268	0.0028
1911—Jan. 20, 23, 24, 25	24	S.I. 2	A.P.O. 8bis	1.0162	0.0016
1912—Nov. 8	9	S.I. 2	A.P.O. 8bis	1.0144	0.0017
1912—Nov. 8	9	S.I. 2	A.P.O. 9	0.9698	0.0013
1911—Jan. 19	6	S.I. 3	A.P.O. 8bis	1.0477	0.0024
1911—Jan. 20	6	S.I. 3	S.I. 2	1.0271	0.0024
1910—Apr. 8	10	S.I. 4	A.P.O. 8	1.0117	0.0023
1911—Dec. 3	4	S.I. 4	A.P.O. 9	0.9803	0.0016
Data for S.I. 5 given in preceding table.					
1911—Mar. 10	8	S.I. 6	A.P.O. 8bis	1.0327	.0017
1911—Mar. 21	9	S.I. 7	A.P.O. 8bis	1.0408	.0022
1912—May 18, 20	22	S.I. 8	A.P.O. 8bis	1.0032	.0018
1911—Apr. 25	10	S.I. 9	A.P.O. 8bis	1.0130	.0021
1911—May 4	6	S.I. 10	A.P.O. 8bis	1.0013	.0012
1911—Dec. 18	6	S.I. 10	A.P.O. 9	0.9703	.0027
1911—Feb. 6	11	S.I. 11	A.P.O. 8bis	1.0044	.0024
1912—Sept. 28	9	S.I. 12	A.P.O. 8bis	1.0427	.0020
1912—Feb. 10	9	S.I. 13	A.P.O. 8bis	1.0466	.0017
1912—Feb. 10	15	S.I. 14	A.P.O. 9	0.9777	.0014
1912—Mar. 7	9	S.I. 15	A.P.O. 8bis	1.0491	.0014
1912—Mar. 11, 16	13	S.I. 16	A.P.O. 8bis	1.0352	.0018
1912—Mar. 16	15	S.I. 17	A.P.O. 9	0.9990	.0011
VARIOUS A.P.O. PYRHELIOMETERS.					
1906—Apr. 2	6	A.P.O. V	A.P.O. IV	1.0615	.0050
1908—Apr. 16, 29	9	A.P.O. V	A.P.O. VII	1.0786	.0035
1908—May 28	13	A.P.O. V	A.P.O.VIII	1.0815	.0016
1910—Dec. 8	5	A.P.O. V	A.P.O. 8	0.7864	.0012
1910—Dec. 13, 15	11	A.P.O, V	A.P.O. 8bis	0.7969	.0024
1911—Jan. 19, 20, 23, 24	34	A.P.O. V	A.P.O. 8bis	0.7927	.0013
1908—May 22–June 3	75	A.P.O. IV	A.P.O. VII	0.9905	.0010
1909—June 1–Sept. 1	160	A.P.O. IV	A.P.O. VII	0.9955	.0007
1910—May 17–Oct. 25	700	A.P.O. IV	A.P.O. VII	0.9802	.0005
1912—May 4–Aug. 12	60	A.P.O. IV	A.P.O. VII	0.9892	.0012

In accordance with the above table, the following values are now adopted as the constants of Smithsonian Silver Disk Pyrheliometers Nos. 1 to 17, which have been furnished to the parties mentioned in the table. The column headed "old value" gives the constant which was furnished at the time of sending out the instrument or subsequently when further data indicated some desirable change. These old values are to be displaced by the new ones which we now give. We believe that the new constants should enable observers to reduce their results to a consistent scale differing probably by less than 0.5 per cent from the true scale of calories per square centimeter per minute.

[1] Instruments which were broken in transportation are omitted from this list.

SMITHSONIAN REVISED PYRHELIOMETRY OF 1913.

Instrument.	New Constant 1913.*	Old values.	Where sent.
S.I. 1	0.3683	0.3709	U. S. Weather Bureau.
S.I. 2	0.3734	†0.3835	(1) Rykačev, Russia; (2) Obsy. Rio Janeiro, Brazil.
S.I. 3	0.3625	†0.3725	Violle, Paris, France.
S.I. 4	0.3713	0.3745	Chistoni, Naples, Italy.
S.I. 5	0.3672	0.3676 0.3662	U. S. Dept. Agriculture, Physical Laboratory.
S.I. 6	0.3666	†0.3771 0.3687	Officina Meteor. Buenos Aires, Argentina.
S.I. 7	0.3638	†0.3747 0.3662	Do.
S.I. 8	0.3774	0.3792	Central Observatory, Madrid, Spain.
S.I. 9	0.3737	†0.3843 0.3756	Imp. Coll. Science and Technology, London, England.
S.I. 10	0.3762	†0.3887 0.3798	K. Preuss. Meteor. Institut, Berlin, Germany.
S.I. 11	0.3769	0.3788	Meteor. Obs., Teneriffe.
S.I. 12	0.3631	0.3649	K. Preuss. Meteor. Institut, Berlin, Germany.
S.I. 13	0.3617	0.3636	Meteor. Centralanstatt, Zurich, Switzerland.
S.I. 14	0.3714	0.3767	University, Toronto, Canada.
S.I. 15	0.3609	0.3627	U. S. National Bureau Standards.
S.I. 16	0.3657	0.3672	University of Arizona, Tucson.
S.I. 17	0.3635	0.3687	Harvard Coll. Obs., Arequipa, Peru.

VARIOUS A.P.O. INSTRUMENTS.

A.P.O. IV	0.5118	‡0.902 ‡0.858	Mount Wilson, Cal.
A.P.O. V	0.4776	‡0.848	Washington, D. C.
A.P.O. VII	0.5072	.....	Mount Wilson, Cal.
A.P.O. VIII	0.5150	.....	(1) U. S. Weather Bureau; (2) Mt. Wilson.
A.P.O. 8	0.3760	.....	Washington and Mt. Wilson.
A.P.O. 8bis	0.3786	0.3805	Do.
A.P.O. 9	0.3631	0.3683	Washington, Mt. Wilson, Mt. Whitney and Algeria.

* These values are the factors by which the corrected temperature rise in 100 seconds is to be multiplied to reduce the readings to calories (15°C.) per square centimeter per minute.
† These oldest values were obtained from a round-about series of comparisons of several years standing, which now proves to have been erroneous.
‡ For 60-second exposures. From Annals Vol. II and later publications.

Note: On the relation between the Ångström scale and that of the Smithsonian Institution.—Observations made at the United States Weather Bureau, at Potsdam, and at Pawlowsk have been kindly communicated to the Smithsonian Institution, and we select from them the results of direct comparisons between the best instruments. From these we find the following ratios between readings on the Smithsonian (1913) and Ångström scales of pyrheliometry:

Observers.	Instruments.		Station.	Ratio.
	S.I.	Ångström.		S. I. / Ångström.
Kimball	S.I. 1	104	Washington	1.047
Marten	S.I. 10	74	Potsdam	1.034
Savinoff	S.I. 2	79	Pawlowsk	1.037

Mean 1.039

Summary.—A new form of standard pyrheliometer has been devised and tested. In this new instrument, as in the water-flow pyrheliometers, the solar rays are absorbed in a deep chamber approximating to the perfect absorber or "black body." Means are provided for introducing electrically test quantities of heat.

It is shown that with Standard Water-flow Pyrheliometers Nos. 2 and 3, and the new Water-stir Pyrheliometer No. 4, test quantities of heat may be measured to within 1 per cent.

A summary is given of all definitive comparisons of the three standards just named with Secondary Silver-disk Pyrheliometers, and also the net of inter-comparisons connecting all Smithsonian secondary pyrheliometers now in use. From these data are derived the best values of the constants of all these secondary pyrheliometers. This system of pyrheliometry we call "Smithsonian Revised Pyrheliometry of 1913."

It rests on 72 comparisons on 20 different days of 3 different years with 3 standard pyrheliometers of different dimensions and 2 widely different principles of measurement, all capable of recovering and measuring within 1 per cent test quantities of heat, and all closely approximating to the "absolutely black body." The 72 comparisons, 40 at Washington, 32 at Mount Wilson, were made in 6 groups. The maximum divergence of the mean results of these groups is 1 per cent. Hence it is believed that the mean result of all the comparisons made under such diverse circumstances must be within 0.5 per cent of the truth. The probable error is 0.1 per cent. It is believed that this standard scale is reproducible by the secondary pyrheliometers with the adopted constants given to within 0.5 per cent. The divergence of this scale from that of Ångström appears to be 3.9 per cent.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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DESCRIPTION OF A NEW GAZELLE FROM NORTHWESTERN MONGOLIA

BY

N. HOLLISTER

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DESCRIPTION OF A NEW GAZELLE FROM NORTH-WESTERN MONGOLIA

By N. HOLLISTER

Among specimens of the great game of the Altai, collected by Dr. Theodore Lyman in 1912 for the United States National Museum and the Museum of Comparative Zoölogy at Harvard, is a new gazelle from Mongolia, which may be known by the following description:

PROCAPRA ALTAICA, new species

Type from Suok Plains, near south end of Bain-Chagan Pass, Little Altai, Mongolia. United States National Museum, No. 175179, skin and skull of adult male. Collected July 5, 1912, by Theodore Lyman. (Orig. No. 4382 N. H.)

General characters.—Nearest to *Procapra gutturosa*, but with colored area of back more extensive; skull broader; molar teeth larger; and horns much more spreading.

Color of type (in summer coat).—General color of upperparts and sides, ochraceous-buff; face from nostrils to between eyes drab, sharply cut off from buff of sides of muzzle and head, which blends into the white of chin and upper throat. Ears scantily haired with light buff; small rump patch of white, sharply marked by the brown spot on the spike-like tail. Outside of legs light buff, with a shading of drab near hoofs. Underside of neck buff; underparts of body and insides of legs white, sharply marked from buff of sides of body and outer sides of legs.

Skull, teeth and horns.—Compared with skulls of *Procapra gutturosa* from the Mongolian Plateau, north of Kalgan, China, the skull of this new gazelle is generally heavier and broader, especially broader across middle of maxillary region; basioccipital short and square; mandible weak, the horizontal rami very low and slender. Teeth larger, the upper row shorter, but the molars considerably wider; m^3 with posterior column 11.5 millimeters across, as against 8.8, 9.3, and 9.4 in specimens of *gutturosa*. Posterior lobe of m_3 not directly in line with interior cusps of molar row, as in *gutturosa*, but forming a column-loop in line with the outer semi-circular lobes of molar row, thus giving m_3 three approximately equal outer semi-circular lobes. As viewed from inner side the posterior column is not separated from middle column by a distinct groove, the posterior two-thirds of inner surface of tooth being smoothly convex. [In *gutturosa,* as viewed from inner side, m_3 presents three equal columns, divided by two shallow re-entrant angles, much like the *outer* surface of the same tooth in *altaica.*[1]] Horns much more spreading than horns of *gutturosa,* distance between tips 180 millimeters, as against 102, 103, and 135 in *gutturosa;* much less closely ringed.

Measurements of type, from made up skin.—Head and body, 1325 millimeters; tail, 12; ear from notch, 97. Skull: Greatest length, 260; condylobasal length, 250; basal length, 237; greatest breadth, 113; breadth of rostrum above m^2, 79; length of nasals, 93; breadth of opening of anterior nares, 43.5; length from orbit to end of premaxillæ, 146; length of upper tooth row, crowns, 70; lower tooth row, crowns, 72; length of horn over curve, 270; distance between horn tips, 180.

Remarks.—The range of this gazelle is comparatively close to that of *Gazella subgutturosa sairensis,* but the two species are separated by the Great Gobi Altai. The relationship being wholly with *Procapra gutturosa,* the distribution is probably nearer continuous with that species, and the two may eventually be found to intergrade.

[1] Examination of large series of gazelle skulls, of various species, shows a remarkable uniformity in the character of this tooth in specimens of the same race.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

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DESCRIPTION OF A NEW AFRICAN GRASS-WARBLER OF THE GENUS CISTICOLA

BY

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(PUBLICATION 2166)

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DESCRIPTION OF A NEW AFRICAN GRASS-WARBLER OF THE GENUS CISTICOLA

By EDGAR A. MEARNS

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This paper is the seventeenth dealing solely with the results of the Smithsonian African Expedition, under the direction of Col. Theodore Roosevelt.

The genus *Cisticola* is a very large one, and contains, among other groups of species, a very compact one, comprising four of the African species: *Cisticola hunteri* Shelley (1889), *C. lovati* Ogilvie-Grant (January, 1900), *C. prinioides* Neumann (July, 1900), and *C. harrisoni* Stone (1906). As three of the above-named species inhabit restricted areas no geographic races have been described; but of *C. prinioides* three tenable races are recognized, and a fourth is described below. The four subspecies of *C. prinioides* are represented in the collection before me by no less than 58 specimens.

CISTICOLA PRINIOIDES WAMBUGENSIS, new subspecies

Wambugu Grass-Warbler

Type-specimen.—Adult male, Cat. No. 215390, U. S. National Museum; collected at Wambugu, altitude 5,500 feet, British East Africa, October 24, 1909, by Edgar A. Mearns. (Original number 17303.)

Characters.—Similar in size to *Cisticola prinioides prinioides* and *C. p. kilimensis,* slightly smaller than *C. p. neumanni.* Color paler throughout than any of the above-named subspecies. It also differs from them in the following particulars: upperparts more rufescent and plainer in coloration, the slightly darker centers to the feathers of the crown and mantle not forming appreciable stripes; tail pale, rusty drab; underparts whitish, suffused with smoke gray on the sides.

Measurements of type (adult male).—Length (of skin), 135 millimeters; wing, 60; tail, 69; exposed culmen, 13; tarsus, 25.5.

Measurements of adult female.—Length (of skin), 125 millimeters; wing, 55; tail, 58; exposed culmen, 11.5; tarsus, 24.

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TWO NEW SUBSPECIES OF BIRDS FROM THE SLOPES OF MOUNT PIRRI, EASTERN PANAMA[1]

By E. W. NELSON

The two subspecies described below were part of the rich collection made by E. A. Goldman in Eastern Panama, during the season of 1912, while engaged in the Smithsonian Biological Survey of Panama. Other new birds from this collection were described in a recent paper.[2]

The present subspecies are additional evidence that the fauna of Mount Pirri is more closely related to that of South America than to that of the Canal Zone.

CAPITO MACULICORONATUS PIRRENSIS, new subspecies

Mount Pirri Barbet

Type.—No. 238116, adult male, U. S. National Museum (Biological Survey Collection) from Cana (1,800 feet alt.), at base of Mount Pirri, Eastern Panama; collected April 11, 1912, by E. A. Goldman. (Original number 15468.)

Distribution.—Known only from type locality.

Subspecific characters.—Colors closely similar to those of *C. m. rubrilateralis* Chapman, from Cauca, Colombia (Bull. Am. Mus. Nat. Hist., vol. 31, p. 144, July 23, 1912), including the bright red side-patches, but the breast patch is a deeper and more orange yellow as in typical *maculicoronatus*. The measurements also agree with those of the typical form in being distinctly less than in *rubrilateralis*.

Measurements of type.—Wing, 81 millimeters; tail, 44; culmen, 21; tarsus, 20.

Remarks.—The present form cannot well be referred to either typical *maculicoronatus* or to *rubrilateralis*, since it has the color of the latter and the size of the former. Its range is intermediate between those of its two relatives, and it is thus an intergrading form which appears worthy of recognition.

PSEUDOTRICCUS PELZELNI BERLEPSCHI, new subspecies

Berlepsch Flycatcher

Type.—No. 238137, adult male, U. S. National Museum (Biological Survey Collection), from Mount Pirri, Eastern Panama; collected April 23, 1912, by E. A. Goldman. (Original No. 15578.)

[1] The present paper is the seventeenth dealing with the results of the Smithsonian Biological Survey of the Panama Canal Zone.

[2] Smiths. Misc. Coll. vol. 60, No. 3, pp. 1-25.

Distribution.—Known only from the type locality.

Subspecific characters.—In general resembles typical *pelzelni*, but upperparts browner, less greenish; crest more blackish; outer edges of wing feathers including coverts and edges of tail feathers rusty chestnut instead of olive greenish; bill larger and entirely black.

Description.—Top of head including the well developed crest of broad round-tipped feathers dusky slate, but forehead paler, more olivaceous; back entirely dull olivaceous brown, becoming more greenish olivaceous in some specimens; sides of head and neck similar to back but paler; wing and tail feathers dusky slate color edged with dark rusty chestnut (lighter rusty on wings), with no trace of olivaceous; chin, throat and abdomen pale greenish yellow, shading laterally into dull olivaceous or brownish olivaceous, becoming browner on flanks; a poorly defined band of dull olivaceous extends across breast separating yellow throat area from that of abdomen; lower thighs and under tail coverts dark rusty or rusty brownish; bill entirely black; feet and tarsus dull horn color.

Comparative measurements of a co-type of *P. pelzelni* from Marhay, East Ecuador, in collection of Count von Berlepsch, and of the type of *P. p. berlepschi.*

P. p. pelzelni (adult male): wing, 56 millimeters; tail, 44.7; culmen, 10.5; tarsus, 19.5.

P. p. berlepschi (adult male): wing, 57 millimeters; tail, 45; culmen, 12; tarsus, 20.7.

Remarks—I am indebted to Count Hans von Berlepsch for his kindness in comparing the type of the present well marked subspecies with a co-type of *P. pelzelni* in his collection, and for the accompanying statement of the differences and measurements of the two forms. As a slight recognition of his work in tropical American ornithology I take pleasure in naming this bird in honor of Count von Berlepsch.

Goldman collected four specimens of this bird near the summit of Mount Pirri which agree in the characters set forth above, but one specimen is much more rusty brown, both above and below, than the others, perhaps a mark of immaturity, and one has the back distinctly more olive greenish; but all agree in the black bill and rusty chestnut margins to wing and tail feathers, including the wing coverts.

In general appearance this species resembles a *Myiobius*. The crest, which is well marked, is made up of rather long and broad feathers, rounded at the tip.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

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DESCRIPTIONS OF NEW MAMMALS FROM PANAMA AND MEXICO

BY

E. A. GOLDMAN

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DESCRIPTIONS OF NEW MAMMALS FROM PANAMA AND MEXICO[1]

By E. A. GOLDMAN

Further study of the collection of mammals taken by the writer while detailed from the Biological Survey, U. S. Department of Agriculture, to the Smithsonian Biological Survey of the Panama Canal Zone has resulted in the discovery of eleven new species and subspecies in addition to those already published.[2] In comparing the specimens from Panama with other Middle American material a new form of the genus *Agouti* and two new forms of the genus *Dasyprocta* were found in the collection of the Biological Survey, all from Mexico. The new species and subspecies from both regions are described below.

For the loan of types and topotypes for comparison, my thanks are due to Dr. J. A. Allen, of the American Museum of Natural History.

BRADYPUS IGNAVUS, new species

Type from Marragantí (about 2 miles above Real de Santa Maria), near the head of tide-water on the Rio Tuyra, Eastern Panama. No. 179551, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 6, 1912. Original number 21596.

General characters.—Somewhat similar to *B. griseus* in color, but upper parts more distinctly spotted with white; ruff grayish brown across forehead (black in *B. griseus*); skull differing in detail, especially the shorter, anteriorly concave or emarginate nasals.

Color.—General color of upper parts brownish or grayish drab, irregularly spotted, mottled, or marbled with nearly pure white, the white predominating on the rump; abdomen and inner sides of limbs very pale drab gray; chin blackish; throat and anterior part of chest rusty brown; orbital areas and usual lines extending posteriorly

[1] The present paper is the eighteenth dealing with the results of the Smithsonian Biological Survey of the Panama Canal Zone.

[2] Smithsonian Misc. Coll., vol. 56, No. 36, pp. 1-11, Feb. 19, 1912; and Smithsonian Misc. Coll., vol. 60, No. 2, pp. 1-18, Sept. 20, 1912.

along sides of cheeks black; rest of face clothed with short whitish or yellowish hairs; frontal roll, or ruff, narrowly edged with rusty brown.

Skull.—Similar in general form to those of *B. castaneiceps* and *B. griseus,* but nasals shorter, with anterior border concave or emarginate, the emargination deepest at median suture; squamosal arm of zygoma broader, more rounded, less acutely pointed anteriorly; palate less deeply grooved posteriorly; symphysis of mandible less produced anteriorly beyond plane of first molars.

Measurements.—Type: Total length, 641 millimeters; tail vertebræ, 47; hind foot, 132. *Skull* (type): Greatest length (occipital condyle to anterior point of nasals), 78.5; zygomatic breadth, 47.5; interorbital breadth, 21.8; palatal bridge, 21.5; maxillary toothrow, 25.5.

Remarks.—This form, based on specimens from Eastern Panama and the adjacent part of Colombia, differs markedly from *B. castaneiceps* and *B. griseus,* and in color pattern as well as cranial details is more like some of the South American species. It appears to be unlike those described, but its exact relationship to some of the South American members of this unrevised genus cannot be determined at present, owing to lack of knowledge of their real characters. While the wide range of variation seen in a series of specimens from a given locality would include many of the characters used as specific by Gray, this variation is shown by examination of the Middle American forms to be within definite limits, and when ample material is available the distinctive characters of the species will become better known.

Specimens examined.—Total number, 3, as follows:

Panama: Marragantí: (type), 1.

Colombia: Atrato River, 2.

MAZAMA TEMA REPERTICIA, new subspecies

Type from Gatun, Canal Zone, Panama. No. 171673, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, June 21, 1911. Original number 21178.

General characters.—Similar to *Mazama tema tema* of Mexico, but somewhat larger; color duller, much less rufescent. Similar in size to *M. pandora,* but color decidedly darker, and skull differing in various details. Differing from *M. bricenii* of Venezuela in larger size, shorter pelage (very short on neck), and less rich rufescent general coloration, the dark facial area more restricted.

Color.—General color of upper parts dull cinnamon rufous, darkest along the broad median line and becoming paler on the sides; middle of face, top of head and upper side of neck, blackish; cheeks and under side of neck drab gray; chest and anterior part of abdomen near cinnamon or fawn color; chin, throat and posterior part of abdomen, white, this color extending a short distance down inner side of thighs; ears dusky, except a buffy spot near edge of anterior base; supraorbital area, including lateral border of frontal tufts, rusty reddish; a white spot on upper lip near rhinarium as usual in the group; feet drab brownish; tail, cinnamon rufous above, white below.

Skull.—Size slightly larger than that of *M. t. tema;* frontal and parietal regions broader; audital bullæ smaller; foramen ovale more elongated; lachrymal depressions and dentition about the same. Approaching in size that of *M. pandora;* frontal region similarly broad, but more inflated near posterior border of nasals; rostrum narrower, the maxillæ less swollen outward; lachrymals less broadly depressed; squamosal arm of zygoma with superior border more everted; foramen ovale more elongated; audital bullæ decidedly smaller.

Measurements.—Type: Total length, 1,114 millimeters; tail vertebræ, 130. *Skull* (type): Greatest length, 185; condylobasal length, 175.7; zygomatic breadth, 81.2; nasals, 59.5; interorbital breadth, 41; palatal length, 107.4; maxillary toothrow, 50.2; upper premolars, 23.4.

Remarks.—The type specimen is a rather young male with very short antlers, but with permanent dentition in place and slightly worn. Another specimen, also a male, is much younger. They appear to represent a rather well marked form related to *M. tema* as shown by comparison with seven Mexican specimens of the latter. Five of these are from Mirador, Vera Cruz, the type locality of *Cervus sartorii* Saussure, a name now regarded as synonymous with *Mazama tema* Rafinesque. Upper canines are present in one of the Mirador specimens, a young male with the third upper molars not yet in place. *M. pandora* possesses very distinctive characters, but is apparently a member of the same group. Besides the pallid coloration and cranial peculiarities, the type and a specimen from Apazote, Campeche, lack of the usual hair whorl near the middle of the face, and the hair is directed upward from an indistinct whorl very near the upper border of the rhinarium. A specimen of *Mazama bricenii* Thomas from the high mountains near Merida, Venezuela, has much longer pelage and is very different in color, the entire face, including the orbital areas, being very dark brown or blackish. In the Middle American brockets the orbital areas and much of the face are rusty reddish.

Specimens examined.—Total number, 3, from localities as follows:

Canal Zone: Gatun (type locality), 2.

Panama: Cana, 1.

SCIURUS VARIABILIS CHOCO,[1] new subspecies

Type from Cana (altitude 3,500 feet), Eastern Panama. No. 179561, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, May 28, 1912. Original number 21752.

General characters.—Closely allied to *S. v. morulus,* but general color darker; a deep black median dorsal stripe usually continuous from near shoulders posteriorly over upper base of tail (this stripe absent or only faintly indicated in *S. v. morulus*); under parts ochraceous rufous instead of tawny ochraceous; under side of tail with broader, more distinct black submarginal stripe. Perhaps similar to *S. gerrardi,* but shoulders less rufous, back darker, and under parts not normally white; mammæ 3 pairs as in *S. v. morulus.*

Color.—Upper parts varying from pale ochraceous buff to tawny ochraceous, finely lined with black, becoming blackish on top of head and along a conspicuous median dorsal stripe usually continuous from near shoulders posteriorly over upper base of tail; shoulders usually a slightly richer ochraceous tone than sides; outer sides of forearms ochraceous rufous mixed with black; outer sides of hind legs like sides of back; under parts, including inner sides of limbs, usually nearly uniform ochraceous rufous, but varied in two specimens by pure white areas in armpits, on pectoral and inguinal regions, and along median line of abdomen; chin and lips pale buff; sides of muzzle and cheeks brownish buffy; ears dark brownish or blackish; feet clothed with short, mixed blackish and buffy or tawny hairs; upper side of tail blackish on proximal fourth, becoming pure, rich ochraceous rufous to near black tip, under side coarsely mixed buff and black, with a distinct black submarginal stripe and ochraceous rufous edging along median portion.

Skull.—As in *S. v. morulus.*

Measurements.—Type: Total length, 444 millimeters; tail vertebræ, 209; hind foot, 61. Average of 3 adult topotypes; 443 (430-

[1] From Choco, the name of the Indians inhabiting the region of the type locality.

455); 214 (299-223); 60 (60-61). *Skull* (type): Greatest length, 55.3; condylobasal length, 50.7; zygomatic breadth, 22.7; nasals, 18.8; interorbital breadth, 18; palatal length, 29.7; maxillary toothrow, 9.8.

Remarks.—The common squirrel of the Darien region, Panama, is closely allied to *S. v. morulus* from the Canal Zone, but is distinguished by darker color throughout. *S. milleri* from the mountains of southwestern Colombia has the same general pattern of coloration, but differs in darker, more rusty reddish general color, the darkening due in part to the much narrower subterminal bands of the hairs on the shoulders and flanks. In the Darien form the median dorsal stripe is pure glossy black in some specimens, and usually extends well down over the upper base of the tail. Variation from the usual ochraceous rufous coloration of the under parts is shown in one individual by limited areas of pure white near the armpits, on the pectoral and inguinal regions, and a very narrow stripe along the median line of the abdomen; in another the white is reduced to a few hairs near the armpits and on the sides of the lower part of the abdomen. These white areas may indicate gradation of this subspecies toward the South American forms of the *S. variabilis* group in which the under parts are normally white. Specimens from 800 to 2,500 feet altitude, on Cerro Azul, are somewhat intermediate between *S. v. morulus* and the Darien form, the dorsal stripe being somewhat indistinct, but in the rich coloration of the under parts they agree with the latter form.

These squirrels are generally distributed throughout the region visited, ranging upward in the forest from sea level in the Tuyra Valley to over 5,000 feet altitude on the summits of the Pirri Range.

Specimens examined.—Total number, 18, from Eastern Panama, as follows: Cana (type locality), 5; Boca de Cupe, 1; Cerro Azul, 3; Marraganti, 3; Mount Pirri, 6.

ORYZOMYS PIRRENSIS, new species[1]

Type from near head of Rio Limon (altitude 4,500 feet), Mount Pirri, Eastern Panama. No. 178993, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 29, 1912. Original number 21662.

General characters.—A large member of the *O. meridensis* group, similar in size to *O. devius*, of Western Panama; color slightly darker; metatarsus dark brown instead of flesh color; under parts without the pure white patches usual in the group; skull large and angular, with moderately developed supraorbital ridges and small audital bullæ.

Color.—Upper parts near Mars brown of Ridgway, darkened along the broad median line from top of head to base of tail, becoming lighter, more rufescent on cheeks, shoulders and sides; throat grayish, rest of under parts usually overlaid with dark ochraceous buff, but varying to dull white, the basal color of the fur everywhere deep plumbeous; nose and ears blackish; outer sides of limbs dark brownish, except a light buffy line extending from outer sides of wrists posteriorly along lower edge of forearms; fore feet blackish, becoming lighter on the toes; hind feet dark brown and thinly clothed with short hairs to toes, the toes dark flesh color and nearly naked, but with rather conspicuous tufts of silvery hairs projecting beyond claws of four longest digits; tail dark brown above, usually somewhat paler below.

Skull.—Similar in size to that of *O. devius*, but more angular, the zygomata more widely spreading, and supraorbital and temporal ridges distinct; audital bullæ decidedly smaller; dentition about the same. Differing from those of *O. meridensis* and *O. maculiventer* in much larger size and greater angularity.

Measurements.—Type: Total length, 340 millimeters; tail vertebræ, 185; hind foot, 38. Average of five adult topotypes, 314 (309-322); 164 (159-170); 35.7 (34-37). *Skull* (type): Greatest length, 37.8; condylobasal length, 34.5; zygomatic breadth, 20; nasals, 14; interorbital breadth, 6; interparietal, 11.8 x 5; incisive foramina, 6; length of palatal bridge, 7.8; maxillary toothrow, 5.9.

Remarks.—Like the allied species—*O. devius*, *O. meridensis* and *O. maculiventer*—this large rice rat is an inhabitant of the mountains. It was found only in the heavy forest at about 4,500 feet altitude where precipitous slopes border the narrow canyon of the Rio Limon. The animals live in holes under logs and rocks along steep overhanging banks of the stream. The skull of *O. pirrensis* combines the large general size of that of *O. devius* with the small audital bullæ of *meridensis* and *maculiventer;* it differs from both in the development of the supraorbital and temporal ridges. *O. meridensis* and *O. maculiventer* are evidently very nearly related, but comparison of three skulls of the former with four of the latter seems to show that *O. maculiventer* differs in the smaller size of the interparietal and heavier maxillary arm of zygoma.

Specimens examined.—Eight, all from the type locality.

NECTOMYS ALFARI EFFICAX, new subspecies

Type from Cana (altitude 1,800 feet), Eastern Panama. No. 178627, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, March 12, 1912. Original number 21498.

General characters.—Closely allied to *Nectomys alfari alfari* (*Sigmodontomys alfari* Allen); general color of upper parts richer, more tawny ochraceous; skull with narrow braincase and massive rostrum. Somewhat similar to *N. esmeraldarum*, but larger; color decidedly paler, more ochraceous; skull more elongated.

Color.—Upper parts rather pale tawny ochraceous mixed with black, the ochraceous predominating especially on cheeks, shoulders, flanks and outer sides of hind limbs; top of head and face darkened by more abundant admixture of black-tipped hairs; under parts dull white, usually more or less distinctly washed with pale buff; feet flesh colored, thinly clothed with short grayish hairs; tail brownish above and below.

Skull.—Similar in general to that of *N. a. alfari*, but braincase narrower; rostrum more massive; nasals shorter and broader posteriorly; frontal region narrower, but with similarly developed supraorbital and temporal ridges; interparietal smaller; interpterygoid fossa narrower; maxillary toothrow shorter. Contrasted with that of *N. esmeraldarum* the skull is relatively narrower and more elongated, the rostrum and frontal region being decidedly longer.

Measurements.—Type: Total length, 305 millimeters; tail vertebræ, 179; hind foot, 36.5. Average of five adult topotypes: 314 (304-320); 178 (168-196); 36.1 (35.5-37). *Skull* (type): Greatest length, 36.2; condylobasal length, 23.8; zygomatic breadth, 19.7; nasals, 14.2; interorbital breadth, 7.2; interparietal, 8.2 x 3.2; incisive foramina, 5.5; length of palatal bridge, 8.5; maxillary toothrow, 5.4.

Remarks.—This form seems to be more closely allied to the species described as *Sigmodontomys alfari* than to any of the small South American members of the genus *Nectomys*. It may be not very unlike *N. russulus* Thomas, from Valdivia, Colombia, specimens of which I have not seen, but judging from the description the latter is darker in general color, with less contrast between upper and under parts.

Specimens examined.—Total number, 23, all from the type locality.

RHIPIDOMYS SCANDENS, new species

Type from near head of Rio Limon (altitude 5,000 feet), Mount Pirri, Eastern Panama. No. 178937, female old adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 25, 1912. Original number 21640.

General characters.—Similar to *R. venezuelæ,* but upper parts darker colored; under parts pure white as in *venezuelæ;* skull with broad braincase and narrow frontal region. Somewhat like *R. cocalensis,* but color less tawny, and skull differing especially in narrower more depressed frontal region.

Color.—Upper parts pale cinnamon rufous lined with black, becoming paler on the cheeks, shoulders and sides where the black-tipped hairs are less numerous; pelage of under parts, including lips and inner sides of limbs, pure white to roots; feet white except the usual clouded metapodial areas; tail brownish above and below, scantily clothed with short hairs to near tip which is slightly tufted.

Skull.—In general form closely resembling that of *R. venezuelæ,* but braincase decidedly broader; inner sides of parietals longer; frontal region narrower posteriorly as in *R. venezuelæ.* Compared with the skull of *R. cocalensis* the braincase is similarly broad, but the frontal region is depressed anteriorly and much narrower, especially posteriorly, the maxillary arm of the zygoma is heavier, and the interparietal is larger.

Measurements.—Type: Total length, 330 millimeters; tail vertebræ, 198; hind foot, 32. *Skull* (type): Condylobasal length, 32.3; zygomatic breadth, 19.2; interorbital breadth, 5.3; interparietal, 10.2 x 4.8; incisive foramina, 7.3; length of palatal bridge, 5; maxillary toothrow, 5.7.

Remarks.—This form is closely allied to *R. venezuelæ,* and the two may intergrade, but until the various forms of this unrevised group are better known it seems preferable to treat the Panama representative of the genus as a distinct species.

Specimens examined.—One, the type.

HETEROMYS AUSTRALIS CONSCIUS, new subspecies

Type from Cana (altitude 2,000 feet), Eastern Panama. No. 178699, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, March 8, 1912. Original number 21468.

General characters.—Closely allied to *H. australis australis* and *H. a. lomitensis,* but darker colored than the former and with the slender hairs among the bristles grayer than in the latter; skull differing from those of both in various details, especially the greater breadth of ascending branches of premaxillæ.

Color.—Ground color of upper parts dark blackish slate or slaty black, the slender grayish hairs among the darker bristles giving the dorsum a finely lined appearance; under parts, including lips and inner sides of limbs, pure white; forearms whitish, more or less mixed with grayish, especially along outer sides; ankles dusky all round; feet grayish to toes, the toes white; tail brownish above, somewhat lighter below, becoming dark all round toward tip.

Skull.—Closely resembling that of *H. a. australis*, but more elongated; ascending branches of premaxillæ broader. Contrasted with that of *H. a. lomitensis* the upper surface of maxillary arm of zygoma is broader, and the ascending branches of premaxillæ are broader posteriorly and more nearly conterminous with nasals (nasals reaching farther posteriorly in *H. a. lomitensis*).

Measurements.—Type: Total length, 260 millimeters; tail vertebræ, 133; hind foot, 32. Average of 2 adult topotypes: 245 (240-251); 125 (120-131); 32.2 (31-33.5). *Skull* (type): Greatest length, 34.7; zygomatic breadth, 16.5; interorbital breadth, 8.3; nasals, 14.4; width of braincase at anterior border of auditory meatus, 14.7; interparietal, 8.7 x 5.3; maxillary toothrow, 5.4.

Remarks.—This pocket mouse and the two South American forms described as *H. australis* and *H. lomitensis* are all very closely allied and may stand subspecifically as follows:

Heteromys australis australis Thomas, San Javier, Ecuador.
Heteromys australis lomitensis Allen, Las Lomitas, Cauca, Colombia.
Heteromys australis conscius Goldman, Cana, Panama.

The form here described was the only pocket mouse found on the lower slopes of the Pirri Range at from 1,800 to 2,000 feet altitude; the upper slopes above 4,500 feet are inhabited by the very different species, *H. crassirostris.*

Specimens examined.—Five, all from the type locality.

AGOUTI PACA NELSONI, new subspecies

Type from Catemaco, southern Vera Cruz, Mexico. No. 65952, male adult, U. S. National Museum (Biological Survey Collection), collected by E. W. Nelson and E. A. Goldman, April 30, 1894 Original number 6135.

Distribution.—Coastal plains and mountain slopes from the vicinity of Jalapa, Vera Cruz, eastward and southward through Tabasco, Chiapas and the peninsula of Yucatan to eastern Guatemala and western Honduras.

General characters.—Similar to *A. paca virgata*, but general color more rusty or reddish brown; dark stripe below lower lateral white stripe obsolescent (broad and distinct in *virgata*); pelage longer and denser; molariform toothrows narrower. Differing from typical *A. paca paca* in the obliteration of the lower lateral stripes.

Color.—Ground color of upper parts varying from dark cinnamon rufous to dark chestnut, interrupted along sides by white arranged in narrow stripes or lines of spots; two lateral white lines begin as rows of spots along sides of neck, become stripes near shoulders, curve downward along lower part of sides, rise again toward hips, and break into spots over sides of rump; above the upper lateral white stripe and separated from it by a broad dark stripe a line of spots reaches from neck to rump, and above this a shorter parallel row extends along posterior part of back; lower lateral white stripe bounded below by a narrow and rather indistinct dark line; a third white stripe, continuous and distinct in *A. p. paca*, is indicated posteriorly near the thigh where it merges with the white of the under parts; under parts, usually including inner sides of limbs, dull white, cheeks grayish brown; outer sides of fore limbs pale fawn color; hind limbs similar to back.

Skull.—Closely resembling that of *A. p. virgata*, but rostrum longer; frontals more inflated along maxillary borders; molariform teeth narrower.

Measurements.—Type: Total length, 794 millimeters; tail vertebræ, 29; hind foot, 127. *Skull* (type): Greatest length, 154.8; condylobasal length, 147.5; zygomatic breadth, 111.7; interorbital breadth, 43.3; nasals, 55.7; palatal length, 93.7; maxillary toothrow, 30; width of crown of second upper molar, 6.5.

Remarks.—In the Mexican paca the encroachment of the white color of the under parts along the sides and the consequent obliteration of stripes, a character separating *virgata* from typical *paca*, has proceeded still farther and the dark stripe below the lower of the two lateral white stripes is reduced to a very narrow line, or may be absent entirely.

Specimens examined.—Total number, 16, from the following localities:

Vera Cruz: Catemaco (type locality), 5; Chichicaxtle, 1.
Tabasco: (Exact locality unknown), 1.
Chiapas: Palenque, 1; Teopisca (20 miles southeast), 1.
Campeche: Apazote, 1.
Guatemala: Puerto Barrios, 1; exact localities unknown, 4.
Honduras: San Pedro Sula, 1.

DASYPROCTA PUNCTATA DARIENSIS, new subspecies

Type from near head of Rio Limon (altitude 5,200 feet), Mount Pirri, Eastern Panama. No. 179056, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 24, 1912. Original number 21637.

General characters.—Closely allied to *D. punctata isthmica*, but size larger and general color darker; top of head blacker; long hairs on rump lacking basal annulations usually present in *D. p. isthmica*, the tips very pale buff or silvery gray in contrast with orange buffy back (rump and back more nearly uniform in *D. p. isthmica*). Somewhat similar to *D. colombiana*, but general color much more ochraceous, less grayish.

Color.—Top of head, nape and shoulders black coarsely mixed with varying shades of pale buff or ochraceous, the black predominating on top of head; back heavily overlaid with rich orange buff, the long hairs here dark and without rings below the broad orange buff tips; long hairs of rump dusky basally and tipped with pale buff or silvery gray, the general color thus contrasting with the richer tints of back; under parts in general mixed black and varying shades of buff, becoming grayish on throat, and white or silvery gray on lips, chin, inguinal region and along median line of abdomen where the hairs are pure white to roots; feet black with a few buffy banded hairs on proximal portion of metatarsus.

Skull.—Similar to that of *D. p. isthmica*, but larger; palate with a short posterior median projection, absent in *D. p. punctata* and the more northern forms of the group, but sometimes present in *D. p. isthmica*. Differing from that of *D. colombiana* in more slender rostrum and lesser vertical extent of anterior part of jugal (in *D. colombiana* the jugal, more developed upward along the orbital border, approaches the lachrymal).

Measurements.—Type: Total length, 610 millimeters; tail vertebræ, 25; hind foot, 133. Average of two adults from Cana (near type locality): 579 (572-586); 25.5 (21-30); 128.5 (127-130). Skull (average of three adults from type locality and vicinity): Greatest length, 115.3 (113-117.8); condylobasal length, 112.8 (105.6-118.8); zygomatic breadth, 53.3 (51.5-55.5); nasals, 45.5 (44.5-47.2); interorbital breadth, 31.5 (29-34); palatal length, 58.9 (57.2-60); maxillary toothrow, 19.3 (18.5-20.8).

Remarks.—Contrasted with *D. p. isthmica* of the Canal Zone the Darien representative of the *D. punctata* group differs in characters which seem to set it off as a fairly well marked geographic race. It may be not very unlike *D. variegata* Tschudi,[1] from Peru, but is very different from Tschudi's figure, and compared with an Ecuadorean specimen in the National Museum, assumed to be near *D. variegata,* is decidedly larger and darker colored. *D. colombiana* of the Santa Marta region of northern Colombia is doubtless a form of the *D. punctata* group characterized by grayish coloration and cranial details pointed out.

In the Darien region the agouti ranges in the unbroken forest from sea level to over 5,000 feet altitude on the summits of the higher mountains. As elsewhere, the animals are shy and apparently mainly nocturnal in habits, but if carefully searched for may be found abroad early in the morning or late in the evening, and occasionally during the middle of the day, especially in wet weather They become alarmed at the slightest noise and scamper away, often giving the characteristic squeak or short bark, rapidly repeated several times, as they go. The usual method of hunting them is to proceed slowly and cautiously, mainly along trails through the forest, or to wait in the vicinity of their holes until they come out. One day, during the dry season, I heard a rustling noise in the dry leaves, and remaining motionless soon saw an agouti which came rapidly nearer and was shot as it stopped suddenly about 20 yards away. The Indians and native colored population hunt the agouti for its flesh, and it is one of the favorite game animals of the region.

Native name *ñequi.*

Specimens examined.—Total number, 8, from localities in Panama as follows: Aruza, 1; Cana, 6; Mount Pirri, 1 (type).

DASYPROCTA PUNCTATA YUCATANICA, new subspecies

Type from Apazote (near Yohaltun), Campeche, Mexico. No. 108293, male adult, U. S. National Museum (Biological Survey Collection), collected by E. W. Nelson and E. A. Goldman, December 22, 1900. Original number 14347.

Distribution.—Campeche and northern Yucatan.

General characters.—Similar to *D. punctata punctata,* but color decidedly paler and grayer, less yellowish or rufescent, and pelage rather more coarsely annulated; audital bullæ large.

Color.—Upper parts in general varying from pale buff to pale tawny ochraceous coarsely mixed with black, the buff or tawny element predominating; an indistinct annulated effect, especially on rump, resulting from the alternating light and dark rings of hairs;

[1] Fauna Peruana (Mammals), pp. 190-192, Taf. 16, 1844-1846.

top of head usually somewhat more rufescent than back; under parts, including under side of neck, chest and sides of abdomen, similar to back but paler and grayer; chin, lips, inner sides of fore and hind legs, inguinal region and median line of abdomen, buffy white; feet blackish, more or less irregularly lined with buffy-ringed hairs.

Skull.—Closely resembling that of *D. p. punctata*, but audital bullæ usually larger, and more inflated anteriorly.

Measurements.—Type: Total length, 522 millimeters; tail vertebræ, 35; hind foot, 120. An adult male topotype: 487; 25; 126. An adult female from La Vega, northeastern Yucatan; 555; 29; 130. *Skull* (type): Greatest length, 108; condylobasal length, 100.5; zygomatic breadth, 49.8; nasals, 44.5; interorbital breadth, 30.5; palatal length, 53.7; maxillary toothrow, 19.

Remarks.—The range of this pale form in the Yucatan peninsula marks the extreme northern limit of the *D. punctata* group. It is a rather common animal in the arid or semi-arid, low-lying forested sections of the region.

Specimens examined.—Total number, 7, from localities as follows:

Campeche: Apazote (type locality), 4; La Tuxpana, 1.

Yucatan: La Vega, 2.

DASYPROCTA PUNCTATA CHIAPENSIS, new subspecies

Type from Huehuetán, southern Chiapas, Mexico. No. 77997, female adult, U. S. National Museum (Biological Survey Collection), collected by E. W. Nelson and E. A. Goldman, February 26, 1896. Original number 9430.

Distribution.—Southern Chiapas, from sea level to at least 3,500 feet altitude, and probably adjacent parts of Guatemala.

General characters.—Similar to *D. punctata punctata* in size and color, but differing in well marked cranial details; premaxillæ broader posteriorly; sphenopalatine vacuities larger; audital bullæ smaller. Differing from *D. punctata yucatanica* in decidedly richer, more rufescent coloration and in important cranial characters.

Color.—Upper parts varying from tawny ochraceous to ochraceous rufous rather finely mixed with black, the hairs annulated about as in *D. p. punctata;* under parts in general similar to back, but paler; chin and armpits, inner sides of hind legs and median line of abdomen varying from pale or yellow buff to pale orange buff; feet blackish, with a few tawny hairs encroaching on metatarsus.

Skull.—Size and general form about as in *D. p. punctata;* ascending branches of premaxillæ much broader posteriorly, the broadening being at the expense of the maxillæ which are correspondingly reduced; sphenopalatine vacuities larger; vertical arm of maxilla between jugal and antorbital vacuity broader; audital bullæ smaller. Compared with that of *D. p. yucatanica* the skull has posteriorly broader premaxillæ, larger sphenopalatine vacuities and much smaller audital bullæ.

Measurements.—Type: Total length, 492 millimeters; tail vertebræ, 30; hind foot, 120. An adult female topotype: 565; 27; 124. *Skull* (type): Greatest length, 102.8; condylobasal length, 95.2; zygomatic breadth, 48.2; nasals, 38.5; interorbital breadth, 28.5; palatal length, 52; maxillary toothrow, 19.5.

Remarks.—An arm of the general range of the *D. punctata* group extends northward near the Pacific coast, and along the west slope of the high mountains of the interior, to southern Chiapas, Mexico. The specimens from the coastal slope in Chiapas closely approach typical *D. p. punctata* in color, but depart from it in the well marked cranial details pointed out. In the region of the type locality this agouti ranges in the forest from near sea level to at least 3,500 feet altitude on the western slope of the mountains.

Specimens examined.—Six, all from Chiapas, Mexico, as follows: Huehuetán (type locality), 4; Chicharras, 2.

POTOS FLAVUS ISTHMICUS, new subspecies

Type from near head of Rio Limon (altitude 5,200 feet), Mount Pirri, Eastern Panama. No. 179042, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, April 21, 1912. Original number 21631.

General characters.—Size and general color of *P. f. chiriquensis*, but with a distinct black dorsal stripe; skull with narrow interorbital region; dentition heavy as in *P. f. chiriquensis*, much heavier than in *P. f. meridensis* and other South American forms.

Color.—General color of upper parts varying from wood brown to tawny yellow or yellowish tawny slightly darkened by blackish-tipped hairs; a narrow but distinct black median stripe extending from near shoulders to base of tail; under parts varying from buff to brownish yellow, becoming abruptly rusty brown on the abdominal and gular spots usual in the group; muzzle, ears and toes more or less blackish; upper side of tail similar to back in color but usually becoming somewhat darker toward tip, the under side paler and more like abdomen.

Skull.—Similar to that of *P. f. chiriquensis*, but interorbital region narrower, the lateral borders of frontals more concave; postorbital processes stouter, broader and more gradually tapering toward base, not so peg-like as in *P. f. chiriquensis;* dentition about the same. Compared with that of *P. f. meridensis* the skull has similarly broad postorbital processes and narrow interorbital space, but the molars are decidedly heavier.

Measurements.—Type: Total length, 910 millimeters; tail vertebræ 455; hind foot, 93. An adult female topotype: 885; 448; 91. *Skull* (type): Greatest length, 89.7; condylobasal length, 83; zygomatic breadth, 57; interorbital breadth, 18.2; palatal length, 36.5; upper molariform toothrow, 19; alveolar length of first upper molar, 4.2.

Remarks.—The specimens from Mount Pirri and Cana vary considerably in intensity of color as usual in the group, but are externally distinguishable from *P. f. chiriquensis* by the distinct black median dorsal stripe. They apparently represent a race combining the general color pattern of some South American forms with the heavier dentition of Middle American forms.

Specimens examined.—Total number, 8, all from the mountains of Eastern Panama as follows: Mount Pirri (type locality), 2; Cana, 6.

EUPROCYON CANCRIVORUS PANAMENSIS, new subspecies

Type from Gatun, Canal Zone, Panama. No. 171669, female adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, June 21, 1911. Original number 21174.

General characters.—Similar in size to *E. cancrivorus proteus*, but general color less tawny; skull with very long palate and anteriorly broad nasals. Differing from *E. cancrivorus cancrivorus* in darker general color, the upper parts being blacker, and under parts and sides more ochraceous buffy or yellowish; black facial area more extended posteriorly across cheeks.

Color.—Ground color over dorsum varying from ashy gray to ochraceous buffy or yellowish ochraceous, heavily overlaid with black; top of head grizzled black and gray, the black predominating; sides of muzzle and rather restricted supraorbital streaks white or grayish white; facial area, including orbits, interorbital space and lower part of cheeks nearly clear black; under parts, including base of tail, varying from pale ochraceous buff to yellowish ochraceous, becoming more or less grayish white on throat, chin and lips; ears well clothed with whitish or yellowish hairs, darkening gradually on upper base by encroachment of body color; outer sides of hind legs and ankles all round deep, glossy black; fore legs black or dark brownish all round; feet thinly clothed with short hairs varying from brownish to grayish; tail with seven or eight alternating black and grayish or yellowish rings and a black tip, the proximal rings more or less interrupted along median line below.

Skull.—In general form closely resembling that of *E. c. cancrivorus,* but palate more elongated, lower surface of basioccipital more convex, the lateral margins turning downward and partly covering audital bullæ; nasals broader; audital bullæ broader, more inflated posteriorly; dentition about the same. Contrasted with that of *E. c. proteus,* the skull differs in longer palate, and anteriorly broader, posteriorly narrower nasals.

Measurements.—Type: Total length, 950 millimeters; tail vertebræ, 350; hind foot, 142. *Skull* (type): greatest length, 130; condylobasal length, 125.8; zygomatic breadth, 83.3; length of nasals, 32; greatest breadth of nasals anteriorly, 14.3; greatest breadth of nasals posteriorly, 13; interorbital breadth, 25.7; palatal length, 75.8; upper molariform toothrow, 40.3.

Remarks.—Comparison of the Panama series and South American material from various localities, including a specimen from northern Brazil assumed to be near typical *E. c. cancrivorus* of Cayenne, and the type and two topotypes of *E. c. proteus* of northern Colombia, shows that the species is represented in Panama by an apparently well-marked geographic race. The close agreement in dentition and the more essential characters, however, point to a probable intergradation of the forms of this group, which may now stand as follows:

Euprocyon cancrivorus cancrivorus (Cuvier), Cayenne.
Euprocyon cancrivorus proteus (Allen), Bonda, Colombia.
Euprocyon cancrivorus brasiliensis (Von Ihering), Southern Brazil.
Euprocyon cancrivorus panamensis Goldman, Gatun, Canal Zone, Panama.

The South American raccoon currently known as *Procyon cancrivorus* was placed in the subgenus *Euprocyon* by Gray in 1864 (type *Ursus cancrivorus* Cuvier), and this division of the genus has been accepted by some later authors. The two sections of the genus differ, however, in characters so important that *Euprocyon* seems entitled to full generic recognition. Besides the characters pointed out by Gray *Euprocyon* is distinguished by the shorter, more rounded condition of the cusps in the molariform teeth and the general obliteration of the rugosity seen in *Procyon.* This is well shown in the upper carnassial where the trenchant commissure of the median outer cusp and the postero-internal cusp present in *Procyon,* is absent. The third upper incisor lacks the internal division commonly developing a short, independent cusp in *Procyon*. The length of the palate behind the posterior molars is less than one-fourth the total length of the palate, while in *Procyon* the reverse is true. Externally *Euprocyon* differs from *Procyon* in the reversed direction of the pelage on the neck;[1] from the hair-whorl on the median line between the shoulders the pelage is inclined forward, meeting the opposing pelage of the head along a V-shaped line between the ears, the apex of the V directed backward; on the under side of the neck the arrangement is similar, but the apex of the V points forward. In addition the claws, especially of the hind feet, are straighter, broader, more bluntly pointed, instead of being laterally compressed, strongly curved and sharply pointed as in *Procyon*. The general non-sectorial character of the dentition, the form of the upper carnassial, and the posterior shortening of the palate in *Euprocyon* suggest gradation toward the ancestral Miocene genus *Phlaocyon*.

Euprocyon differs from *Procyon* in its blunt claws, indicating a non-arboreal habit, and its short powerful molariform cusps, adapted for crushing hard substances, seems to fit it for a life, where crabs, fish and mollusks are common foods.

In Panama this raccoon inhabits the lowlands along the Caribbean coast from the northern end of the Canal Zone easterly toward Colombia. Mr. P. L. Sclater[2] recorded specimens from Colon in 1875. One of the specimens obtained by me was killed as it emerged from some tall *papyrus* grass near the edge of a swamp whence it had been driven by a pack of hounds. Others were shot at night along the banks of the Chagres River, where they were located. The stomachs examined contained fragments of fish and crabs.

Specimens examined.—Total number, 5, from the following localities:

Canal Zone: Gatun (type locality), 3.
Panama: Cana, 1; Porto Bello, 1.

ALOUATTA PALLIATA INCONSONANS, new subspecies

Type from Cerro Azul (altitude 2,500 feet), near the headwaters of the Chagres River, Panama. No. 171068, male adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, March 23, 1911. Original number 20995.

[1] Von Ihering mentions this character in describing the south Brazilian subspecies, *Procyon cancrivorus brasiliensis* (Revista do Museu Paulista, vol. 8, p. 229, May 10, 1911).

[2] Proc. Zoöl. Soc. Lond., 1875, p. 421.

General characters.—Similar to *A. palliata palliata*, but general color purer black, less suffused with brownish or rufous, especially on flanks, rump, and posterior part of back; pelage of forehead, anterior part of cheeks and chin inclined backward, and that of upper side of neck directed forward, forming a ruff about face as in *A. p. palliata;* skull with broad braincase and narrow premolars. Differing from *A. coibensis* in decidedly larger size, and from *A. p. mexicana* in much darker body color as well as larger size.

Color.—Upper parts varying from pure black to black finely and usually rather inconspicuously mixed with buff over most of dorsum, leaving head and rump pure black; under parts in general thinly haired, black or dark brownish, becoming lighter through varying shades from burnt umber of Ridgway to brownish ochraceous on the long hairs overhanging lower part of sides; chin, arms, legs and tail pure glossy black.

Skull.—Size and general form similar to that of *A. p. palliata*, but braincase broader posteriorly; frontal profile in male rising more abruptly from rostrum; zygomata usually more squarely spreading posteriorly, the superior border of squamosal root more strongly curved inward over auditory meatus; supraoccipital protuberance stouter, more projecting; interpterygoid fossa broader; audital bullæ flatter; premolars narrower. Skull differing from those of *A. coibensis* and *A. p. mexicana* in decidedly larger size.

Measurements.—Type: Total length, 1,272 millimeters; tail vertebræ, 715; hind foot, 143. An adult male topotype; 1,267; 685; 142. Average of 5 adult female topotypes: 1,262 (1,123-1,552): 657 (603-710); 140 (135-142). *Skull* (type): Greatest length, 123.5; condylobasal length, 103.7; zygomatic breadth, 87.2; length of nasals, 21.8; anterior width of nasals, 10.5; width of nasals at median constriction, 8; interorbital breadth, 12.2; palatal length, 46.8; maxillary toothrow, 29.4; width of crown of third upper premolar, 7.7; anteroposterior extent of supraoccipital protuberance (measured from lambdoid suture) 14.1.

Remarks.—*Mycetes palliatus* Gray was described and figured from specimens supposed to be from Caracas, Venezuela, and that place has been republished as the type locality of the species in several recent lists. Mr. Sclater[1] and Mr. Alston,[2] however, have shown that the specimens really came from the shores and islands of Lake Nicaragua. Comparison of series of specimens from various localities

[1] Proc. Zoöl. Soc. Lond., 1872, p. 7.

[2] Biologia Centrali-Americana, Mammalia, p. 5, 1879.

shows that *A. p. palliata* of Nicaragua ranges southward through Costa Rica as far as Talamanca, and is replaced in Eastern Panama by the new form here described. Unaware of the real type locality of *A. p. palliata* Dr. Allen,[1] in publishing *Alouatta palliata matagalpæ* from Lavala, Nicaragua, renamed the typical form,[2] using Panama examples assumed to be *A. p. palliata* for comparison. Farther north this group of howlers is represented by *A. palliata mexicana* whose range appears to extend from Tabasco, Mexico, southeastward to northern and eastern Honduras. *A. p. mexicana* is characterized by smaller general size, and by having more buffy ochraceous suffusion of upper parts than *A. p. palliata*. The long-haired, black howler currently recognized as *A. villosa* (Gray) is a very distinct species, ranging from Guatemala into the lowlands of Campeche, Tabasco and northern Chiapas, Mexico, where it occurs at the same elevations and perhaps the same localities as *A. p. mexicana*. It is distinguished from *A. p. mexicana* by long pure black pelage, and elongated, flattened skull.

In Eastern Panama howling monkeys are generally distributed from near the coasts well up toward the summits of the higher mountains. They occur in small numbers near Gatun in the northern end of the Canal Zone. Several parties were met with on the mountains near the headwaters of the Chagres River. On Cerro Azul a troop of about twelve was found in a group of very tall trees. The troop included several full grown males, females, and young. A very young individual was seen clinging to the lower part of its mother's back as she climbed into the topmost branches along with other females and the younger animals. The older males gave the usual roar when shots were fired, jumping about, looking down, and showing signs of anger rather than fear, as they made no effort to escape. The so-called howling of these monkeys was heard soon after daylight nearly every morning not far from camp on the Cascajal River near Cerro Brujo, and at intervals during the day. Near the summit of the Pirri Range sudden showers of rain often brought forth deep-toned notes during the night. The voice of this animal, as it reverberates through the forest, is wonderfully impressive, but seems better described as a series of deep growls, becoming a prolonged roar when given by several in unison, than as howling. Although the howler can pass rapidly through the tree tops, its

[1] Bull. Amer. Mus. Nat. Hist., vol. 24, p. 670, Oct. 13, 1908.

[2] Dr. Allen directs attention to this error (Bull. Amer. Mus. Nat. Hist., vol. 28, p. 114, Apr. 30, 1910).

movements seem sluggish when compared with those of *Ateles* or even *Cebus*. The flesh is eaten by the natives, but is less prized than that of *Ateles* and *Cebus*. It is commonly cut in strips and after being smoked over a fire may be kept for several days without salting. All of the specimens obtained carried numerous large larvæ of flies, mainly in the skin on the throat, which added materially to their repugnant appearance. These larvæ were not found on the spider monkeys taken in the same vicinity. Perhaps the greater activity of the latter may not permit the deposition of eggs.

Native name *mono negro*.

Specimens examined.—Nine, all from the type locality.

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THE INFLUENCE OF THE ATMOSPHERE ON OUR HEALTH AND COMFORT IN CONFINED AND CROWDED PLACES

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THE INFLUENCE OF THE ATMOSPHERE ON OUR HEALTH AND COMFORT IN CONFINED AND CROWDED PLACES

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INTRODUCTION

It is generally thought and taught that the ill effects which arise from ill-ventilated houses, factories, workshops, theaters,—from stuffy and crowded rooms where many people congregate together—are due to alterations in the chemical quality of the air. The purpose of this paper is to demonstrate that no evidence has yet been brought forward which shows that the chemical quality of the air has anything to do with these ill effects, and that, apart from the influence of infecting bacteria, the ventilation problem is essentially one of the temperature, relative humidity, and movement of the air. In Germany this point of view has been upheld by that distinguished hygienist, Flügge, and he and his co-workers have contributed a series of papers in which convincing evidence is adduced. In England, Haldane and Lorrain Smith have advanced the same view, and we find it expressed in the evidence given to the Departmental Committee of the Home Office on the Humidity and Ventilation of Cotton Weaving Sheds. (Haldane, Pembrey, Leonard Hill, etc.) Confirmatory evidence has been brought forward in America by Billings, Weir Mitchell, and Bergey.

In all the elementary text-books of hygiene, and in most of the standard works, the chemical aspect of the question is treated as if it were the fundamental factor, and this opinion, widely reiterated in the daily press and in daily conversation, has become accepted as an article of faith.

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Everyone thinks that he suffers in an ill-ventilated room owing to some change in the chemical quality of the air, be it want of oxygen, or excess of carbon dioxide, the addition of some exhaled organic poison, or the destruction of some subtle property of the air by its passage over steam coils, or other heating or conducting apparatus. We hear of "devitalized" or "dead" air and "tinned" or "potted" air of the battleship. The good effects of open-air treatment, of sea and mountain air, are no less generally ascribed to the chemical purity of the air. We maintain that the health-giving properties are primarily those of temperature, light, movement, and relative moisture of the circumambient atmosphere, and, leaving on one side those gross chemical impurities which arise in mines and in some manufacturing processes, that the alterations in chemical composition of the air in buildings where people crowd together and suffer from the effects of ill ventilation, have nothing to do with the causation of these effects.

Satisfied with the maintenance of a specious standard of chemical purity, the public has acquiesced in the elevation of sky-scrapers and the sinking of cavernous places of business. Many have thus become cave-dwellers, confined for most of their waking and sleeping hours in windless places, artificially lighted, monotonously warmed. The sun is cut off by the shadow of tall buildings and by smoke—the sun, the energizer of the world, the giver of all things which bring joy to the heart of man, the fitting object of worship of our forefathers.

The ventilating and heating engineer hitherto has followed a great illusion in thinking that the main objects to be attained in our dwellings and places of business are chemical purity of the air and a uniform, draughtless, summer temperature.

Life is the reaction of the living substance to the ceaseless play of the environment. Biotic energy arises from the transformation of those other forms of energy—heat, light, sound, etc.—which beat upon the transformer, the living substance. Thus, when all the avenues of sense are closed, the central nervous system is no longer aroused and consciousness lapses. Laura Bridgeman, paralyzed in almost all her avenues of sense, fell asleep whenever her remaining eye was closed. The patient who lost one labyrinth by disease and, to escape unendurable vertigo, had the other removed by operation, was quite unable to guide his movement or realize his position in the dark. Rising from bed one night, he collapsed on the floor and remained there helpless till succor arrived.

Sherrington points out that a sense organ—the receptor apparatus—is not stimulated unless there is a change of rate in the transference of energy; and that a change of rate, to be effectual, must occur in most cases with considerable quickness; "otherwise there is a mere unperceived shift in the stationary equilibrium which forms the resting zero of the sensual apparatus." "Both for sensation and for reflex action a function in the threshold value of stimulus is time as well as intensity and quantity. If a weak agent is to stimulate, its application must be abrupt."

Thus the slow changes of barometric pressure on the body surface originate no skin sensations, though such changes of pressure, if applied suddenly, are much above the threshold value for touch. A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus the almost unbearable discomfort which a child feels on putting on for the first time a "natural" wool vest fades away and is no longer noticed with continued wear. Thomas à Becket soon must have become oblivious to his hair shirt and its harbingers. It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind.

"There streams constantly from the body through the skin a current of thermal energy much above the threshold value of stimuli for warmth sensations; yet this current evokes—under ordinary circumstances—no sensation. It is the stationary condition, the fact that the transference of energy continues at constant speed, which makes it unperceived." The inflow of sensations keeps us active and alive, and all the organs working in their appointed functions. Those from the great cutaneous field are of the highest importance. The salt and sand of wind-driven sea air and sea baths act on the skin and brace up the body. The changing play of wind, of light, of cold and warmth, stimulate the activity and health of mind and body. Monotony of occupation and external conditions for long hours destroy vigor and happiness and bring about the atrophy of disuse. Daily observation shows us that a drayman, navvy, or policeman can live in London or any other big city strong and vigorous, and no less so than in the country: the brain worker, too, can keep himself perfectly fit if his hours of sedentary employment are not too long and he balances these by open air exercise. The horses stabled, worked, and fed in London are as fine as any in the world: regular open-air exercise and proper feeding and housing ensure the health and fitness of a horse, and no less of a man.

The hardy men of the north were evolved to stand the vagaries of climate—cold and warmth, a starved or full belly, have been their changing lot. The full belly and the warm sun have expanded them in lazy comfort; the cold and the starvation have braced them to action. Modern civilization has withdrawn many of us from the struggle with the rigors of nature; we seek for and mostly obtain the comfort of a full belly and expand all the time in the warm atmosphere afforded us by clothes, wind-protected dwellings, and artificial heat—particularly so in the winter, when the health of the business man deteriorates.

Cold is not comfortable, neither is hunger; therefore we are led to ascribe many of our ills to exposure to cold, and seek to make ourselves strong by what is termed good living. In reality the bracing effect of cold is of supreme importance to health and happiness; we become soft and flabby and less resistant to the attacks of infecting bacteria in the winter not because of the cold, but because of our excessive precautions to preserve ourselves from cold; the prime cause of "cold" or "chill" is not really exposure to cold, but exposure to the overheated and confined air of rooms, factories, and meeting-places.

Seven hundred and eleven survivors were saved from the *Titanic* after hours of exposure to cold. Many were insufficiently clad and others were wet to the skin. Only one died after reaching the *Carpathia*, and he three hours after being picked up. Those who died perished from actual cooling of the body. Exposure to cold did not cause in the survivors the diseases commonly attributed to cold.

Conditions of city and factory life diminish the physical and nervous energy, and reduce many from the vigorous health and perfectness of bodily functions which a wild animal possesses to a more secure, but poorer and far less happy, form of existence. The ill-chosen diet, the monotony and sedentary nature of daily work, the windless uniformity of atmosphere, above all, the neglect of vigorous muscular exercise in the open air and of exposure to the winds and light of heaven—all these, together with the difficulties in the way of living a normal sexual life, go to make the pale, undeveloped, neurotic, and joyless citizen. Nurture in unnatural surroundings, not nature's birth-mark, moulds the criminal and the wastrel. The environment of childhood and youth is at fault rather than the stock; the children who are taken away and trained to be sailors, those sent to agricultural pursuits in the Colonies, those who become soldiers, may develop a physique and bodily health and vigor in striking contrast to their brothers who become clerks, shop assistants, and compositors.

Too much stress cannot be put on the importance of muscular exercise in regard to health, beauty, and happiness. Each muscle fills with blood as it relaxes, and expels this blood on past the venous valves during contraction. Each muscle together with the venous valves forms a pump to the circulatory system. It is the function of the heart to deliver the blood to the capillaries, and the function of the muscles—visceral, respiratory, and skeletal—to bring it back to the heart. The circulation is contrived for a restless mobile animal; every vessel is arranged so that muscular movement furthers the flow of blood.

The pressure of the blood in the veins and arteries, under the influence of gravity, varies with every change of posture. The respiratory pump, too, has a profound influence on the circulation. Active exercise, such as is taken in a game of football, entails endless changes of posture, varying compressive actions—one with another struggling in the rough and tumble of the game—forcible contractions and relaxations of the muscles, and a vastly increased pulmonary ventilation; at the same time the heart's action is accelerated and augmented and the arterial supply controlled by the vaso-motor system. The influence of gravity, which tends to cause the fluids of the body to sink into the lower parts, is counteracted; the liver is rhythmically squeezed like a sponge by the powerful respiratory movements which not only pump the blood through the abdominal viscera, but thoroughly massage these organs, and, kneading these with the omentum, clean the peritoneal cavity, and prevent constipation. At the same time the surplus food products, such as sugar and fat stored in the liver, are consumed in the production of energy, and the organs are swept with a rapid stream of blood containing other products of muscular metabolism which are necessary to the inter-relation of chemical action. The output of energy is increased very greatly; a resting man may expend two thousand calories per diem; one bicycling hard for most of the day expended eight thousand calories, of which only four thousand were covered by the food eaten.

Such figures show how fat is taken off from the body by exercise, for the other four thousand calories came from the consumption of surplus food products stored in the tissues. While resting, a man breathes some 7 liters of air, and uses 300 cc. of oxygen per minute, against 140 liters and 3,000 cc. while doing very hard labor. The call of the muscles is for more oxygen, and their waste products stimulate the formation of hæmoglobin, and in other not fully defined ways influence the metabolism.

Exposure to cold, cold baths, and cold winds has a like effect, accelerating the heart and increasing the heat production, the activity of the muscles, the output of energy, the pulmonary ventilation, and the intake of oxygen and food. In contrast with the soft, pot-bellied, overfed city man, the hard, wiry fisherman trained to endurance has no superfluity of fat or tissue fluid. His blood volume has a high relative value in proportion to the mass of his body. His superficial veins are confined between a taut skin and muscles hard as in a race-horse trained to perfection. Thus the adequacy of the cutaneous circulation and loss of heat by radiation rather than by sweating are assured. His fat is of a higher melting point, hardened by exposure to cold. In him less blood is contained in adipose tissue and skin, and the circulation through the brain muscles and viscera is more active. He uses up the oxygen in the arterial blood more completely and with greater efficiency; for the output of each unit of energy his heart has to circulate much less blood (Krogh); his blood is sent in full volume by the well-balanced activity of his vaso-motor system to the moving parts. Owing to the perfect coördination of his muscles, trained to the work, and the efficient action of his skin and cutaneous circulation—the radiator of the body—he performs the work with far greater economy and less fatigue. The untrained man may obtain 12 per cent of his energy output as work, against 30 per cent or perhaps even 50 per cent obtained by the trained athlete. Hence the failure and risk suffered by the city man who rushes straight from his office to climb the Alps. On the other hand, the energetic man of business or brain worker is kept by his work in a state of nervous tension. He considers alternative lines of action, but scarcely moves. He may be intensely excited, but the natural muscular response does not follow. His heart is accelerated and his blood-pressure raised, but neither muscular movements, and accompanying changes of posture, nor the respiratory pump materially aid the circulation. The activity of his brain demands a rapid flow of blood, and his heart has to do the circulatory work, as he sits still or stands at his desk, against the influence of gravity. Hence a high blood-pressure is maintained for long periods at a time by vaso-constriction of the arteries in the lower parts of the body and increased action of the heart. Hence, perhaps, arise those degenerative changes in the circulatory system which affect some men tireless in their mental activity. We know that the bench-worker, who stands on one leg for long hours a day, may suffer from degeneration and varicosity of the veins in that leg. Long-continued, high, arterial pressure, with systolic and diastolic pressures approximately the same, entails a stretched arterial wall, and this must impede the circulation in the vaso-vasorum, the flow of tissue lymph in and nutrition of, the wall. Since his sedentary occupation reduces the metabolism and heat production of his body very greatly, the business man requires a warmer atmosphere to work in. If the atmosphere is too warm it reduces his metabolism and pulmonary ventilation still further; thus he works in a vicious circle. Exhausting work causes the consumption of certain active principles, for example, adrenalin, and the reparation of these must be from the food. To acquire certain of the rarer principles expended in the manifestation of nervous energy more food may have to be eaten by the sedentary worker than can be digested and metabolized. His digestive organs lack the kneading and massage, the rapid circulation and oxidation of food-stuffs which are given by muscular exercise. Hence arise the digestive and metabolic ailments so common to brain workers.

Mr. Robert Milne informs us that of the thousands of children who have passed through Barnardo's Homes—there are 9,000 in the homes at any one time—not one after entering the institution and passing under its regimen and the care of his father, Dr. Milne, has developed appendicitis. Daily exercise and play, adequate rest, and a regular simple diet have ensured their immunity to this infection. It pays to keep a horse healthy and efficient; it no less pays to keep men healthy. One of us (L. H.) recently investigated the case of clerks employed in a great place of business, whose working hours are from 9 to 6 on three days, and 7 to 9 on the other three days of each week, and, working such overtime, they make from \$5 to \$10 a week. These clerks worked in a confined space—forty to fifty of them in 8,200 cubic feet, lighted by thirty electric lamps, cramped for room, and overheated in warm summer days. It is not with the chemical purity of the air of such an office that fault is to be found, for fans and large openings ensured this sufficiently. These clerks suffered from their long hours of monotonous and sedentary occupation, and from the artificial light, and the windless, overwarm and moist atmosphere. Many a girl cashier has worked from 8 to 8.30, and on Saturdays from 8 to 10, and then has had to balance her books and leave perhaps after midnight on Sunday morning. (The Shop Act has given a little relief to these hours.) Her office is away in the background—confined, windless, artificially lighted. What is the use of the State spending a million a year on sanatoria and tuberculin dispensaries, when those very conditions of work continue which lessen the immunity and increase the infection of the workers?

Isolation hospitals, sputum-pots, and anti-spitting regulations will not stamp out tuberculosis. Such means are like shutting the door of the stable when the horse has escaped. Flügge has shown that tubercle bacilli are spread by the droplets of saliva which are spread yards around as an invisible spray when we speak, sing, cough, sneeze. Sputum-pots cannot control this. The saliva of incipient cases of phthisis may teem with the bacilli. The tuberculin reaction tests carried out by Hamburger and Monti in Vienna show that 94 per cent of all children aged eleven to fourteen have been infected with tubercle. In most the infection is a mere temporary indisposition. We believe that the conditions of exhausting work and amusement in confined and overheated atmospheres, together with ill-regulated feeding, determine largely whether the infection, which almost none can escape, becomes serious or not. Karl Pearson suggests that the death statistics afford no proof of the utility of sanatoria or tuberculin dispensaries, for during the very years in which such treatment has been in vogue, the fall in the mortality from tuberculosis has become less relatively to the fall in general mortality. He opines that the race is gradually becoming immune to tubercle, and hence the declination in the mortality curve is becoming flattened out—that nature is paramount as the determinant of tuberculosis, not nurture. From a statistical inquiry into the incidence of tuberculosis in husband and wife and parent and child, Pearson concludes that exposure to infection as in married couples is of little importance, while inborn immunity or diathesis is a chief determinant. Admitting the value of his critical enquiries and the importance of diathesis, we would point out that in the last few years the rush and excitement of modern city life has increased, together with the confinement of workers to sedentary occupations in artificially lighted, warm, windless atmospheres. The same conditions pertain to places of amusement, eating-houses, tube railways, etc. Central heating, gas-radiators, and other contrivances are now displacing the old open fire and chimney. This change greatly improves the economical consumption of coal and the light and cleanliness of the atmosphere. But in so far as it promotes monotonous, windless, warm atmospheres, it is wholly against the health and vigor of the nation. The open fire and wide chimney ensure ventilation, the indrawing of cold outside air, streaky air—restless currents at different temperatures, which strike the sensory nerves in the skin and prevent monotony and weariness of spirit. By the old open fires we were heated with radiant heat. The air in the rooms was drawn in cool and variable in temperature. The radiator and hot-air system give us a deadly uniformly heated air—the very conditions we find most unsupportable on a close summer's day.

In Labrador and Newfoundland, Dr. Wakefield tells us, the mortality of the fisher folk from tuberculosis is very heavy. It is generally acknowledged to be four per 1,000 of the population per annum, against 1.52 for England and Wales. Some of the Labrador doctors talk of seven and even eight per 1,000 in certain districts. The general death-rate is a low one. The fishermen fish off shore, work for many hours a day in the fishing season, and live with their families on shore in one-roomed shanties. These shanties are built of wood, the crannies are " stogged " with moss, and the windows nailed up, so that ventilation is very imperfect. They are heated by stoves and kept at a very high temperature, for example, 80° F. Outside in the winter the temperature may be 30° below freezing. The women stay inside the shanties almost all their time, and the tuberculosis rate is somewhat higher in them. The main food is white bread, tea stewed in the pot till black, fish occasionally, a little margarine and molasses. The fish is boiled and the water thrown away. Game has become scarce in recent years; old, dark-colored flour—spoken of with disfavor—has been replaced by white flour. In consequence of this diet beri-beri has become rife to a most serious extent, and the hospitals are full of cases. We (M. F. and L. H.) have found by our feeding experiments that rats, mice, and pigeons cannot be maintained on white bread and water, but can live on whole meal or on white bread in which we incorporate an extract of the sharps and bran in sufficient amount. Recent work has shown the vital importance of certain active principles present in the outer layers of wheat, rice, etc., and in milk, meat, etc., which are destroyed by heating to 120° C. A diet of white bread or polished rice and tinned food sterilized by heat is the cause of beri-beri. The metabolism is endangered by the artificial methods of treating foods now in vogue. As to the prevalency of tuberculosis in Labrador, we have to consider the inter-marriage, the bad diet, the over-rigorous work of the fishermen, the over-heating of, and the infection in, the shanties.

Dr. Wakefield has slept with four other travelers in a shanty with father, mother and ten children. In some there is scarce room on the floor to lie down. The shanties are heated with a stove on which pots boil all the time; water runs down the windows. The patients are ignorant, and spit everywhere, on bed, floor, and walls. In the schools the heat and smell are most marked to one coming in from the outside air. In one school 50 cubic feet per child is the allowance of space. The children are eating all day long, and are kept in close, hot confinement. They suffer very badly from decay of the teeth. Whole families are swept off with tuberculosis, and the child who leaves home early may escape, while the rest of a family die. Here, then, we have people living in the wildest and least populated of lands, with the purest atmosphere, suffering from all those ill results which are found in the worst city slums—tuberculosis, beri-beri, and decayed teeth.

The bad diet probably impels the people to conserve their body heat and live in the overwarm, confined atmosphere, just as our pigeons fed on white bread sit, with their feathers out, huddled together to keep each other warm.

The metabolism, circulation, respiration, and expansion of the lung are all reduced. The warm, moist atmosphere lessens the evaporation from the respiratory tract, and therefore the transudation of tissue lymph and activity of the ciliated epithelium. The unexpanded parts of the lung are not swept with blood. Everything favors a lodgment of the bacilli, and lessens the defences on which immunity depends. In the mouth, too, the immune properties of the saliva are neutralized by the continual presence of food, and the temperature of the mouth is kept at a higher level, which favors bacterial growth. Lieutenant Sein (Norwegian navy) informs us that recently in northern Norway there has been the same notable increase in tuberculosis. The old cottage fireplaces with wide chimneys have been replaced with American stoves. In former days most of the heat went up the chimney, and the people were warmed by radiant heat. Now the room is heated to a uniform moist heat. The Norwegians nail up the windows and never open them during the winter. At Lofoten, the great fishing center, oil motor-boats have replaced the old open sailing boats and rowboats. The cabin in the motor-boat is very confined, covered in with a watertight deck, heated by the engine, crowded with a dozen workers. When in harbor the fishermen used to occupy ill-fitted shanties, through which the wind blew freely; now, to save rent, they sleep in the motor-boat cabins. Here, again, we have massive infection, and the reduction of the defensive mechanisms by the influence of the warm, moist atmosphere.

The Norwegian fishermen feed on brown bread, boiled fish, salt mutton, and margarine, and drink, when in money, beer and schnapps; there is no gross deficiency in diet, as in Labrador, and beri-beri does not attack them. They return home to their villages and longshore fishing when the season is over. The one new condition which is common to the two districts is confinement in stove-heated, windless atmospheres. In old days the men were crowded together, but in open boats or in draughty shanties, and had nothing but little cooking-stoves.

The conditions of great cities tend to confine the worker in the office all day, and to the heated atmosphere of club, cinema show, or music-hall in the evening. The height of houses prevents the town dweller from being blown upon by the wind, and, missing the exhilarating stimulus of the cool, moving air, he repels the dull uniformity of existence by tobacco and by alcohol, or by indulgence in food, for example, sweets, which are everywhere to his hand, and by the nervous excitement of business and amusement. He works, he eats, and is amused in warm, windless atmospheres, and suffers from a feeble circulation, a shallow respiration, a disordered digestion, and a slow rate of metabolism.

Many of the employments of modern days are detestable in their long hours of confinement and monotony. Men go up and down in a lift all day, and girls in the bloom of youth are set down in tobacco stalls in underground stations, and their health and beauty there fade while even the blow-flies are free to bask in the sun. In factories the operatives feed machines, or reproduce the same small piece of an article day after day. There is no art, no change, no pleasure in contrivance and accomplishment. The miner, the fisherman, even the sewerman, face difficulties, changing risks, and are developed as men of character and strength. Contrast the sailor with the steward on a steamer, the drayman outside with the clerk inside who checks the goods delivered at some city office, the butcher and the tailor, the seamstress and the market woman, and one sees the enormous difference which a confined occupation makes. Monotonous sedentary employment makes for unhappiness because the inherited functional needs of the human body are neglected, and education—when the outside field of interest is narrowed—intensifies the sensitivity to the bodily conditions. The sensations arising within the body—

proprioceptive sensations—come to have too large a share in consciousness in comparison with exteroceptive. In place of considering the lilies how they grow, or musing on the beauty and motions of the heavenly bodies, the sedentary worker in the smoke-befouled atmosphere with the limited activity and horizon of an office and a disturbed digestion, tends to become confined to the inward consideration of his own viscera and their motions.

Many of the educated daughters of the well-to-do are no less confined at home; they are the flotsam and jetsam cast up from the tide in which all others struggle for existence—their lives are no less monotonous than those of the sweated seamstress or clerk. They become filled with "vapors" and some seek excitement not in the cannon's mouth, but in breaking windows, playing with fire, and hunger strikes. The dull monotony of idle social functions, shopping, and amusement, equally with that of sedentary work and an asexual life, impels them to a simulated struggle—a theatrical performance, the parts of which are studied from the historical romances of revolution.

Each man, woman, and child in the world must find the wherewithal for living, food, raiment, warmth, and housing, or must die or get some other to find it for him. It seems to us as if the world is conducted as if ten men were on an island—a microcosm—and five sought for the necessaries of life, hunted for food, built shelters and fires, and made clothes of skins, while the other five strung necklaces of shells, made loin cloths of butterfly wings, gambled with knuckle bones, drew comic pictures in the sand, or carved out of clay frightening demons, and so beguiled from the first five the larger share of their wealth. In this land of factories, while the many are confined to mean streets and wretched houses, possessing no sufficiency of baths and clean clothing, and are ill-fed, they work all day long, not to fashion for themselves better houses and clothing, but to make those unnecessaries such as "the fluff" of women's apparel, and a thousand trifles which relieve the monotony of the idle and bemuse their own minds.

The discovery of radium and its disintegration as a source of energy has enabled the physicist to extend Lord Kelvin's estimate of the world's age from some thirty to a thousand million years. Arthur Keith does not hesitate to give a million of these years to man's evolution. Karl Pearson speaks of hundreds of thousands of years. The form of the human skull, the brain capacity of man, his skill as evidenced by stone implements and cave drawings of animals in action, was the same tens of thousands of years ago as now. For ages primitive man lived as a wild animal in tropical climes; he discovered how to make fire, clothe himself in skins, build shelters, and so enable himself to wander over the temperate and arctic zones. Finally, in the last few score of years, he has made houses draughtless with glass windows, fitted them with stoves and radiators, and every kind of device to protect himself from cold, while he occupies himself in the sedentary pursuits and amusements of a city life. How much better, to those who know the boundless horizon of life, to be a frontiersman and enjoy the struggle, with body hardened, perfectly fit, attuned to nature, than to be a cashier condemned to the occupation of a sunless, windless pay-box. The city child, however, nurtured and educated in confinement, knows not the largeness and wonders of nature, is used to the streets with their ceaseless movement and romantic play of artificial light after dark, and does not need the commiseration of the country mouse any more than the beetle that lives in the dark and animated burrows of his heap. But while outdoor work disciplines the body of the countryman into health, the town man needs the conscious attention and acquired educated control of his life to give him any full measure of health and happiness.

CHEMICAL PURITY OF THE AIR

THE OXYGEN

Experimental evidence is strongly in favor of our argument that the chemical purity of the air is of no importance.

Russell[1] gives the average percentage of oxygen as follows:

In the open country or sea	20.95
In the streets of London	20.888
Backs of houses	20.70
Mines	20-18.2
Pit of a theater, 11.30 p. m.	20.74
Court of Queen's Bench	20.65
Chemical Theater (Sorbonne) (before and after lecture)	20.28-19.86
Cow house	20.75

Analyses show that the oxygen in the worst-ventilated schoolroom, chapel, or theater is never lessened by more than 1 per cent of an atmosphere; the ventilation through chink and cranny, chimney, door and window, and the porous brick wall, suffices to prevent a

[1] F. A. R. Russell: The Atmosphere in Relation to Human Life and Health. Smithsonian Miscellaneous Collections, Vol. 39, 1896. Pub. No. 1072.

greater diminution. So long as there is present a partial pressure of oxygen sufficient to change most of the hæmoglobin of the venous blood into oxyhæmoglobin during its passage through the lungs, there can arise no lack of oxygen.

At sea-level the pressure of oxygen in the pulmonary alveolar air is about 100 mm. Hg. Exposed to only half this pressure, the hæmoglobin is more than 80 per cent saturated with oxygen.

In noted health-resorts of the Swiss mountains the barometer stands at such a height that the concentration of oxygen is far less than in the most ill-ventilated room. On the high plateau of the Andes there are great cities; Potosi, with a hundred thousand inhabitants, is at 4,165 meters, and the partial pressure of oxygen there is about 13 per cent of an atmosphere in place of 21 per cent at sea-level. Railways and mines have been worked up to altitudes of 14,000 to 15,000 feet. At Potosi girls dance half the night, and toreadors display their skill in the ring. On the slopes of the Himalayas shepherds take their flocks to altitudes of 18,000 feet. No disturbance is felt by the inhabitants or by those who reach these great altitudes slowly and by easy stages. The only disability to a normal man is diminished power for severe exertion, but a greater risk arises from want of oxygen to cases of heart disease, pneumonia, and in chloroform anæsthesia at these high altitudes. The newcomer who is carried by the railway in a few hours to the top of Pike's Peak or the Andes may suffer severely from mountain sickness, especially on exertion, and the cause of this is want of oxygen. Acclimatization is brought about in a few days' time. The pulmonary ventilation increases, the bronchial tubes dilate, the circulation becomes more rapid. The increased pulmonary ventilation lowers the partial pressure of carbon dioxide in the blood and pulmonary air, and this contributes to the maintenance of an adequate partial pressure of oxygen. Haldane and Douglas[1] maintain that the oxygen is actively secreted by the lung into the blood, and find that the number of red corpuscles and total quantity of the hæmoglobin increase, but the method by which their determinations have been made has not met with unqualified acceptance.[2] Owing to the combining power of hæmoglobin the respiratory exchange and metabolism of an animal within wide limits is independent of the partial pressure of oxygen. On the other hand the process of combustion is dependent on the

[1] Phil. Trans. Roy. Soc. B., Vol. 203, p. 185, 1912; and Fitzgerald, ditto, p. 351.

[2] Cf. Dreyer, Ray & Walker, Skand. Arch. für Physiologie, Bd. 28, p. 299, 1913.

percentage of oxygen. Thus the aëroplanist may become seized with altitude sickness from oxygen want, while his gas-engine continues to carry him to loftier heights.

The partial pressure of oxygen in a mine at a depth of 3,000 feet is considerably higher than at sea-level, and if the percentage is reduced to 17, while the firing of fire-damp and coal dust is impossible, there need be in the alveolar air of the lungs no lower pressure of oxygen than at sea-level. Thus the simplest method of preventing explosions in coal mines is that proposed by J. Harger,[1] viz., to ventilate them with air containing 17 per cent of oxygen. There is little doubt that all the great mine explosions have been caused by the enforcement of a high degree of chemical purity of the air. In old days when ventilation was bad there were no great dust explosions. Mr. W. H. Chambers, general manager of the Cadeby mine, where a recent disastrous explosion occurred, with the authority of his great and long practical experience of fiery mines, told us that the spontaneous combustion of coal and the danger of explosion can be wholly met by adequate diminution in ventilation. The gob-fires can be choked out while the miners can still breathe and work. The Coal Mines Regulation Act enforces that a place shall not be in a fit state for working or passing therein, if the air contains either less than 19 per cent of oxygen, or more than 1.25 per cent of carbon dioxide. A mine liable to spontaneous combustion of coal may be exempted from this regulation by order of the Secretary of State. It is also provided that any intake airway shall not be deemed to be fit for persons travelling thereon, if the average percentage of inflammable gas found in six samples of air, taken at intervals of not less than a fortnight, exceeds 1.25 per cent. Workmen must be withdrawn from any working place, if worked with safety-lamps, if the percentage of inflammable gas is found to be 2.5 per cent or upward, or if worked with naked lights, 1.25 per cent or upward.

These regulations impel the provision of such a ventilation current that the percentage of oxygen is sufficient for the spread of dust explosions along the intake airways, with the disastrous results so frequently recorded. If the mine were ventilated with air containing 17.5 per cent of oxygen in sufficient volume to keep the miners cool and fresh, not only would explosions be prevented but the mines could be safely illuminated with electric or acetylene lamps, and

[1] Coal, and the Prevention of Explosions. Longmans, Green & Co., London, 1913.

miners' nystagmus be prevented, for this is due to the dim light of the safety-lamp. The comfort and the working power of the miners would be greatly augmented in a well-lighted mine. To show how little the proposed diminution in the oxygen percentage affects the men, Harger cites a report of Cadman and Whalley concerning a place where there was a quantity of black damp given off, and where "a light would not burn 1 foot 6 inches from the floor, or in the waste, but the men had no fault to find with the atmosphere." The foreman said it was "better than usual."

Analyses of samples taken (1) at the floor, and (2) at the coal face showed:

		Per cent		Per cent		Per cent
(1)	CO_2	4.56	O_2	13.13	N_2	82.28
(2)	CO_2	1.21	O_2	18.97	N_2	79.80

The problem perhaps may be solved by purifying and cooling furnace air, and mixing and circulating this with a sufficiency of fresh air.

All the experimental evidence which we detail later goes to show that it is only when the partial pressure of oxygen is lowered very considerably that signs of oxygen want arise. The athlete suffers from oxygen want in the performance of any rapidly executed and strenuous effort because he uses up oxygen in his muscles more rapidly than it can be supplied by the respiration and circulation. The rapid contraction of the muscles impedes the circulation of blood through the muscles. The blood can flow through them only during the relaxations, not during the contractions. Douglas and Haldane have found that a man doing the hard exercise of pushing a motor-cycle up a steep hill may use up 3,000 cc. of oxygen per minute against 300 cc. when resting. The heart called upon to circulate blood ten times as fast—a strenuous effort—may suffer from want of oxygen, because the circulation of blood through the coronary vessels is impeded by the contraction of the heart muscle during the height of systole, and the total period spent in systole is increased when the heart beats quickly. To start with the lungs full of pure oxygen benefits the athelete; so, too, the breathing of oxygen helps him when cycling and exhausted, or in the intervals of boxing. The strength of the pulse and the fulness of the artery are increased and the frequency of the heart diminished thereby. The athlete in these conditions is like the mountain-sick person. So, too, the pneumonic patient is benefited by oxygen-inhalation. Apart from the influence of high concentrations of oxygen in conditions of extraordinary exertion or in disease, the evidence shows that a diminution of oxygen by 1 per cent at sea-level has not the slightest effect on health and comfort, and that none of the effects of ill-ventilated rooms can be ascribed to want of oxygen.

By breathing over 70 per cent of oxygen the frequency of the heart is diminished four or five beats per minute in the normal resting individual. (J. Parkinson, Journ. Physiol., 1912; also Benedict and Higgins, Amer. Journ. Physiol., Vol. 28, 1911.) In cases of pneumonia with failing heart, the regularity, strength and fulness of the pulse are notably restored by oxygen-inhalation. G. N. Stewart has found that the rate of blood-flow in the arm of one particular cyanosed patient was increased four or five times by oxygen-inhalation—not so in the other cases tested or in the resting, normal man. Cases of pneumonia and heart disease are sent down to the sea-level from high altitudes such as Mexico City, for this is recognized as giving the best chance of recovery. Chloroform, too, is a more dangerous anæsthetic at high altitudes (Johannesburg) and is made safe when given with oxygen.

THE CARBON DIOXIDE

Owing to the fact that the percentage of CO_2 is the usual test of ventilation and that only a very few parts per 10,000 in excess of fresh air are permitted by the English Factory Acts, it is generally supposed that CO_2 is a poison and that any considerable excess has a deleterious effect on the human body. No supposition could be further from the truth.

Reiset[1] gave the percentage of CO_2 as 0.0294 four miles from Dieppe, 0.02898 in a trefoil field, 0.03178 near a flock of sheep. In London a summer average is 0.0379, and a winter average 0.0422. In fog it was 0.072 and once as high as 0.141. In a Court of Chancery, 0.20; in a workshop, 0.30; in the pit of a theater, 0.32; in a crowded meeting, 0.365; in badly ventilated barracks, 0.1242 to 0.195; in the general hospital, Madrid, 0.32 to 0.43; in a girls' school (70 girls and 10,400 cubic feet), 0.73. We see, then, that the percentage of CO_2 in the worst-ventilated room assuredly does not rise above 0.5 per cent or, at the outside, 1 per cent. It is impossible that any excess of CO_2 should enter into our bodies when we breathe such air, for whatever the percentage of CO_2 in the atmosphere may be, that in the pulmonary air is kept constant at about 5 per cent of an atmosphere by the action of the respiratory center. It is the con-

[1] Cited after Russell. Vide supra.

centration of CO_2 which rules the respiratory center, and to such purpose as to keep the concentration both in the lungs and in the blood uniform. (J. S. Haldane.) The only result from breathing such a slight excess of CO_2 as 0.5 per cent (slight to the physiologists, but regarded as enormous by the hygienist) is an unnoticeable increase in the ventilation of the lungs. The increased ventilation is exactly adjusted so as to keep the concentration of CO_2 in the lungs always at the normal 5 to 6 per cent of an atmosphere. The very same thing happens when we take gentle exercise and produce more CO_2 in our bodies; the pulmonary ventilation is slightly increased, and thus the concentration of CO_2 in the blood and lungs is kept the same.

We turn to the evidence of former researchers. Leblanc[1] found that an animal could survive exposure to an atmosphere containing 30 per cent of carbon dioxide, provided the percentage of oxygen was 70 per cent, and recover quickly from the depression produced by this mixture. So, too, Regnault and Reiset[2] found that an animal could survive exposure to an atmosphere containing a relatively high concentration of CO_2 so long as sufficient oxygen was supplied.

Pettenkofer[3] demonstrated clearly that the symptoms produced in crowded ventilated places were due neither to excess of CO_2 nor deficiency of O_2. He found that 1 per cent of CO_2 could be breathed for hours with no discomfort. Pettenkofer did not regard the impure air of dwellings as directly capable of originating specific disease, or as a poison in the ordinary sense of the term, but concluded that the capability of withstanding the influence of disease-producing agencies was diminished in those who continually breathed such air. He laid down the doctrine accepted by sanitarians, that the percentage of CO_2 is a guide to the other deleterious properties of the atmosphere.

It is manifest, however, in regard to the heat, moisture, and movement of a confined atmosphere, that the CO_2 percentage may give no indication, and fails wholly as an adequate test.

R. A. Smith[4] enclosed men in a chamber and found that the pulse frequently fell from 73 to 57, while the frequency of respiration rose from 15 to 24, in an atmosphere in which the CO_2 increased

[1] Ann. de Chim. et Phys. Paris, 1842, (3), v, 223.

[2] Ann. de Chim. et Phys. Paris, 1849, (3), xxvi, p. 299.

[3] Ann. de Chem. u. Pharm. Leipzig u. Heidelberg, 1862-3, 2. Suppl. Bd. p. 1-52.

[4] Air and Rain. London, 1872.

in four hours' time from 0.04 to 1.73. He found the circulation was weak and the respiration difficult when the CO_2 rose to 3 per cent, but attributed these results to other conditions than the excess of CO_2. The air in his chamber must have become overwarm and moist.[1]

J. T. F. Hermans[2] employed a tin chamber 1.8 meters high, 1.75 meters broad, and 1.2 meters deep. Observations were made on the body temperature, frequency of pulse, and respiration. In some experiments the CO_2 was absorbed, in others not. The air of the chamber was also analyzed for combustible gases by passing over glowing copper oxide, but none could be detected even with two people in the chamber. No organic products could be traced by drawing the air of the chamber through H_2SO_4.

The following figures show the effect of absorption or non-absorption of CO_2.

	CO_2	O_2	Pulse	Respiration
	Per cent	*Per cent*		
1 person in chamber......	3.3	12.7	70–72	24
1 person in chamber......	0.87	....	75–72	16–18
2 persons in chamber.....	5.13	14.4	(a) 80–84	34
			(b) 68–72	30

When, with two people in the chamber, the CO_2 percentage reached 5.13, they suffered from dyspnœa and headache.

Haldane and Lorraine Smith confirmed the results of Hermans. With 3.9 per cent there were hyperpnœa and slight headache, which disappeared on leaving the chamber. On breathing 5.5 to 6 per cent there was great hyperpnœa, which was very exhausting. By breathing in and out of a bag they found that distress became very severe when CO_2 reached 10 per cent and the oxygen was correspondingly decreased. If the bag was filled with oxygen to start with, they endured the inhalation until the percentage of CO_2 reached 10.4, the oxygen being 58.6 per cent. Hill and Flack have confirmed this.

By breathing oxygen for two or three minutes, and then holding the breath with the lungs full of oxygen, the breath can be held for astonishingly long periods of time, for example, for 5 to 6 minutes and even for 8 to 9 minutes.[3]

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[1] Above authorities cited after Billings, Weir Mitchell, and Bergey. Smithsonian Contributions to Knowledge, Vol. 39, 1895.

[2] Arch. f. Hygiene. München u. Leipzig, 1883, Vol. 1, p. 1.

[3] Cf. Vernon, Journ. Physiol. Proc., XVIII, Vol. 38, 1909.

Sweating and slight headache are the only abnormal results of the short exposure to such percentages of CO_2.

If the CO_2 be removed from the blood and tissues by a preliminary period of increased ventilation of the lungs, analyses of the pulmonary alveolar air taken at the breaking point, show that when the partial pressure of CO_2 is lower, a lower partial pressure of oxygen can be borne, and vice versa; for example, the breaking point occurred with 6.6 to 6.9 per cent CO_2, and 11.1 to 9.1 per cent O_2; with 5.5 to 5.9 per cent CO_2 and 5.8 to 3.7 per cent O_2; with 8 to 10 per cent CO_2 and 30 to 50 per cent O_2.

Oxygen-inhalation notably increased the power to do work with the breath held, and the partial pressure of CO_2 in some cases rose to 11 per cent of an atmosphere before the breaking point occurred.[1]

One subject, with the breath held, ran 113 yards in 79⅗ seconds after ordinary breathing, 150 yards in 35⅔ seconds after deep breathing, and 256 yards in 62⅗ seconds after deeply breathing oxygen.

As some reserve of energy must be kept for collecting the sample of pulmonary air, it is clear that the percentage of CO_2 must rise higher than 11 per cent in those who run to the utmost limit of endurance with the breath held.

These experiments make it quite clear that while the lungs normally contain 5 to 6 per cent of CO_2, at sea-level pressure, it is no less certain that they may contain more than this amount when the breath is held during any effort, and such temporary exposures have no ill effect.

Speck found that the inhalation of 7 per cent CO_2 produced great hyperpnœa, but he managed to endure it for 2.5 minutes. On breathing an atmosphere containing 11.5 per cent he found that the first breath was uncomfortable—there resulted headache, sweating, dimness of vision, and tremors. He could hardly endure the inhalation for a period of one minute. On inhaling 5.4 per cent CO_2 he exhaled 6 per cent and still maintained a respiratory exchange by the intensity of his breathing; with 7 to 8 per cent CO_2 inspired, 7 to 8 per cent was expired, and the output of CO_2 from the body was checked. The symptoms of poisoning begin when this happens; the lower percentages, which cause no retention of CO_2 in the body, have no effect other than the production of hyperpnœa. Löwy found with 6 per cent CO_2 considerable dyspnœa and with 8 per cent very great dyspnœa. Emmerich recorded that the inhalation of 8.4 per cent CO_2 caused dyspnœa, a flushed face and headache in 10

[1] Hill and Flack, Journ. Phys., Vol. 40, 1910, p. 347.

minutes. We can confirm these findings. High percentages of CO_2, for example, 30 to 50 per cent cause spasm of the glottis and cannot be inhaled by the normal individual.

At each breath we rebreathe into our lungs the air in the nose and large air-tubes (the dead-space air), and about one-third of the air which is breathed in is dead-space air when we are resting. Thus, no man breathes in pure outside air into his lungs, but air contaminated perhaps by one-third or (on deep breathing during muscular work) by one-tenth with his own expired air. When a child goes to sleep with its head partly buried under the bed clothes, and in a cradle confined by curtains, it rebreathes the expired air to a still greater extent; and so with all animals that snuggle together for warmth's sake. Not only the new-born babe sleeping against its mother's breast, but pigs in a sty, young rabbits, rats and mice clustered together in their nests, and young chicks under the brooding hen, all alike breathe a far higher percentage than that allowed by the Factory Acts. Cattle in ill-ventilated stalls may breathe 10 times the normal percentage[1] of CO_2.

When the air of a room is still, the expired air may not be blown away and hangs round a person recumbent therein. Thus B. Heymann[2] found 0.44 per cent in the inspired air, against 0.0318 in the air of the room. On putting an electric fan to blow across his face at a rate of 3.3 meters per second the CO_2 in the inspired air fell to 0.0307 per cent.

To rebreathe one's own breath is a natural and inevitable performance, and to breathe some of the air exhaled by another is the common lot of men who, like animals, have to crowd together and husband their heat in fighting the inclemency of the weather.

Lehmann found in a brewery 1.5 to 2.5 per cent CO_2 in the air of the fermentation rooms. This was breathed by 5 to 8 workers for hours long with no ill effects. All were strong, healthy young men, some having done the work for years. Weak men with affections of the lungs are not allowed to do this form of work. With 11.6 to 14.7 per cent most were constrained to leave the room in two minutes, but two strong young men endured it for 5 minutes and were all right afterwards.

An experiment was made of breathing for three-fourths of an hour 1.8 to 3.5 per cent CO_2, rising finally to 10 per cent, when the

[1] Schultze u. Maercker. Neben den CO_2 Gehalt der Stallfult. Göttingen, 1869. Cited after B. Heymann.

[2] Ztschr. f. Hygiene, Vol. 49, 1905, p. 403.

subjects were compelled to go out. The workers stood 8 to 14 per cent no better than the experimenters.

In the Albion Brewery, Whitechapel (Mann, Crossman & Co.), we analyzed on three different days the air of the room where the CO_2, generated in the vats, is compressed and bottled as liquid carbonic acid. Work goes on night and day; 18 tons of liquid CO_2 are sold per week; three men work per shift. We found from 0.14 to 0.93 per cent of CO_2 in the atmosphere of that room. The men who were filling the cylinders and turning the taps on and off to allow escape of air must often breathe more than this. The men engaged in this occupation worked twelve-hour shifts, having their meals in the room. Some had followed the same employment for eighteen years, and without detriment to their health. It is only when the higher concentrations of CO_2 are breathed, such as 3 to 4 per cent of an atmosphere, that the respiration is increased so that it is noticeable to the individual himself; such percentages diminish the power to do muscular work, for the excess of CO_2 produced by the work adds its effect to that of the excess in the air, and the limit of panting is soon reached.

ALBION BREWERY

CO_2 COMPRESSION ROOM

	Sample taken	Per cent CO_2
Jan. 10, 1912, morning	At breathing level	0.3
	Near cylinder from which air (and CO_2) was escaping during filling process	1.48
	At another part of the room	0.44
Jan. 10, afternoon	At breathing level	0.54
	Near cylinders in foreman's office	0.39
	In center of room about 20 minutes after blowing off cylinders	0.79
	Ditto a few minutes after blowing off cylinders	0.93
Jan. 12	In the middle of the room, no taps open for some time	0.196
	Near cylinders	0.345
	In foreman's office	0.142
	In middle of room after blowing off cylinders, at breathing level	0.533

Haldane and Priestley found that with a pressure of 2 per cent of an atmosphere of CO_2 in the inspired air the pulmonary ventilation was increased 50 per cent; with 3 per cent, about 100 per cent; with 4 per cent, about 200 per cent; with 5 per cent, about 300 per cent; and with 6 per cent, about 500 per cent. With the last, panting is severe; while with 3 per cent it is unnoticed until muscular work is done, when the panting is increased 100 per cent more than usual. With more than 6 per cent the distress is very great, and headache, flushing, and sweating occur. With more than 10 per cent there occurs loss of consciousness after a time, but no immediate danger to life. Even exposure to 25 per cent may not kill an animal within an hour or two.

Such high concentrations, when sufficient O_2 is supplied, poison the heart and lower the blood-pressure (Hill and Flack).

It is only when the higher concentrations of CO_2 are breathed, such as 3 to 4 per cent of an atmosphere, that the respiration is increased so that it is noticeable to the resting individual; but percentages over 1 per cent diminish the power to do muscular work, for the excess of CO_2 produced by the work adds its effect to that of the excess in the air, and the difficulty of coördinating the breathing to the work in hand is increased. Nevertheless, divers who work in diving dress and men at work in compressed-air caissons constantly do heavy and continuous labor in concentrations of CO_2 higher than 1 per cent of an atmosphere, and so long as the CO_2 is kept below 2 to 3 per cent they are capable of carrying out efficient work. The excess of oxygen helps them. In the case of workers in compressed air it is important to bear in mind that the effect of the CO_2 on the breathing depends on the partial pressure and not on the percentage of this gas in the air breathed.[1] Thus the volume of air breathed was increased 2 to 2.5 times by inhaling 5 per cent CO_2 at 1 atmosphere, and to the same extent by inhaling 1.6 per cent at 3.7 atmospheres. The partial pressure in the two cases was approximately the same. It follows from this that whatever the pressure a diver is under he requires the same volume of air for ventilation, measured at that pressure. Thus at 2 atmospheres (33 feet depth of water) the air supply, measured at atmospheric pressure where the pump is, must be doubled; at 3 atmospheres, trebled; and so on.

In the boring of the St. Gothard tunnel the laborers carried out the work in an atmosphere containing 0.3 to 0.96 per cent CO_2. At the altitude of the tunnel the partial pressure was considerably less, but yet far above that set as the limit in factories. In the compressed-air caisson at Nussdorf the CO_2 percentage varied from .04 to 0.5, and the partial pressure was about three times this amount, that is, equivalent to 0.12 to 1.5 per cent at sea-level.

[1] Haldane and Priestley, Journ. of Physiol., Vol. 32, 1905, p. 225, and Report of Admiralty Committee on Deep-sea Diving, 1905.

In these tunnels the temperature is often very high (21° to 30.2° C. in the St. Gothard) and almost saturated with moisture. The discomfort, weariness, excessive sweating, loss of appetite, and pallor, which may affect tunnel workers, are, we believe, due to the excessive heat and moistness of the atmosphere. That this is so is shown by the experiments of L. Paul and Ercklentz. (See later, p. 53 of this paper.)

RATS AND CO_2.

By a series of observations made on rats confined in cages fitted with small, ill-ventilated sleeping chambers, we (M. F. and L. H.)

EXPERIMENTS ON RATS

Animals	Temperature	CO_2	O_2	Remarks
	Degrees C.	*Per cent.*	*Per cent*	
8 Rats.....	19	4.69	.....	In sleeping chamber.
Do.....	....	4.95	14.90	Do.
Do. ...	19	3.39	16.95	6 in, 1 out.
Do.....	23	....	.....	Put over stove, the rats kept coming out.
Do.....	....	3.01	18.00	After putting outside window in cold air, all went in.
7 Rats.....	21	4.23	16.19	All inside sleeping chamber.
Do.....	24	2.90	17.24	Put on stove, all inside still.
Do.....	23.5	....	.....	Later, 3 or 4 outside.
Do.....	22	2.24	17.74	Off stove, all inside.
Do.....	....	3.07	.....	Little later, all inside.
Do.....	23	3.18	17.66	All inside.
Do.....	23	2.33	.....	Do.
Do.....	23	5.8	13.06	Chamber put out in the cold and opening in it made smaller, all inside.
Do.....	34½	5.70	.....	Put on stove, all inside. No moist bread inside.
Do.....	25	....	.....	Much moist bread put inside sleeping chamber.
Do.....	31	....	.....	Noses at hole.
Do.....	32	....	.....	2 out.
Do.....	32.5	3.36	16.28	3 out.
				4 out.
Do.....	27	5.61	.....	Put out in the cold again, 1 out.
18 Rats.....	30	5.51	.....	All in.
7 Rats.....	35	5.56	.....	Dry sleeping place, all in.
Do.....	31½	3.80	.....	Moist bread in sleeping place, all gradually came out.

have found that the temperature and humidity of the air—not the percentage of carbon dioxide or oxygen—determine whether the animals stay inside the sleeping room or come outside. When the air is cold, they like to stay inside, even when the carbon dioxide rises to 4 to 5 per cent of an atmosphere. When the sleeping chamber is made too hot and moist, they come outside.

We cite the view expressed by Benjamin Moore,[1] that the living cell fat and carbohydrate are elaborated with protein into molecular union, the whole forming the water-clear bioplasm in which both fat and carbohydrate are lost to ordinary chemical tests. As a preliminary step to oxidation, the sugar or fat molecule must be built in as an intrinsic part of the bioplasm. Oxygen is likewise taken up, and there exists in the cell a delicately balanced equilibrium between the bioplasm, which acts as a catalyst, the carbohydrate (or fat) in labile union, the oxygen, and the carbon dioxide formed in the reaction. Variations of the concentrations, or osmotic pressures of any member of the system, may lead to corresponding alterations in rate of oxidation.

In regard to osmotic pressure of the dissolved oxygen, there is a very large factor of safety, for Edie, Moore, and Roaf's experiments on cats, rats, and rabbits show that, provided the carbon dioxide formed in respiration is not allowed to accumulate to a poisonous extent, the animals can be kept for over 40 hours on 5 to 6 per cent of oxygen (rabbits) and 9 to 10 per cent of oxygen (cats) without any evil after-effects, and with no glycosuria. On the other hand, "in accordance with the general fundamental principles of chemical equilibrium, and kinetics of chemical reactions, any accumulation of the products of reaction causing an increase in osmotic pressure, and hence an increased chemical potential of these produced constituents, will act as a resistance upon the reaction, and with further increase will finally bring it to a standstill."

Thus when the CO_2 in the air breathed was allowed to exceed 13 per cent (7 per cent sufficed in the case of a cat), sugar always appeared in the urine, even though the oxygen percentage was kept up to 25 per cent or more. These experiments also show how very great must be the accumulation of CO_2 in the air to produce such an effect as a temporary slight glycosuria. The CO_2 percentage must exceed that in the pulmonary air; viz., 5 to 6 per cent. The increase in badly ventilated rooms, at the outside 0.5 per cent, can cause no accumulation of CO_2 in the body. The experiments also confirm all the other evidences which demonstrate how very greatly the O_2 percentage can be reduced (at sea-level) without endangering the life of the resting animal.

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[1] Cf. Edie, B. Moore, and Roaf, Biochem. Journ., Vol. 5, p. 325. Liverpool, 1911.

THE SUPPOSED EXISTENCE OF A CHEMICAL ORGANIC POISON IN EXHALED AIR

In a paper published by the Smithsonian Institution, F. A. R. Russell[1] says:

"Organic matter is given off from the lungs and skin, of which neither the exact amount nor the composition has been hitherto ascertained. The quantity is certainly very small, but of its importance there can be no doubt. It darkens sulphuric acid, decolorizes permanganate of potash, and makes pure water offensive when drawn through it.... Since this organic matter has been proved to be highly poisonous, even apart from carbon dioxide and vapor, we may safely infer that much of the mischief resulting from the inspiration of rebreathed air is due to the special poisons exhaled from the body, their fatal effect being accelerated by the depression of vitality caused by the gaseous products of respiration and by the want of oxygen.... *As to the frequent emission of a deadly particulate poison, no doubt whatever can exist.* It is a dangerous and pernicious element in all aggregations, and, combined with carbon dioxide, produces, when in moderate quantity, depression, headache, sickness, and other ailments; when in large quantity, as in the Black Hole of Calcutta,..... rapid death in the majority. .... Much of the mortality of infant and adult life may be due to the rebreathing of poison excreted by breath and skin."

This passage expresses the popular view.

We shall show that there is no evidence to justify these statements. The deaths in the Black Hole of Calcutta, the depression, headache, etc., in close rooms, are alike due to heat stagnation; the victims of the Black Hole died from heat-stroke.

From what has gone before, it is evident that neither the diminution of oxygen nor the increase in carbon dioxide has any influence in crowded rooms, and we shall now show that there is no evidence of the existence of any organic chemical poison in exhaled air.

The sanitarian says it is necessary to keep the CO_2 below 0.01 per cent, so that the organic poisons may not collect to a harmful extent. The evil smell of crowded rooms is accepted as unequivocal evidence of the existence of such. He pays much attention to this and little or none to the heat and moisture of the air. The smell arises from the secretions of the skin—sweat, spray from the mouth;

[1] F. A. R. Russell: The Atmosphere in Relation to Human Life and Health. Smithsonian Miscellaneous Collections, Vol. 39, 1896, p. 44. Pub. No. 1072.

from food eaten, such as onions, garlic; from carious teeth; from the bad breath of dyspepsia, due to regurgitation of food particles and their decay on the unhealthy, flabby mucous membrane of the tongue; from the passage of wind from the alimentary canal; from dirty clothes soiled with body secretions—sweat, menstrual discharge, etc. The clothes, too, absorb smells such as those of the stable, tobacco, etc., and give these out. The air may also be contaminated by smells of cooking, or smells arising from urinals, latrines, stables, etc., or by trade smells, many of which are most offensive to the newcomer. The smell is only sensed by, and excites disgust in, one who comes to it from the outside air. He who is inside, and helps to make the "fugg," is both wholly unaware of and unaffected by it. Flügge[1] points out, with justice, that while we naturally avoid any smell that excites disgust and puts us off our appetite, yet the offensive quality of the smell does not prove its poisonous nature. For the smell of the trade or food of one man may be horrible and loathsome to another.

The sight of a slaughterer and the smell of dead meat may be loathsome to the sensitive poet, but the slaughterer is none the less healthy. The clang and jar of an engineer's workshop may be unendurable to a highly-strung artist or author, but the artificers miss the stoppage of the noisy clatter. The stench of glue-works, fried-fish shops, soap and bone-manure works, middens, sewers, becomes as nothing to those engaged in such; and the lives of the workers are in no wise shortened by the stench they endure. The nose ceases to respond to the uniformity of the impulse, and the stench clearly does not betoken in any of these cases the existence of a chemical organic poison. On descending into a sewer, after the first ten minutes, the nose ceases to smell the stench; the air therein is usually found to be far freer from bacteria than the air in a schoolroom or tenement (Haldane).

If we turn to foodstuffs, we recognize that the smell of alcohol and of stilton or camembert cheese is horrible to a child, while the smell of putrid fish—the meal of the Siberian native—excites no less disgust in an epicure who welcomes the cheese. Among the hardiest and healthiest of men are the North Sea fishermen, who sleep in the cabins of trawlers reeking with fish and oil, and for the sake of warmth shut themselves up until the lamp may go out from want of oxygen. The stench of such surroundings may effectually put the sensitive, untrained brain-worker off his appetite, but the robust

[1] Ztschr. f. Hygiene, Vol. 49, 1905, p. 433.

health of the fisherman proves that this effect is nervous in origin, and not due to a chemical organic poison in the air.

Studying the ventilation of sleeping-cars, T. R. Crowder[1] finds that in those cars called "close" or "stuffy" the temperature invariably is high. There has sometimes been an unpleasant odor. A high temperature renders this more noticeable. The most marked offensiveness noticed was in a day coach, where "the air was of such a degree of chemical purity as to indicate ideal ventilation by any standard that has ever been proposed. The car was hot and had many filthy people in it." Perfect comfort has been found associated with the highest chemical impurity in other cars.

Ventilation cannot get rid of the source of a smell, while it may easily distribute the evil smell through a house.

As Pettenkofer said, "if there is a dungheap in a room, it must be removed. It is no good trying to blow away the smell." Houses and people and their clothes and bodies must be made clean, and latrines and kitchens must be placed on the top of houses, or outside them, and on the least windy side.

The right way of dealing with an offensive smell is to remove its cause. By opening the window and letting the wind blow in we may only drive the smell elsewhere. In schools, hospitals, or houses an open window in a latrine may cause the impulsion of the smell into the house. Aspiration by fans may be employed or deodorization by ozone; the latter is one of the simplest methods of dealing with an offensive trade odor. Schoolrooms may be cleared at short intervals, and all the windows and doors thrown open for five minutes, while the children take a "breather" in the form of active exercise in the open air.

Flügge and his school, Beu, Lehmann, Jessen, Paul, and Ercklentz controvert the supposition that there is an organic poison, and bring convincing evidence to show that a stuffy atmosphere is stuffy owing to heat stagnation, and that the smell has nothing to do with the origin of the discomfort felt by those who endure it.

Flügge points out that the inhabitants of reeking hovels in the country do not suffer from chronic ill health, unless want of nourishment, open-air exercise, or sleep come into play. Town workers are pale, anæmic, listless, who take no exercise in the fresh air. Sheltered by houses they are far less exposed to winds, and live day and night in a warm, confined atmosphere.

[1] Arch. of Internal Medicine, 1911, Vol. 7, pp. 85-133.

We will now summarize the evidence for and against the existence of an organic chemical poison in expired air.

Hammond[1] arranged an experiment in which a mouse was enclosed in a large jar with sponges soaked in baryta to absorb the exhaled CO_2, etc., and he attributed the death of the mouse to organic poison. His method undoubtedly was at fault, the mouse dying of suffocation.

Ransome[2] condensed the aqueous vapor of human breath and found that " in ordinary respiration about 0.2 of a gramme or 3 grs. of organic matter is given off from a man's lungs in 24 hours," and that this amount varies greatly in certain diseases; for example, it is greatest in a case of phthisis complicated with Bright's disease.

Seegen and Nowak[3] demonstrated, as they thought, the presence of poisonous organic matter in the expired air, but the quantity obtained was so small that its nature and properties could not be determined.

Hermans[4] was unable to detect any organic matter in the atmosphere of the small chamber in which he confined persons for many hours.

The widespread belief in the presence of organic poisons in the expired air is mainly based on the statements of Brown-Séquard and D'Arsonval, almost wholly unsubstantiated by other workers. These statements have done very great mischief to the cause of hygiene, for they have led ventilating engineers to seek after chemical purity, and neglect the attainment of adequate coolness and movement of the air.

In their first series of experiments Brown-Séquard and D'Arsonval injected into the blood-vessels of a rabbit water with which they had repeatedly washed out the air-tubes of a dog. In a second series they injected the water condensed from the exhaled breath of man; in a third series, the water condensed from the exhaled breath of a tracheotomized dog.

The symptoms recorded[5] were dilatation of the pupil, acceleration of the heart, slowing of the respiration; there usually occurred diarrhœa and paralysis of the posterior limbs. The larger doses caused, as a rule, labored breathing, retching, and contracted pupils.

[1] A Treatise on Hygiene. Philadelphia, 1863. Cited after Billings, etc.

[2] Journ. Anat. and Physiol. London, 1870, Vol. 4, p. 209.

[3] Arch. d. ges. Physiol. Bonn, 1879, Vol. 19, p. 347.

[4] Cited supra.

[5] Compt. Rend. Soc. de Biol., 1887 (8), iv, 814; 1888 (8), v, 33, 54, 94, 108, 121; Compt. Rend. Acad. d. Sc., Paris, Vol. 106, 1888, p. 106.

They attributed the results to a volatile organic poison of the nature of an alkaloid or ptomaine. The poison, they said, is reduced by ammoniacal nitrate of silver or chloride of gold solution. Boiling made no difference to the toxic action of the trachea washings. The condensed liquid turned concentrated sulphuric acid yellow.

The boiled trachea washings might kill even when injected into the rectum or stomach. Intraperitoneal injection killed a guinea-pig in 12 hours. Injection of the liquid into the lungs produced inflammation. Some of these results may be attributed to bacterial infection, others to the toxic effect which is known to follow injection of foreign protein or water containing bacteria, and others to the large doses of water injected at room temperature.

An experiment with two dogs was so arranged that one breathed the air exhaled from the lungs of the other. The experiment continued for nearly seven hours and no untoward results followed.

Dastre and Loye[1] repeated these experiments, but with no result. They inoculated animals with the condensation water of the breath and obtained no effect when 33 to 75 cc. of the fluid was injected into each of five rabbits and two dogs, and 5.7 cc. into each of two guinea-pigs. Two rabbits were killed by the injection of 50 to 190 cc. (60 cc. per kilo) and one puppy by the injection of 30 cc. of distilled water (25 cc. per kilo). The marvel is that all the animals were not rendered severely ill by the injection of such large amounts of water. An equivalent injection for a man would be 2 to 4 liters. Russo-Gilberti and Alessi[2] confirmed the negative findings of Dastre and Loye. They obtained the condensation water from a crowded schoolroom which was sealed up for 2 hours. The air produced headache and was offensive.

von Hofmann Wellenhof[3] obtained the symptoms noted by Brown-Séquard and D'Arsonval when he injected not only large quantities of condensation liquid, but also distilled water at the temperature of the laboratory. There occurred muscular weakness, slowing of respiration, fall of temperature, and dilatation of the pupils. When he injected 10 rabbits with 6 to 30 cc. of the condensation fluid warmed to body temperature, the results were negative.

Lehmann and Jensen[4] likewise obtained wholly negative results

[1] Compt. Rend. Soc. de Biol. Paris, 1888 (8), v, 91.

[2] Bull. Soc. d'Igiene di Palermo, Vol. 3, 1888, p. 331.

[3] Wien. Klin. Wochenschr., 1888, I, p. 753.

[4] Archiv. f. Hygiene, 1890, Vol. 10, p. 367.

with the condensation water of human breath. The fluid was obtained by breathing through a glass spiral surrounded with ice. It was clear, odorless, and neutral in reaction, contained traces of ammonia, and yielded a small sediment on evaporation which they believe originated from the glass vessel. There was no trace of an alkaloid, and ammoniacal silver solution gave no reaction. The reducing power as tested by permanganate of potash was given as 3 to 4 milligrams of O_2 for the oxidation of 1 liter. They confined a man in a metal box for half an hour and then allowed a boy and a girl to inhale the air from the box. No effects resulted excepting slight hyperpnœa. Lipari and Crisafulli[1] also reported results directly contrary to those of Brown-Séquard and D'Arsonval.

J. S. Haldane and Lorrain Smith[2] found that hæmaturia was produced when more than 100 cc. of boiled distilled water was injected subcutaneously into rabbits weighing 1,800 grams. They injected therefore 80 cc. of condensation liquid (human), and without result, an amount corresponding to a dose of 3 liters in a man.

Beu[3] collected the condensation water after cleansing his apparatus with potassium permanganate and distilled water and sterilizing it. The saliva was collected in a Woulfe bottle attached before the condenser. From 3,000 liters, expired in 8 hours, 100 cc. of fluid were collected. This gave a distinct ammonia reaction with Nessler's reagent. Its reducing power with permanganate of potash solution indicated that 50 milligrams of O_2 were required to oxidize 1 liter. The reactions for alkaloid were negative.

He expired 500 liters through 150 cc. of a 1 per cent solution of KHO and evaporated the solution to dryness. The deposit, dissolved in distilled water, formed a fatty layer on the surface of the water which was tinged slightly yellow.

The fluid had a distinctive smell. It was warm to body temperature, and the whole of it was injected under the skin of a mouse without producing any sign of disturbance—a most conclusive experiment and complete refutation of Brown-Séquard and D'Arsonval's statements.

Billings, Weir Mitchell, and Bergey[4] have published the results of a very thorough investigation. They found that in ordinary quiet

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[1] Sicilia med. Palermo, 1889, Vol. 1, p. 229; Abstr. Arch. de Physiol. norm. et path., Paris, 5 s., Vol. 2, p. 679.

[2] Journ. Path. and Bact. Edinburgh and London, 1892-3, I, 168.

[3] Ztschr. f. Hygiene. Leipzig, 1893, Vol. 14, p. 64.

[4] Smithsonian Contributions to Knowledge, Vol. 29, 1895. Pub. No. 989.

respiration no bacteria, epithelial scales, or particles of dead tissue are exhaled.

Flügge has shown that in the act of coughing, sneezing, or speaking, such organisms or particles may be thrown out (droplet contagion). The minute quantity of ammonia or other oxidizable matter in the condensed moisture of human breath appears to be due to the decomposition of organic matter in the mouth and pharynx. Thus the reducing power is greater 4 hours after eating than ½ hour after, and far less if the mouth is cleansed; for example, equivalent to 12 milligrams of O_2 per liter against 3 milligrams. Experiments on the air of the hospital ward, and the moisture condensed therefrom, showed that the greater part of the ammonia is connected with dust particles, microorganisms, etc., which can be filtered off. The bacteria are probably the only really dangerous elements in the air.

The fluid condensed from the pulmonary exhalations of man has no toxic or specially injurious effect when injected into animals, and there is no evidence that such fluid contains an organic poison. The fluid was collected with great care in sterilized apparatus, and was proved to be sterile; it was warmed to body temperature, and was injected in doses in some instances less, in others greater, than the smallest quantities which were used by Brown-Séquard and D'Arsonval with fatal effects.

Peters tested the condensation fluid obtained from human breath on the frog's heart. It had no poisonous effect. In the last year or two Weichardt[1] claims to have found traces of "kenotoxin" in expired air. This, he says, is a protein decomposition product of high molecular weight obtainable in the juice expressed from fatigued muscles. He obtained the condensation fluid from the expired air of a fatigued man of 60 years who breathed through wadding for 2 hours. The fluid was expressed from the wadding. He claims to have obtained it also from blotting paper exposed in a room crowded with sleepers. The fluid was concentrated by evaporation and 1 cc. or more was injected into a mouse.

Inaba[2] carried out similar experiments and reached the conclusion that the mice were poisoned no less by an equally large dose of distilled water. Thus 0.3 to 0.7 cc. gave no result, while 1 to 1.5 cc. made the mice ill. So, too, with distilled water; to put 1 or 1.5 cc. of water into a 13-gram mouse is the same as injecting 5 liters into a 60-kilogram man.

[1] Arch. f. Hygiene, Vol. 74, p. 185, 1911.
[2] Ztschr. f. Hygiene, Vol. 68, p. 1, 1911.

Weichardt[1] rejoined that the respiratory condensation fluid gives the guiac reaction and so must contain some trace of protein. He also said the mouse was not affected by 1 cc. of the concentrated condensation water, if heated to dryness and redissolved, while it was affected by the same dose of unheated condensation water.

He gives details of only one or two such experiments. We now know that either distilled water or isotonic saline solution, when kept in the laboratory, may produce toxic symptoms, especially when large doses are injected. The solution or water becomes infected with bacteria and although sterilized by boiling, when injected intravenously into men, may produce febrile and other disturbances, such as have been observed after the injection of salvarsan. These mischances have been altogether prevented by the use of freshly prepared, pure, sterile, salt solution.[2]

The toxic effect is due to the dosage of dead bacteria injected with the water. The symptoms are shivering, fever, and cyanosis, vomiting, headache, and pain in the back lasting about four hours. The only conclusion which can be drawn from the above is that the evidence in favor of the existence of poison in the condensation water is entirely unsubstantiated. The negative results obtained by so many capable workers are convincing, while the few positive results cannot be accepted in the absence of proper controls. To inject one-thirteenth of its body weight into a mouse, and expect it not to be ill, is about the limit of absurd experiment. Recently Rosenau and Amoss[3] have brought forward evidence of another kind which seems to show that traces of protein may pass away in the expired air, at any rate under their experimental conditions. They breathed through a Drechsel flask, interposing a plug of cotton wool, for 6 to 10 hours; 10 to 20 cc. of condensation fluid was so obtained; 5 to 10 cc. of this fluid was injected into guinea-pigs; and a month later 0.2 cc. of human serum was injected either into the heart or into the brain. Symptoms of anaphylactic shock occurred in many of the animals; but, be it noted, several of the experiments gave negative results, and in particular some in which a double plug of glass wool was employed. It seems to us that in breathing through a tube droplets of saliva will be carried away from the mouth and the glass wool in time will become wet through. When this hap-

[1] Weichardt and Stötter, Arch. f. Hygiene, Vol. 75, p. 265, 1912.

[2] McIntosh and Fildes: Syphilis, pp. 200, 207. Arnold, London, 1911; Lancet, March 9, 1912.

[3] Journ. Med. Research, Boston, 1911, Vol. 25, p. 35.

pens, droplets may be carried on from the farther side of the wool into the condensation water. Breathing through a tube leads to an expulsion of saliva which does not occur in natural breathing. Dust of white lead may be carried through four wash bottles by a current of air.[1]

The guinea-pigs, as we might expect, therefore became sensitized to human protein by the injection of the condensation water containing traces of salivary protein.

Rosenau and Amoss do not take this view, and think that their results afford evidence in favor of the exhalation of a volatile protein —an organic chemical poison. They say they "have always felt that a vitiated air must contain substances which are harmful, even though not demonstrable to science," and suggest that the sensitivity of some adults to a first injection of horse serum may be due to such adults having worked with horses and breathed their breath. Horse dung and horse hairs seem to us far more likely to produce anaphylactic sensitivity in a groom than the breath of ten thousand horses. The authors say "there is a growing tendency to regard the ill effects of vitiated air as due to increased temperature and moisture; it is now apparent that there are other factors which must be taken into account." But the question is—Do men breathe out a substance poisonous to man? If there were anything in these claims, we should expect to find guinea-pigs which dwell in the same confined cage, and breathe each other's breath, sensitive to the injection of a trace of each other's protein. All those who study the phenomena of anaphylaxis know that no such sensitivity can be shown. Anaphylaxis can be produced only by the injection of a foreign protein. No one has ever demonstrated that it is possible to produce anaphylactic sensitivity by the assimilation of protein from the alimentary tract; in fact all the evidence of daily experience is against such a possibility. There is no more likelihood that a foreign protein should have such an effect when absorbed from the respiratory tract. We (M. F. and L. H.) have put the matter to the test, and in this part of the research Dr. James McIntosh coöperated with us. The method we have adopted is one which places the animals in a condition similar to that of men living in a crowded, confined atmosphere. Rats and guinea-pigs lived together at the bottom of boxes, the lids of which were only so far opened as to give imperfect ventilation. Thus, the animals lived in obscurity, and in an atmosphere containing 0.5 to 1.5 per cent CO_2. The

[1] Legge and Goadly: Lead Poisoning; Arnold, 1912.

boxes were cleaned out daily and the animals were well fed. They not only must have inhaled each other's breath, but must have eaten food contaminated with each other's fur and excreta. After so living for weeks, we injected rat's serum into the guinea-pigs and guinea-pig's serum into the rats. In neither case was there any evidence of anaphylaxis.

We made the injections into the veins of the ear of most of the guinea-pigs, using a fine needle. In others, and in the rats, we made the injections into the heart. A month later we gave a second dose of rat's serum to the guinea-pigs, and each one died within a minute or so with all the symptoms of anaphylactic shock. The rats, on the other hand, did not become sensitized to guinea-pig's serum. It is recognized that rats are immune to anaphylaxis.

We sensitized more guinea-pigs by an injection of rat's serum and a month later injected into these the condensation water we obtained from the air drawn through a vessel containing rats—a father, mother and seven young rats. The result was nil. 0.5 and 0.75 cc. were the doses of condensation water injected. While entirely unaffected by the condensation water, these *sensitized* guinea-pigs suffered from anaphylactic shock when a dose of rat's serum (of the minutest volume) was injected three hours later. We are driven to conclude, then, that Amoss and Rosenau's positive results were due to contamination of the condensation water by saliva, and that when the experiments are conducted under the conditions which pertain in a crowded room, there is no evidence of the exhalation of any volatile protein.

Brown-Séquard and D'Arsonval[1] sought to substantiate their results obtained with condensation water by another form of experiment. They confined a rabbit in each of a series of four metallic cages connected by means of rubber tubing through which a continuous current of air was aspirated. The animal in the last cage breathes the air which has passed through all the previous cages and which is contaminated with the other rabbits' breath. This animal after a time dies, then after a time the rabbit in cage 3 succumbs, while rabbits in cages 1 and 2 usually survive. They could not attribute the deaths to CO_2 poisoning, because they rarely found in the last cage more than 3 per cent with small animals, and 6 per cent with larger animals. On interposing between the last two cages (3 and 4) absorption tubes containing concentrated H_2SO_4,

[1] Compt. Rend. Acad. de Sc. Paris, 1889, Vol. 108, 267-272.

the animal in cage 4 remained alive, while the one in cage 3 was the first to die. They concluded that the deaths were due to a volatile poison which was absorbed by H_2SO_4.

Such were their statements, definite and precise and apparently backed up by well-contrived experiments.

As it turns out, no one except Merkel has claimed to have obtained similar results.

Haldane and Lorrain Smith constructed an air-tight wooden chamber containing 70 cu. ft., measuring 6 ft. 2 in. by 2 ft. 11 in. by 3 ft. 11 in., and fitted with a large window. One of them stayed 4 hours within the chamber with no renewal of the air until the CO_2 reached 3.9 per cent. The subject had slight hyperpnœa and slight headache. Both disappeared as soon as he left the chamber. In another experiment they varied the conditions by placing a large tray of soda lime in the roof of the chamber. There were very much less hyperpnœa and no headache on this occasion. Slight hyperpnœa occurred when the deficiency of oxygen in the chamber air became greater than 5.5 per cent. In yet another experiment they charged the air of the chamber with 5.4 per cent CO_2 at the beginning, and at the same time kept the oxygen percentage up to 19.8 per cent. There was great hyperpnœa, with great relief on coming out, but frontal headache followed the experiment. In other experiments they breathed the same air over and over again, in and out of a bag; they found the distress became unbearable when the CO_2 reached 10 per cent. On breathing 5 per cent of CO_2, hyperpnœa and headache occurred equally whether there was 14 per cent or 70 per cent of oxygen in the bag, so they concluded that with air vitiated by respiration up to the extreme limit which we can tolerate, the diminution in the percentage of O_2 is practically without effect on the hyperpnœa. Brown-Séquard and D'Arsonval stated that they had breathed air containing 20 per cent of *pure* CO_2 for 2 hours without hurt and with no marked distress, and drew a distinction between the chemically pure CO_2 and impure exhaled CO_2. This is a wholly erroneous statement. Haldane and Lorrain Smith breathed air containing 18.6 per cent pure CO_2. After 15 seconds there was hyperpnœa; in 60 seconds this was severe; at the end of 90 seconds the subject turned blue and had to stop; in the 134th second the hyperpnœa ceased. They next breathed in and out of the bag of air through a Woulfe bottle containing soda lime. The subject stopped after 2 hours because he was getting blue in the face and felt abnormal. There was no headache, throbbing, flushing or marked hyperpnœa. At the end of the experiment the bag contained 0.0 per cent CO_2 and 8.7 per cent O_2; in another experiment only 6.7 per cent O_2. They blindfolded the subject and let him breathe alternately air containing 7 per cent CO_2 and 11.3 per cent O_2 and air containing almost no CO_2 and 9.5 per cent O_2. The first caused hyperpnœa and the second relieved it.

In another experiment the subject breathed from a bag filled with hydrogen. At 30″ he was getting blue; at 40″ he was blue and hyperpnœic; at 50″ he lost his senses and fell down in his chair, but recovered at once without headache or any other symptoms.

They placed two large rabbits in a chamber, and drew a current of air through this, and through a chamber in which were two small rabbits. No effect was produced. They took five bottles, each of a capacity of 1 to 1.5 liters, and connected these by tubes and, placing a mouse in each, drew a current of air through the whole series. The mice were exposed to this for 53 hours without harm.

In another experiment, lasting 3 days, the mice remained normal, and yet the percentage of CO_2 in the last bottle varied from 2.4 to 5.2 per cent, averaging about 3 per cent, during the whole period.

Beu also repeated the Brown-Séquard experiments and attributed the death of their animals to accumulation of moisture and change of temperature. His animals became wet and cold, and the protection afforded by the H_2SO_4 absorption tube Beu attributed to the removal of moisture.

Bauer carried out the same kind of experiment but inserted between the fourth and fifth cages an H_2SO_4 absorption tube, and between the fifth and sixth cages soda-lime absorption tubes. The sixth animal remained alive, while the fifth died, proving that excess of carbonic acid was the cause of death.

Lubbert and Peters reached the same conclusion. Between the third and fourth flasks they placed a tube containing red-hot cupric oxide to remove the organic matter, and other tubes for cooling the air and drying it. The animal in the fifth jar died when the CO_2 increased to 11 to 12 per cent. When a soda-lime tube was interposed between the fourth and fifth cages, the animal in the fifth lived. None of these researches yielded any evidence of organic poison in the exhaled air.

Billings, Weir Mitchell, and Bergey investigated the duration of life of mice in closed jars of about 2 liters' capacity and found as a general rule that the animals died when the CO_2 increased to 12 to 13 per cent and the oxygen diminished to 5 to 6 per cent.

The death of animals confined in a small chamber is due to deficiency of oxygen, which has its effect before the CO_2 rises to a poisonous level. "The duration of life in such conditions is very perceptibly shortened through the influence of a higher as well as a lower temperature than 18° to 20° C." If the oxygen be kept above 6 per cent, animals may live for hours even when the CO_2 rises to 20 per cent or more. "An atmosphere consisting of 90 per cent oxygen and 10 per cent nitrogen does not support life quite as long as does ordinary atmospheric air when the temperature is 0° C., while at a temperature of 50° C. the atmosphere rich in oxygen supports life much longer than the ordinary atmosphere."

We can scarcely explain these interesting results on the ground that the high concentration of oxygen lessened the respiration, metabolism, and formation of body heat—an effect advantageous in the high temperature but not in the low. It is more likely that oxygen maintained the beat of the heart by lessening the production of lactic acid, and thus had the same sustaining effect as we have found in men carrying out strenuous work. The experiments are few, need further confirmation, and suggest enquiry.

In the case of other animals enclosed in a chamber, the air confined was driven to and fro in the chamber through potash tubes, so that the CO_2 was absorbed. No deleterious effect developed from the continual rebreathing of this air. We must conclude from all these experiments that so long as the oxygen is sufficient and the CO_2 does not rise to a poisonous level, and the temperature is kept normal, the animals do not suffer, and there is no evidence of the presence of any exhaled organic poison.

Thirty-three experiments of the Brown-Séquard type were performed by the authors. The animals were confined one in each of a series of bell glasses, through which air was aspirated.

To begin with, trouble was experienced owing to the difficulty of making the connections air-tight. Failure to do so led to failure of ventilation and to death from asphyxia, with the ordinary postmortem appearances. None of the focal necroses or peculiar degenerative changes recorded by Brown-Séquard and D'Arsonval were noticed. "From the data accumulated with reference to the composition of the atmosphere in these bell jars by repeated analyses at short intervals, compared with the results reported by Brown-

Séquard and D'Arsonval, it seems probable that the cases in which the last animal in the series survived some of the others and a low percentage of carbonic acid was found in the jar, should be attributed entirely to defects either in methods of air-analysis or in the apparatus, or in both. If, however, the life of the last animal was apparently saved by H_2SO_4, it was due to leakage in the connections from the increased resistance caused by the interposition of the absorption tube. This is an important fact, which is in direct opposition to the theory of Brown-Séquard and D'Arsonval with regard to the influence of H_2SO_4 in the absorption tubes." . . . .

"In experiment No. 33, with a series of six rabbits confined for two days, the proportion of carbonic acid in the last two jars, for the greater part of the time, was between 4 and 7 per cent, and that of the oxygen between 12 and 16 per cent. None of the animals died or were seriously ill. Those in the first three and in the fifth jars gained in weight, those in the fourth and sixth lost slightly in weight."

An experiment of this nature, and result, once and for all negatives the organic poison theory.

The experiments have shown that animals such as mice may live in an atmosphere in which, by gradual change, the proportion of oxygen has become so low and that of the carbonic acid so high that a similar animal, brought from fresh air into it, dies almost immediately. This immunity may continue when the experiment is interrupted for a day or two. The immunity is exceptional, is limited to certain individuals, and requires further enquiry.

We (M. F. and L. H.) repeated the Brown-Séquard experiment and placed two chambers (capacity 6 liters) in series, the one containing three rats and the second a guinea-pig; in another series we placed three rats in the first and three rats in the second chamber. Air was aspirated through each series at such a rate as to give 2.5 to 4 per cent CO_2 in each of the second chambers. We cleaned out the animals' chambers each day, and filled them with dry hay so as to avoid the cooling and wetting effect of the air, which was saturated with moisture. The experiment continued for three weeks and both the guinea-pig and the rats in the second chamber increased in weight.

Finally, the first of these two experiments terminated by an accidental failure in the aspirating current which led to the asphyxiation of the animals in both chambers.

		End of first week	End of second week	End of third week	End of fourth week
(I)					
Chamber II, guinea-pig, weight in grams...	292	325.7	370.5	385	
Percentage of CO_2		2.95–3.78	3.88	3.76	
(II)					
Chamber II, rats (3) weight in grams.... 1	90	96	111.2	128.7	144
2	81	90.7	99.5	109.5	120.5
3	78	80.5	84.8	85.2	85.5
Percentage of CO_2		2.21–2.59	2.88	2.55	2.48

We (M. F. and L. H.) also carried out experiments of a somewhat different kind, the results of which wholly negative the Brown-Séquard and D'Arsonval statements.

We confined tame rats and guinea-pigs together in a deep wooden box, the lid of which was so shut down as to give imperfect ventilation. The animals lived for 2½ weeks in an atmosphere containing 1.6 to 3.8 per cent CO_2.

	Weights				
	Feb. 1 Initial weights	Feb. 8	Increment first week	Feb. 15	Increment second week
GUINEA-PIGS	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
(1) Large, short haired, brown	335.5	381.5	46	413	31.5
(2) Large, black, short hair	331	373	42	406	33
(3) White dot and black.	191.5	229.5	38	263	33.5
(4) White dot and brown fur	139.5	176	36.5	203.5	27.5
(5) Large, long hair.....	266	316.5	50	340	24
(6) Right black and left brown	191	251.5	60.5	278.5	27
RATS					
Stumpy tail	133.5	159.5	26	162	2.5
Black + ...	165	182.5	17.5	184	1.5
Black −	186.5	212.5	26	212	—.5
Red head	126.5	153.5	27	163.5	10
Warty + ...	190	224	34	234	10
Warty −	166	190.5	24.5	197.5	7

Date	CO_2	
	Per ct.	
Feb. 1	12.3	Ventilation too little first day
2	1.6	
6	2.28	
7	2.41	
8	2.7	Second week
9	3.6	
12	3.78	
14	3.38	
15	3.0	

In the third week the lid of the box was accidentally closed and left so all night. Three guinea-pigs and one rat died from the effects of suffocation. The remainder lost weight very seriously; for example, guinea-pigs 42 to 77 grams and rats 3 to 26 grams. The loss of weight was recovered at the end of another week, during which the box lid was left full open.

The fact that the animals put on so much weight shows conclusively that there was no active toxic substance in the exhaled air; the experiment negatives the conclusions not only of Brown-Séquard and D'Arsonval, but of Rosenau and Amoss, for the surviving guinea-pigs were not sensitized in the slightest degree to an intracardial injection of 0.5 cc. of rat's serum. Subsequent intravenous injection, however, with 0.1 cc. of rat's serum killed the animals with all the characteristic anaphylactic symptoms.

The animals, especially the rats, did not gain weight so well in the second week as in the first; there was evidently some deleterious influence at work. To determine this we first tried the effect of partially drying the air. We took two boxes of equal size, but with the same number of rats and guinea-pigs in each, and arranged the same degree of ventilation. In one box we placed just above the animals large trays of granular calcium chloride, and in the other, as a control, trays of broken pumice. The temperatures wet and dry were taken, as well as the percentage of CO_2. The animals were fed and the boxes were cleaned daily. As the temperature did not exceed 22.5° C. and generally was below 20° C., it was not likely that the drying of the air and lowering the wet bulb by 2° to 3° C. would make any difference in the rate of growth; and it did not.

Ten of these guinea-pigs, after living with rats for 14 weeks, received injections of rat's serum into the veins of the ear. None of them showed any symptoms of anaphylaxis.[1]

We next tried the effect of substituting for the wooden lid of each box one made of glass, so submitting the animals to the stimulus of light and a view of the outside world, in place of dim obscurity. Periods of light and dark alternated. The growth of the animals appears accelerated by light and retarded by dark. The light and the sight of the surrounding world stimulates activity, and so the metabolism and growth. The experiment demonstrates in terms of

[1] Four of these guinea-pigs later received an intravenous injection of 0.1 cc. by the ear and were all killed by anaphylactic shock. Two of the others were injected intraperitoneally with 5 cc. of water condensed on a piece of glass covering a box containing 12 rats. This injection caused no ill effects. We have since pursued this line of research further. In all, including the above-mentioned two, twelve guinea-pigs have been injected intraperitoneally with doses varying, according to the size of the animal, from 3-5 cc. of condensation water. Subsequent intravenous injection a month later with 0.2-0.3 cc. of rat's serum has *in no case* caused any anaphylactic symptoms. A further intravenous injection of 0.2-0.3 cc. rat's serum has evoked marked anaphylactic symptoms resulting in death in all but one case, which however suffered severely and subsequently recovered. One of the young born after the first injection of rat's serum into the mother was killed by an intravenous injection of 0.1 cc. of rat's serum. (Foot-note added in proof, May, 1913.)

Box I	Initial weight	Increments of weight per week in grams												
		1	2	3	4 and 5	6	7	8	9	10	11	12	13	14
GUINEA-PIGS	*Grams*													
Fawny..........	121	1	20	36	23 (11½ 11½)	4	13	26	47	18	1	20	35	
Browny, brown dot..........	113	5	17	29	24 (12 12)	13	36	29	36	13	—1	31	24	
Ginger white....	125	19	21	22	13 (6 6)	11	22	21	42	11	—4	17	32	
Long hair......	121	26	27	29	26 (13 13)	13	23	27	42	5	—20	45	23	
Darky..........	161	37	26	35	31 (15½ 15½)	24	41	27	32	12	3	44	26	
Whitey.........	165	..	15	17	—2 (—1 —1)	7	20	20	25	14	7	21	7	
RATS														
Black and white	101	..	15	—4	dead	..	..	..	..	..	....	..	..	..
Black and white	76	..	12	8	—9 (—4½ —4½)	8	8	16	12	8	—37 (ill)	..	..	...
Black and white	106	..	0	2	dead	..	..	..	..	..	....	..	..	...
White..........	152	..	7	10	1 (½ ½)	20	11	15	8	12	—17	25	1	—
White..........	86	..	13	3	4 (2 2)	14	14	20	11	8	8	16	10	
		Dark				Light			Dark			Light		Dar

	Temperature		CO_2
	Dry bulb	Wet bulb	
	Degrees C.	*Degrees C.*	*Per ct.*
irst week.....	19	15	0.73
	19½	18½	5.53
	20	16½	0.98
	16	13	1.85
	16½	13½	2.17
econd week..	18	16½	5.4
	17	15½	0.6
	20	17½	1.01
	21	18	0.59
	20½	17	0.90
hird week....	20	16	0.85
	20	17	0.66
	18½	16	0.99
	15½	13½	0.67
ourth week...	16	14	0.85
	18	13	0.73
fth week....	18	13	1.35
	16	14	0.782
	16	13	1.43
	16	13½	1.6
xth week....	17½	17½	0.99
	18½	17	0.98
	20	19	0.31

Calcium chloride trays in from first to fifth week, inclusive

	Temperature		CO_2
	Dry bulb	Wet bulb	
	Degrees C.	*Degrees C.*	*Per c.*
Seventh week..	18	17½	0.4
	16	15½	0.5
	19½	18½	1.0
Eighth week...	19	19	0.7
	22½	22½	1.1
Ninth week....	20½	19	0.5
	21½	20	0.5
Tenth week....	22	20½	0.5
	21½	20	0.6
Eleventh week.	20½	19½	...
	18½	17	0.5
Twelfth week....	21½	21¼	0.8
Thirteenth w'k.	21½	19½	9.5
	22	21½	0.6
Fourteenth wk.	22	20½	0.5
	20½	19½	0.9

Box II	Initial weight	Increments of weight per week in grams: 1	2	3	4 and 5	6	7	8	9	10	11	12	13	14
GUINEA-PIGS	*Grams*													
Ginger white....	121	8	15	27	2 (1 1)	33	30	12	53	9	7	24	27	12
Light brown....	141	17	22	23	27 (13½ 13½)	30	34	15	53	13	—6	24	23	30
Black and tan...	115	11	25	—1	29 (14½ 14½)	22	33	13	63	14	27	14	24	2
Brown, white star...........	127	12	23	32	25 (12½ 12½)	14	48	18	62	15	1	20	15	27
Dark brown.....	160	8	33	26	25 (12½ 12½)	40	40	15	63	1	14	19	37	0
Fawny..........	178	..	—17	3	—17 (—8½ —8½)	7	1	1	12	4	16	7	7	23
RATS														
Black and white	90	..	1	—4	dead	..	..	..	..	..	..	..	..	
Black and white	67	..	13	12	lost	..	..	..	..	..	..	..	..	..
Black and white	117	..	12	7	3 (1½ 1½)	—8	—7	3	5	—2	5	7	2	0
White.........	165	..	31	dead	......	..	..	..	..	..	..	..	..	..
White........	102	..	dead	....	......	..	..	..	..	..	..	..	..	..
White.........	76	..	9	—3	4 (2 2)	0	12	8	10	0	—1	0	1	2
		Dark				Light			Dark			Light		Dark

	Temperature: Dry bulb	Temperature: Wet bulb	CO_2	
	Degrees C.	*Degrees C.*	*Per ct.*	
First week	18½	18½	0.78	Pumice trays in from first to fifth week, inclusive. In dark.
	19½	19½	1.69	
	19	18	2.01	
	14	13½	1.95	
	16½	15½	3.5	
Second week	16½	16½	4.53	
	16	16	0.65	
	19	18	1.11	
	20½	20	1.13	
	20½	19	0.71	
Third week	20¼	19½	0.86	
	20	19½	0.72	
	18	17	0.63	
	16	15	0.89	
	15	15	1.23	
Fourth week	16	15	0.9	
	18	17	0.89	
Fifth week	17	17	1.03	
	15	13	0.749	
	16	15	0.69	

	Temperature: Dry bulb	Temperature: Wet bulb	CO_2	
	Degrees C.	*Degrees C.*	*Per ct.*	
Sixth week....	15	14	0.91	In light
	17	16	0.63	
	18	16½	0.97	
	20½	19¾	0.34	
Seventh week..	17½	17	0.44	
	16	15½	0.49	
	19½	19½	0.88	
Eighth week...	19	19	0.78	
	22½	22	1.17	
Ninth week....	20½	19	0.51	In dark
	21½	20	0.55	
Tenth week....	22	20½	0.51	
	21½	20	0.61	
Eleventh w'k...	20½	19½	....	
	18½	17	0.51	
Twelfth week..	22½	21½	0.91	In light
Thirt'th week..	21	19½	0.56	
	21½	21	0.81	
Fourt'th week..	22	20½	0.51	
	21	20	0.91	

growth the depressive effect of darkness. In our cities the dullness of sunless days and fogs of winter are intensified by the smoky air. The smoke discourages cleanliness and opening of windows, damages plant life, destroys buildings, clothes, etc., is wasteful of energy, entails the needless production of artificial light, intensifies the dirt and blackness of the streets, depresses the spirits of the inhabitants, and is generally economically unsound. We counterbalance the absence of sun by the illumination of our places of business and entertainment; the shop lights, the twinkling reflections in the wet pavements, the green and red signals of the railways, the moving lamps of the vehicles, the cinema shows, etc., make up a kaleidoscopic effect which stimulates fancy and dispels the monotony and gloom of the atmosphere. The warmth and brightness of our houses impels us to stay within doors, and we suffer in winter from loss of open-air exercise. How much sun the Londoner has lost is shown by figures recorded by Russell: In four years there were 3,925 hours of sunshine in London, 5,713 at Kew and 6,880 at St. Leonards. Between November and February in one year, there were 62 hours of sunshine in London, 222 at Kew and 300 at Eastbourne. For the years 1902-1906 the yearly average of hours of sunshine in London was 1,257; and for the years 1907-1911, 1,341. Twenty per cent of the fogs in London are wholly due to smoke.[1] The great manufacturing districts suffer no less from the plague of darkness. The age of the gas-engine is now upon us, and the displacement of steam as a source of power, with its wasteful consumption of coal, and of open coal fires by smokeless methods of heating, will bring back the days of clean skies. The present dark age of coal, steam, and slums will emerge into one of garden cities and clean living. We must see to it that the method of house warming is contrived on the same lines as the open fire, otherwise we may lose in health from the want of cool moving air more than we gain from light. Gas fires fitted as open fires with flues, or sources of radiant heat combined with impulsion of cool air, are the kind of methods which require development. The method so widely employed of heating rooms by heating the air, is the one which particularly lends itself to the production of ill effects.[2]

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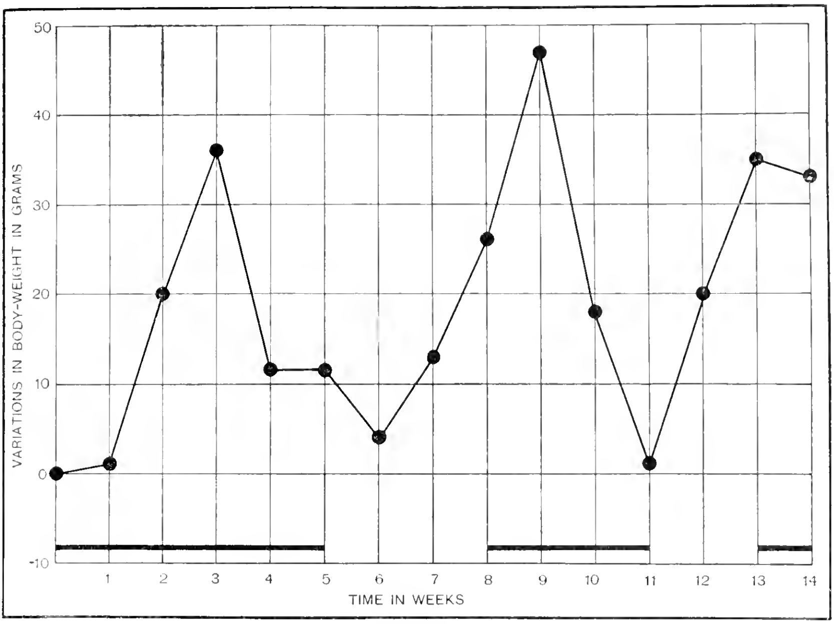
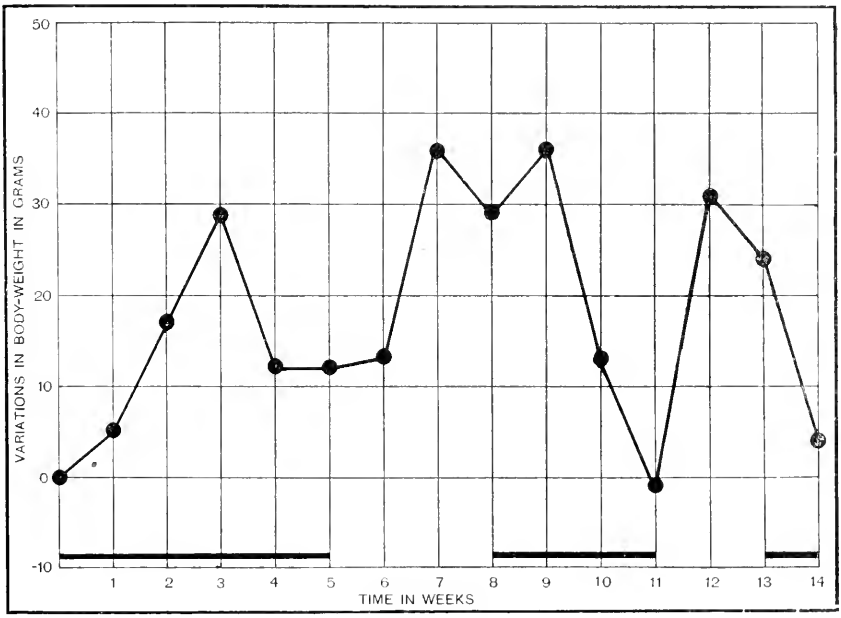
[1] Dr. Norman Shaw. Cited in Report of Smoke Abatement Conference, 1912, p. 68.

[2] The expenses of the foregoing part of this research were defrayed by a grant from the Science Committee of the British Medical Association.



Box I. Guinea-Pig No. 1.



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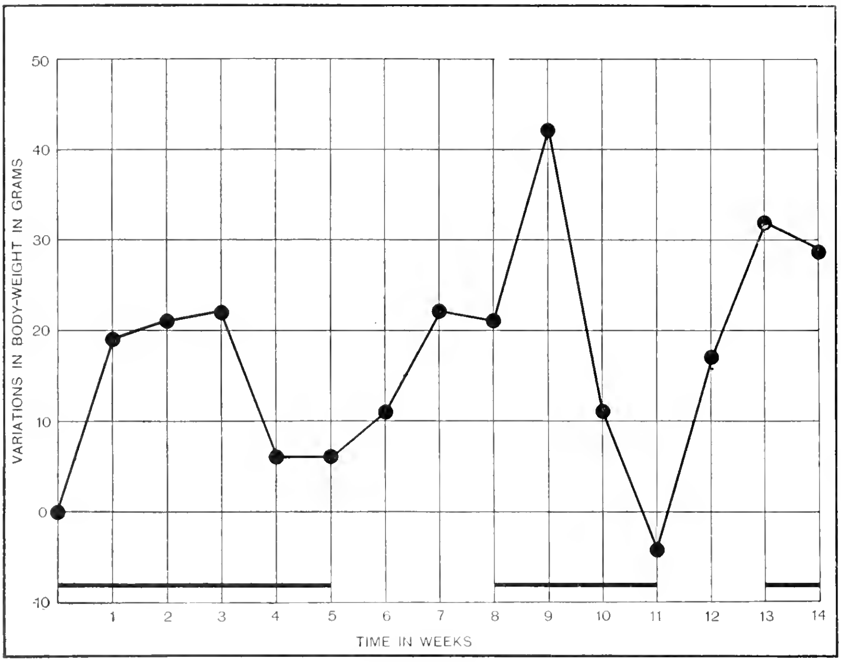

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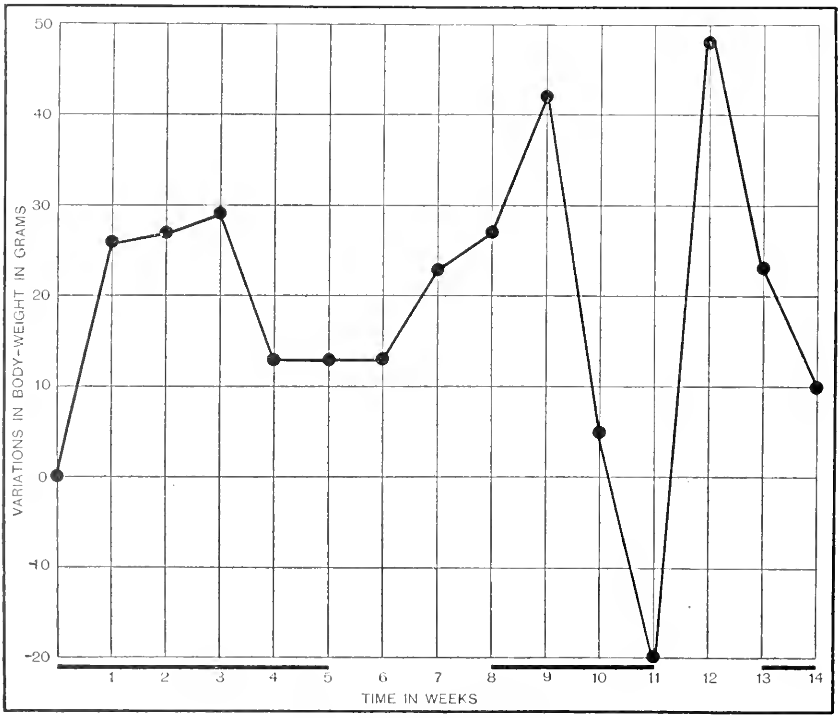

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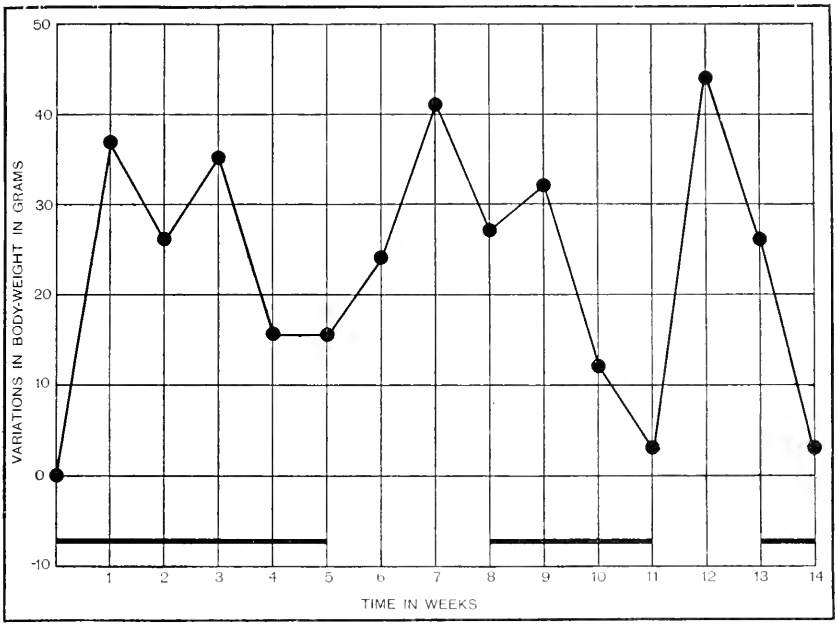

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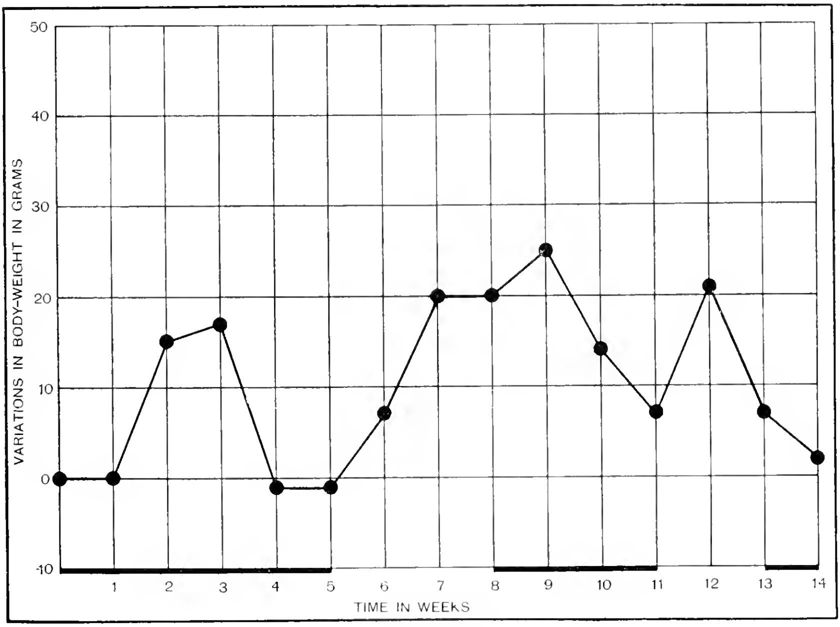

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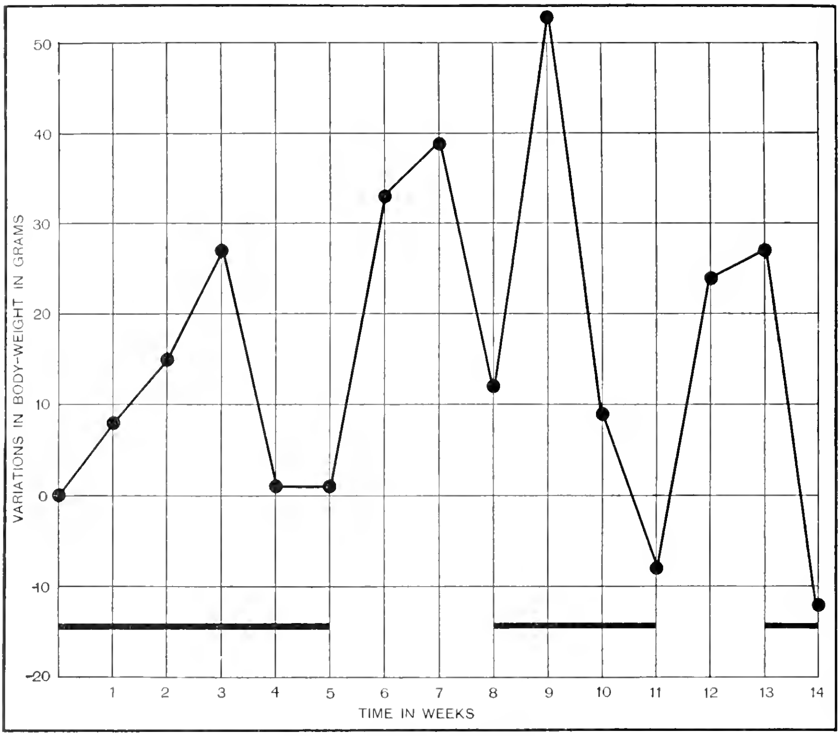

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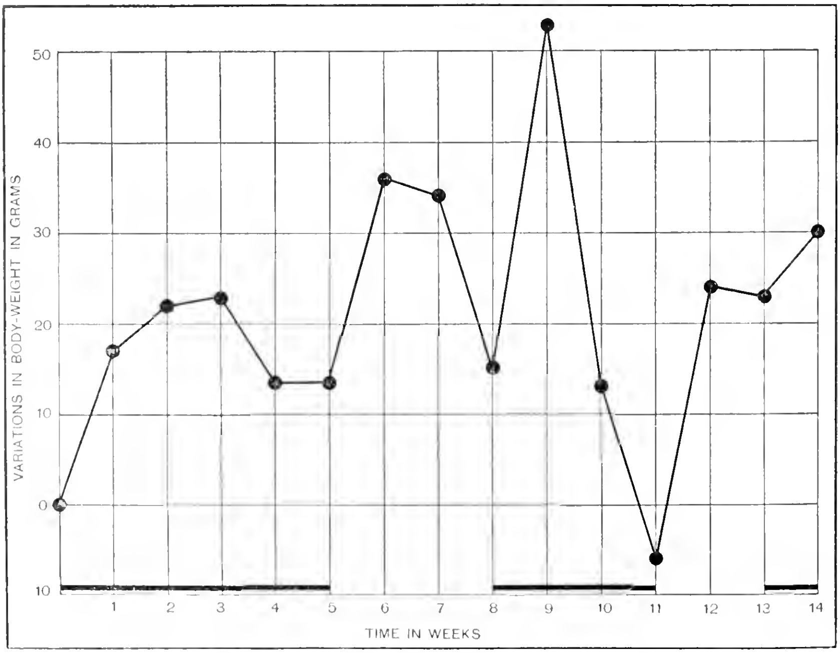

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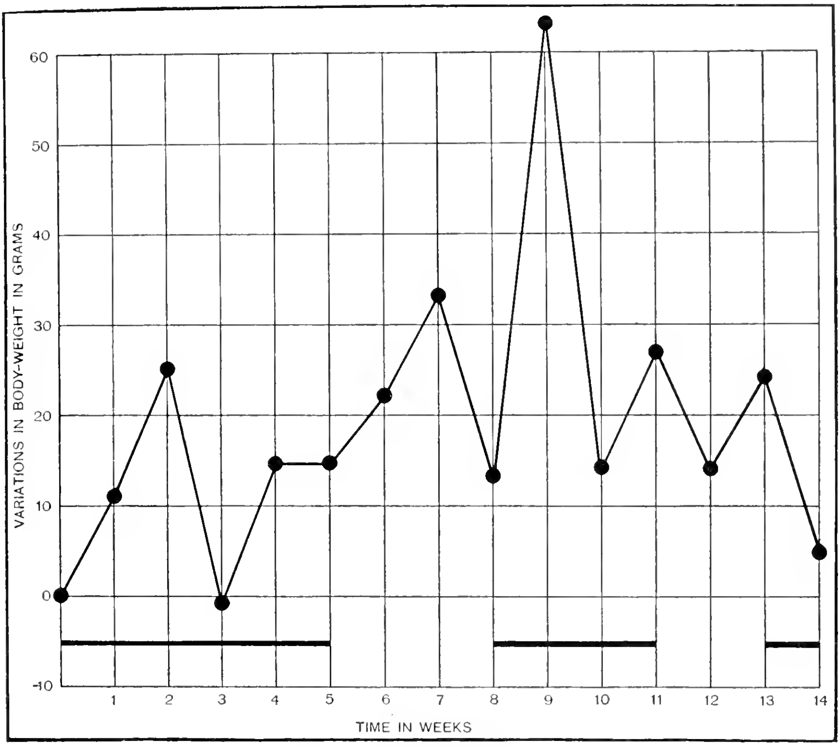

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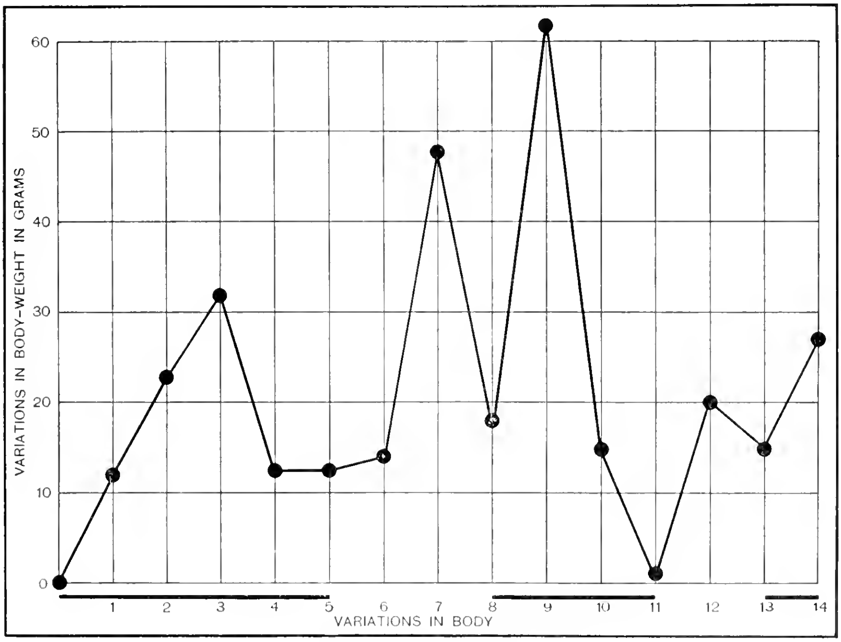

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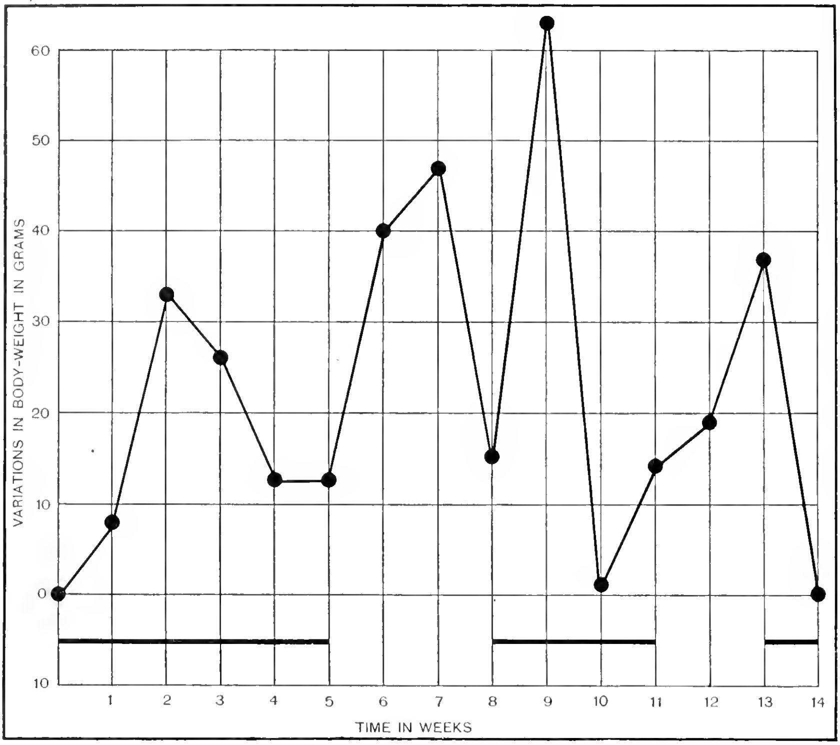

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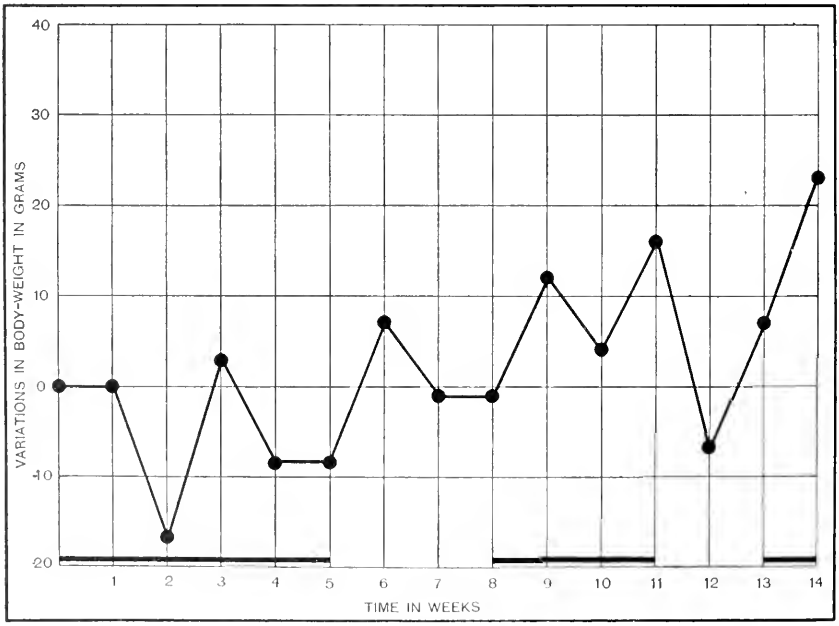

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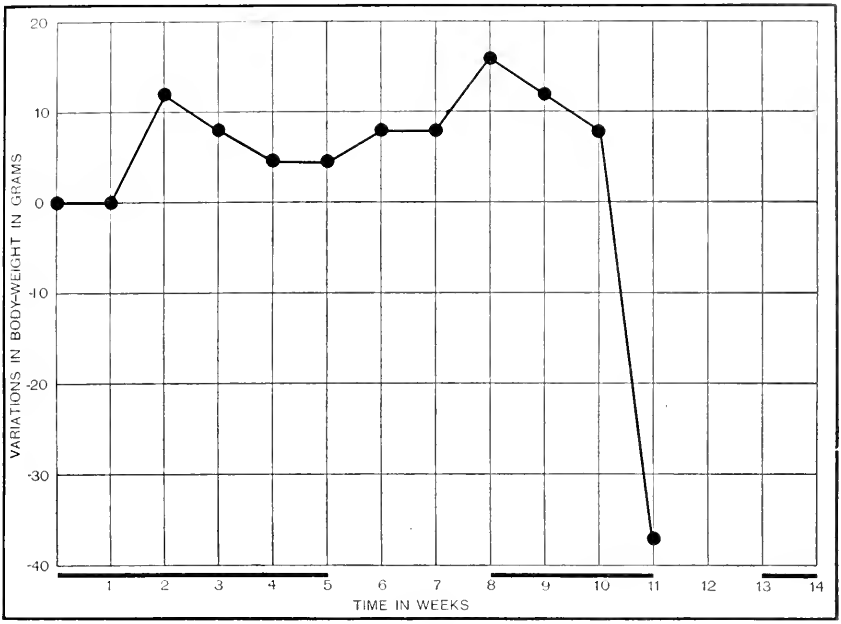

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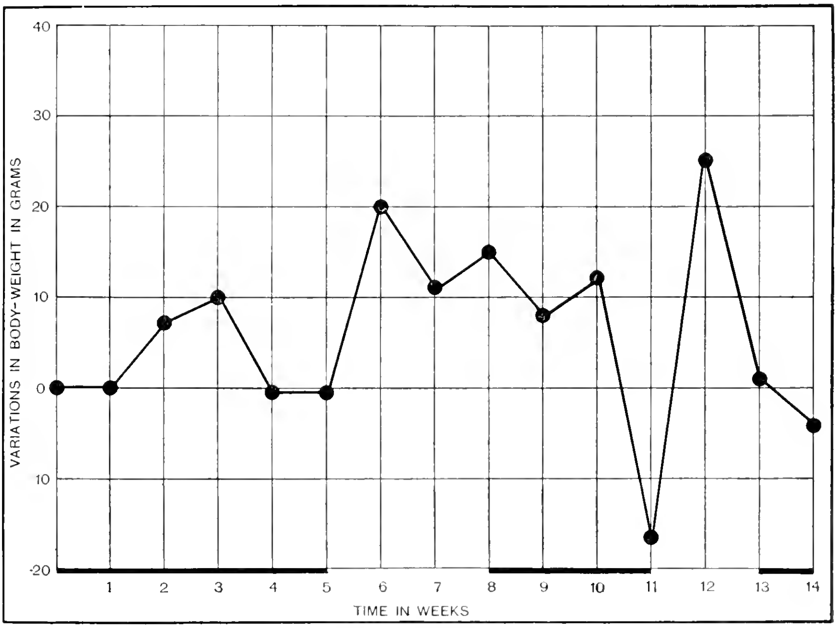
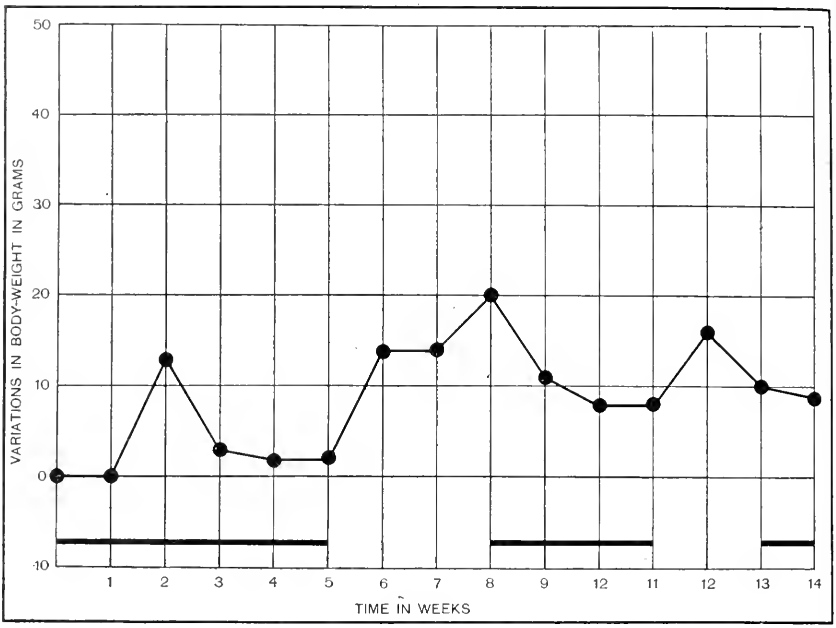
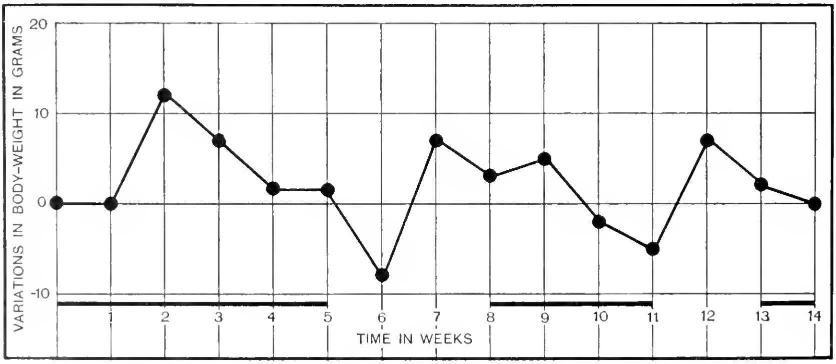


Box I. Rat No. 4.



Box I. Rat No. 5.



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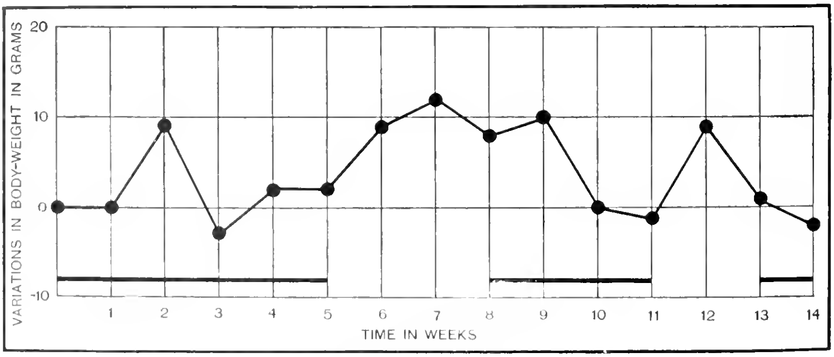

Box II. Rat No. 6.

THE HEAT AND RELATIVE MOISTURE

No less than thirty years ago Hermans[1] found the evidence in regard to the bad effect of the chemical impurities insufficient, and suggested that the results of bad ventilation are thermal in origin. Susceptible individuals suffer from oppression, headache, sickness, and may faint under certain conditions in crowded rooms. The symptoms resemble those experienced in the open air on excessively hot and humid days. The axillary temperature may be raised 0.3° to 0.6° C. in a hot theater. Heat and moisture increase very greatly in crowded places where the occupants are jammed together and the usual channels of dissipation of body heat are checked. Flannel and linen garments may increase in weight 13 to 14 per cent. The wetness of the clothes increases the unpleasant feelings and the danger of chill on coming out of warm rooms into the outer air.

Under the direction of Flügge[2] a series of admirable experiments have been carried out on this question in the Institute of Hygiene in Breslau by Heymann, Paul, and Ercklentz.

Normal individuals were placed in a cabinet of 3 cubic meters capacity, and shut within it for periods up to four hours until the CO_2 percentage rose to from 1.0 to 1.5. No symptoms of illness or discomfort were felt and the chemical impurity of the air had no influence on the power to carry out ergographic tests or mental computations so long as the temperature and moisture of the air were kept low. Paul shut a man in the chamber for 4¾ hours. The temperature rose to 24° C., the relative humidity to 89 per cent, the CO_2 to 1.2 per cent. He was very uncomfortable. Those who, from outside the chamber, breathed the air in through a mouthpiece, felt no discomfort. *Immediate* discomfort was felt by one who went into the chamber. In another experiment the temperature was 30.2° C., relative humidity 87 per cent, CO_2 1.1 per cent. Symptoms of discomfort were pronounced although the subject breathed pure air from outside through a mouthpiece. The symptoms were allayed by a fan which impelled the air in the chamber at a rate of a few meters per second.

When the chamber was cooled to 17° C. there were no symptoms of discomfort although the CO_2 rose to 1.6 per cent. Ercklentz found that the sensitivity of patients to close air is wholly due to tempera-

[1] Arch. f. Hygiene, Vol. 1, 1883, p. 1.

[2] Ztschr. f. Hygiene, Vol. 49, 1905, pp. 363, 388, 405, 433.

ture and moisture. Thus those suffering from heart disease and bronchitis—when shut in the cabinet—were comfortable so long as the temperature readings lay between 8° and 20° C., in spite of the CO_2 rising to 1.57 per cent. They were very sensitive to high readings, and endured less heat (for example, 20° to 27° C.), and for much less time (for example, only 40 to 50 minutes), than healthy men. They complained of dizziness and were generally uneasy. Normal men became uncomfortable when the temperature rose to from 27° to 31° C., with a relative humidity of 51 to 60. The skin temperature of the forehead rose 2° to 3° C., and the relative moisture of the air in contact with the skin as taken with a hygrometer under the clothes rose 20 to 30 per cent.

Benedict[1] has shown that a man can live many days in a closed calorimeter chamber in comfort, without damage to his health, and having not the slightest cognizance of any defect in ventilation when this is so reduced that the CO_2 accumulates to from 1 to 2 per cent—that is, so long as the air of the chamber is kept cool and dry. Zuntz[2] suggested that this result might be due to the circulation of the air through the H_2SO_4 driers and the destruction thereby of organic chemical poison, but no H_2SO_4 driers were used in the experiments of Haldane and Lorrain Smith, Paul, Ercklentz and in our own experiments, in which all discomfort was prevented by cooling the air.

Our experimental chamber was constructed of wood, with large glass observation windows. It was rendered air-tight by filling all cracks with putty and by pasting layers of brown paper over the wood. The chamber was entered through a man-hole which was closed by a shutter.

On one side of the chamber were fixed two small electric heaters, and a tin containing water was placed on these in order to saturate the air with water vapor. On another side of the chamber was placed a large radiator through which cold water could be circulated when required, so as to cool the chamber. In the roof were fixed three electric fans, one big and two small, by means of which the air of the chamber could be effectually stirred. A wet- and a dry-bulb thermometer were placed within, and readings were taken periodically after whirling these round in the air of the chamber.

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[1] Bull. 175, U. S. Dept. Agric., p. 235.

[2] Report Brit. Asso. Adv. Sci., 1911, p. 543.

The readings were taken at about chest height. The chamber held approximately 3 cubic meters of air. In one class of experiments we shut within the chamber seven or eight students for about half an hour and observed the effect of the confined atmosphere upon them. We kept them therein until the CO_2 reached 3 to 4 per cent, and the oxygen had fallen to from 17 to 16 per cent. The wet-bulb temperature rose meanwhile to about 80° to 85° F. and the dry-bulb a degree or two higher. The students went in chatting and laughing, but by and by as the temperature rose they ceased to talk and their faces became flushed and moist. We have watched them trying to light a cigarette (to relieve the monotony of the experiment) and puzzled by their matches going out, borrowing others, only in vain. They had not sensed the percentage of the diminution of oxygen, which fell below 17. Their breathing was slightly deepened by the high percentage of CO_2, but no headache occurred in any of them from the short exposure to from 3 to 4 per cent CO_2. Their discomfort was relieved to an astonishing extent by putting on the electric fans placed in the roof. Whilst the air was kept stirred the students were not affected by the oppressive atmosphere. They begged for the fans to be put on when they were cut off. The same old stale air containing 3 to 4 per cent CO_2 and 16 to 17 per cent O_2 was whirled, but the movement of the air gave complete relief, because the air was 80° to 85° F. (wet bulb) while the air enmeshed in their clothes in contact with their skin was 98° to 99° F. (wet bulb). The whirling away of this stationary air cooled the body effectually, for air at 80° to 85° F. holds considerably more water vapor when heated up to from 98 to 99° F.

January 29, 1912. Seven students and M. F. shut in chamber.

Time	Fans	Temperature of chamber		
		Dry bulb	Wet bulb	
P. M.		*Degrees F.*	*Degrees F.*	
2.47	Off	74	63	
2.49	Off	76	67	
3.6	Off	83	77	
3.10	Off	83	77	M. F.'s pulse 108.
3.12	Off	83	78	M. F.'s pulse 96.

Analysis of air taken at 3.10 p. m.: CO_2 3.87 per cent; O_2 16.37 per cent. Matches would not burn in the air. The students acknowledged the great benefit derived from the fans, particularly those placed beneath the big fan. One student breathed the air from outside the chamber through a tube and felt little relief.

L. H., standing outside, breathed the air in the chamber through a tube, and felt no discomfort; the only result therefrom was a deepening of the respiration. After the students had left the chamber, L. H. entered it; the air was warm and moist but there was no offensive smell, or any sense of closeness when the fans were put on. The air then felt like a pleasant summer breeze.

June 3, 1910. Seven students and R. A. R. entered the chamber.

Time	Fans	Temperature of chamber		Time	Fans	Temperature of chamber	
		Dry bulb	Wet bulb			Dry bulb	Wet bulb
A. M.		*Degrees F.*	*Degrees F.*	*A. M.*		*Degrees F.*	*Degrees F.*
11.20	Off	65	62	11.50	Off	81	77
11.32	Off	74.8	73	11.55	On	83	79
11.42	Off	79.5	76	11.57	Off	84	80
11.47	On	80	76				

The surface skin temperature of a student standing close under the biggest fan rose from 31.6° at 11.29 a. m. to 34° C. at 11.42 a. m. and fell to 31.5° C. on putting on the fans. A sample of air taken at 11.40 a. m. gave CO_2 2.2 per cent, O_2 17.54 per cent; and another taken at 11.55 a. m. gave CO_2 3.61 per cent, O_2 16.4 per cent.

June 10, 1910. Eight students and R. A. R. in chamber.

Time	Fans	Temperature of chamber		Time	Fans	Temperature of chamber	
		Dry bulb	Wet bulb			Dry bulb	Wet bulb
A. M.		*Degrees F.*	*Degrees F.*	*A. M.*		*Degrees F.*	*Degrees F.*
11.10	Off	77	75	11.23	On	84	80
11.15	Off	79	78	11.25	Off	85	81
11.20	On	82	75	11.30	On	85	81

The surface temperature of two of the students was slightly lowered, 0.5° to 1.0° C., when the fans were on; they were not standing directly under the big fan.

The air contained 2.58 per cent CO_2 at the end of the experiment. All testified to great benefit derived from the fans.

June 17, 1910. Seven students and R. A. R. in chamber.

Time	Fans	Temperature of chamber		Time	Fans	Temperature of chamber	
		Dry bulb	Wet bulb			Dry bulb	Wet bulb
A. M.		*Degrees F.*	*Degrees F.*	*A. M.*		*Degrees F.*	*Degrees F.*
11.5	Off	69	65	11.45	Off	86	81
11.20	Off	81	74	11.49	Off	87	83
11.35	Off	87	82				

The air taken at 11.34 a. m. gave CO_2 4 per cent, O_2 15.63 per cent; and that taken at 11.49 a. m. gave CO_2 5.26 per cent, O_2 15.1 per cent. The surface temperature of a student standing under the big fan was raised from 32° C. at 11.7 a. m. to 33° C. at 11.34 a. m. and was lowered by the fans to 32.5° C. at 11.38 a. m., finally reaching 34° C. at 11.49 a. m., when the fans were off. The surface temperature of another student rose from 32.7° C. at 11.7 a. m. to 34.5° C. at 11.49 a. m. He was not standing directly under the fans.

Great relief was given by the fans, and the students were quite unaware of any chemical alteration in the atmosphere. The air of the chamber at the end of the experiment did not smell, but felt warm and moist.

June 20, 1910. Seven students and R. A. R. in the chamber.

Time	Fans	Temperature of chamber		Time	Fans	Temperature of chamber	
		Dry bulb	Wet bulb			Dry bulb	Wet bulb
P. M.		*Degrees F.*	*Degrees F.*	*P. M.*		*Degrees F.*	*Degrees F.*
2.30	Off	77	72	3.0	On	86	81
2.45	Off	82	77	3.3	On	85	80

The air contained 5.05 per cent CO_2 at 2.50 p. m. and 5.24 per cent at 3.5 p. m. The figures show how the pulse was accelerated. Readings were taken at 2.30 p. m. and again when the fans were off, at 2.50 p.m.

Subject	Pulse frequency	Respiration frequency
C	72	24
	92	24
A	86	20
	96	20
E	84	20
	128	24
W	74	16
	94	20
A. B	100	30
	106	30
H	57	18
	72	22
R. A. R	86	20
	92	22

The pulse frequency was diminished in each case by putting on the fans and the discomfort relieved. No headache followed the experiment.

After making these preliminary experiments two of us (R. A. Rowlands and H. B. Walker) carried out a series of observations, each acting as subject in turn.

The subject breathed through a Zuntz meter fitted with a mouthpiece, an inlet and an outlet valve. A soda-lime tin, to absorb CO_2, was at times interposed between the inlet and the mouth. The effect on the respiratory ventilation and on the pulse rate was recorded both when resting and when working. The work consisted in pulling up a 20-kilogram weight about 1 meter high by means of a pulley and rope.

In many of the experiments CO_2 was put into the chamber from a bag full of the gas. The subjects inside could not tell when the gas was introduced, not even if the percentage was suddenly raised to 2.

The introduction of this amount of the gas made no sensible difference to them. The subjects wore only a vest, pants and shoes in most of these experiments. When they wore their ordinary clothing the effect on the frequency of the pulse was more marked and the discomfort from heat and moisture much greater.

In every one of the experiments the putting on of the fans gave great relief. The refreshing effect of the moving air acting on the skin is very great, but this cannot be measured and recorded in figures.

October 4, 1910. H. B. W. and R. A. R. in chamber. Subject, H. B. W. Fans off and CO_2 absorbed.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*
2.30	23	6	250.9	82	78	78
2.31	19	6	316			
2.32	19	7	368		79	79
2.33	20	7.5	375	(Accel. 4)		
2.34	16	7.5	469		80	80
2.35	23	7.5	326			
2.36	22	8	363			
2.37	20	10	500	86	83	83
2.38	22	8.5	386			

Average volume breathed, 6.5 liters per minute.

3.50	23	9	391			
3.51	27	10	370		84	79
3.52	26	10.5	404			
3.53	24	7	292			
3.54	23	8.5	369	(Accel. 14)		
3.55	24	7.5	312			
3.56	23	9	371		86	79
3.57	23	9.5	413			
3.58	24	7	291			
3.59	25	9.5	380	100	86	79
4.00	24	9.5	396			

Average volume breathed, 9.6 liters per minute.

At 4.25, fans put on.

4.30	22	9	409	(Ret. 22) 78	86	83
4.31	24	11.5	479			
4.32	23	11.5	500			
4.33	24	11	460			
4.34	22	8	364			
4.35	23	8.5	370			
4.36	20	11	550		86	83
4.37	24	11.5	479			
4.38	21	10	476			
4.39	23	13	565	76	86	83

Average volume breathed, 10.5 liters per minute.

At 4.42, CO_2 let out of bag and fans put on to thoroughly mix the atmosphere in chamber. At 4.48, sample taken. Analysis: CO_2 4.75 per cent; O_2 17.4 per cent.

Fans off and CO_2 on.

Time	Body temperature	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.	*Degrees F.*		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*
4.50	98	24	28	1166	(Accel. 13) 89	87	84
4.51		24	27	1125			
4.52		27	28	1039			
4.53		24	26	1083			
4.54		25	27	1080		87	86
4.55		25	30	1200			
4.56		27	31	1146			
4.57		26	31	1192			
4.58		26	32	1230			
4.59		27	31	1148	86	89	87

Average volume breathed, 29 liters per minute.

Fans and CO_2 on.

Time	Body temperature	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Dry bulb	Wet bulb
5.10	98.5	25	26	1040	(Ret. 5)		
5.11		26	33	1269		89	85
5.12		30	37	1233	84		
5.13		27	35	1222			
5.14		26	32	1230			
5.15		27	30	1111			
5.16		27	35	1296			
5.17		27	32	1181			
5.18		26	37	1423	82	89	86
5.19		28	35	1250			

Average volume breathed 32.2 liters per minute.

At 5.20, sample taken. Analysis: CO_2 5.29 per cent; O_2 16.43 per cent.

October 12, 1910. Series I. R. A. R. and H. B. W. in chamber. Subject, R. A. R. Fans off and CO_2 absorbed.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*
3.00	17	12	705.7	76	91	90
3.01	19	13	684.2			
3.02	18	12	666.6			
3.03	18	16	888.8			
3.04	20	19	950	(Accel. 4)		
3.05	18	15	833.3			
3.06	20	15	759			
3.07	19	11	578.9			
3.08	19	12	631.5			
3.09	20	15	750	80	89	87

Average volume breathed, 14 liters per minute.

Series II. CO_2 absorbed and fans on.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Temperature of chamber	
					Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*
3.23	16	8	500	74	90	85
3.24	15	6	400			
3.25	17	8	470.5			
3.26	17	7	411.8			
3.27	15	7	366.6	(Retard. 4)		
3.28	17	7	411.8			
3.29	17	7	411.8			
3.30	17	8	470.6			
3.31	14	7	500			
3.32	15	8	533.3	70	90	87

Average volume breathed, 7.3 liters per minute.

Series III. Breathing air of chamber. CO_2 equals 1.70 per cent. Fans off.

3.47	17	17	1,000	76	92	89
3.48	18	18	1,000			
3.49	17	15	883.5			
3.50	17	28	1,705.9			
3.51	17	8	470.5	(Accel. 4)		
3.52	17	15	882.3			
3.53	17	19	1,117.6			
3.54	18	22	1,222.2			
3.56	17	17	1,000			
3.57	18	23	1,277.7	80	92	90

Average volume breathed, 18.2 liters per minute.

Series IV. Breathing air of chamber. Fans on.

4.3	18	15	833.3	78	93	89
4.4	17	11	647			
4.5	17	12	705.9			
4.6	13	17	764.7			
4.7	16	18	888.8	(Accel. 2)		
4.8	11	18	611.1			
4.9	18	10	555.5			
4.10	17	11	647			
4.11	15	10	666.6			
4.12	15	12	800	80	96	92

Average volume breathed, 13.8 liters per minute.

Series V. CO_2 was passed into chamber from outside. Fans on.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Temperature of chamber	
					Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*
4.23	25	22	880	74	90	87
4.24	25	20	800			
4.25	23	23	1,000			
4.26	23	22	956	(Accel. 4)		
4.27	22	19	863.8			
4.28	21	17	809.5			
4.29	21	17	809.5			
4.30	20	22	1,100			
4.31	21	21	1,000			
4.32	22	19	863.6	78	95	92

Average volume breathed, 20 liters per minute.

Series VI. Fans off and same atmosphere breathed.

4.38	24	37	1,541.7	76	95	92
4.39	24	50	2,083.3			
4.40	24	40	1,666.6			
4.41	25	45	1,800			
4.42	24	44	1,833.3	(Accel. 20)		
4.43	26	40	1,538.4			
4.44	24	36	1,500			
4.45	21	36	1,719			
4.46	21	41	1,952.4			
4.47	21	38	1,809.5	96	95	93

Average volume breathed, 40.8 liters per minute. Increase, 91 per cent.

Sample taken. Analysis: CO_2 4.54 per cent; O_2 16.33 per cent.

The temperature was high and the cooling effect of fans lowered the pulmonary ventilation greatly, as well as the pulse rate.

October 19, 1910. Series I. Subject, H. B. W. Fans off and CO_2 absorbed.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
						Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
3.50	24	12	500	84	94.4	81	78
3.51	27	10	370.37				
3.52	26	7	269.23				
3.53	24	8.5	354.16				
3.54	23	9	391.3	(Accel. 6)			
3.55	27	10.5	388.8				
3.56	25	9	360				
3.57	23	9.5	413.04				
3.58	21	9	428.57				
3.59	22	9	409.09	90	99.5	88	86

Average volume breathed, 9.3 liters per minute.

Series II. CO_2 absorbed by soda lime and fans on.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Liters*	*c. c*		*Degrees F.*	*Degrees F.*	*Degrees F.*
4.10	25	10	400	82	99	90	85
4.11	24	10	416				
4.12	24	9	375				
4.13	23	8	347.82				
4.14	23	8.5	369.56	(Accel. 6)			
4.15	20	8	400				
4.16	21	8.6	409.52				
4.17	21	7.9	376.2				
4.18	21	8.6	409.52				
4.19	23	9.4	409.6	88	99.1	93	88

Average volume breathed, 8.8 liters per minute.

Great relief by fans, with much less perspiration.

At 4.35, CO_2 was let into the chamber and fans were put on for a time to thoroughly mix the atmosphere of the chamber. Soda lime tin was removed and fans put off.

Series III. CO_2 on and fans off.

4.49	21	14	666.6	100	99.5	95	92
4.50	26	16	615.3				
4.51	24	12.5	520.83				
4.52	25	15.5	620				
4.53	23	14	608.7	(Accel. 8)			
4.54	24	13	541.7				
4.55	24	11.5	479.7				
4.56	25	11.5	460				
4.57	24	13	541.6				
4.58	26	17	653.8	108	99.8	97	95

Average volume breathed, 14.8 liters per minute. Bladder emptied.

Sample of air taken at 5 o'clock. Analysis: CO_2 3.935 per cent; O_2 17.91 per cent.

Series IV. Fans put on and same atmosphere as in last series breathed.

5.15	24	29	1,208.3	92	99.5	97	93
5.16	24	20	833.3				
5.17	25	23	920				
5.18	27	20	740.7				
5.19	27	18	666.6	(Retard. 8)			
5.20	27	17	629.6				
5.21	24	17	708.3				
5.22	25	18	720				
5.23	25	17	680				
5.24	26	15	576.9	84	99.5	99	95

Average volume breathed, 19.4 liters per minute. Increase 108 per cent.

At 5.25 sample taken. Analysis: CO_2 4.56 per cent; O_2 16.27 per cent.

Specimen of urine: No glucose found, or not sufficient to reduce Fehling's solution.

October 26, 1910. Series I. I. F. and R. A. R. in chamber. Subject, I. F. Fans off and CO_2 absorbed.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
						Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
4.15	22	10	454.5	76	98.5	85	80
4.16	24	8	333.3				
4.17	23	8	347.8				
4.18	20	8	400				
4.19	24	9	375	(Accel. 11)			
4.20	24	8	333.3				
4.21	22	8	363.6				
4.22	21	8	381				
4.23	21	8	381				
4.24	20	7	350	87	99	89	85

Average volume breathed, 8.2 liters per minute.

Series II. CO_2 absorbed and fans on.

4.35	21	12	571.4	88	99	89	85
4.36	24	10	416.6				
4.37	19	9	473.7				
4.38	20	9	450				
4.39	19	8	421	(Accel. 0)			
4.40	22	10	454.5				
4.41	21	11	523.8				
4.42	21	9	428.6				
4.43	22	8	363.6				
4.44	22	10	454.5	88	99.4	95	89

Average volume breathed, 9.6 liters per minute.

At 4.55 CO_2 let in from bag. Fans put on to thoroughly mix atmosphere with CO_2. Sample taken. Analysis: CO_2 1.7 per cent; O_2 19.21 per cent. Fans put off.

Series III. Fans off and CO_2 on.

5.10	21	11	523.8	100	99.6	97	93
5.11	17	12	705.9				
5.12	19	15	789.5				
5.13	19	14	736.8				
5.14	21	15	714.3	(Accel. 24)			
5.15	22	15	681.7				
5.16	19	14	736.8				
5.17	20	14	700				
5.18	23	17	739.1				
5.19	22	16	727.2	124	99.8	100	96

Average volume breathed, 14.3 liters per minute.

Series IV. CO_2 and fans on.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
						Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
5.30	19	13.5	710.5	116	100	100	99
5.31	22	20	919.1				
5.32	21	16.5	785.7	(Accel. 4)			
5.33	21	17.5	833.3				
5.34	22	18	818.1				
5.35	22	16	727.2				
5.36	23	15	652.1				
5.37	22	20	909.1				
5.38	23	19	826.1				
5.39	24	18	750	120	100.1	100	95

Average volume breathed, 17.3 liters per minute. Increase, 111 per cent.

Sample taken. Analysis: CO_2 3.56 per cent; O_2 17.02 per cent.

November 2, 1910. Series I. Subject, H. B. W. Work done by lifting a weight of 20 kilograms 1 meter from the ground by means of a rope attached to it over a pulley. The weight was lifted up 6 times (once every 10 seconds) per minute, for 10 minutes. Fans off and CO_2 absorbed by tin containing soda lime attached to inspiratory valve.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
15	4	266.6	84	99.2	75	72
19	5	263.15				
21	5	238.1	(Accel. 30)			
26	5	192.3				
21	6	285.6				
19	6	315.7				
22	7	318.1				
20	6	300				
16	6	374.9				
24	10	416.6	114	99.2	81	79

Average volume breathed, 6 liters per minute.

Series II. CO_2 absorbed and fans on.

15	3	200	92	99.2	81	79
20	3.5	175				
18	6	333.3	(Accel. 10)			
21	6	285.6				
20	6	300				
20	7	350				
17	5	294				
19	8	421				
19	7	368.4				
22	9	409	102	99	81	77

Average volume breathed, 6 liters per minute.

CO_2 was let into chamber from the bag outside. Fans put on to thoroughly mix atmosphere. Sample (No. 2) taken. Analysis: CO_2 2.76 per cent; O_2 18.13 per cent.

Series III. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
21	11	476.2	92	99	80	77
19	11	579				
21	14	666.6				
19	15	789.4				
19	15	789.4	(Accel. 18)			
20	16	800				
20	12	600				
19	14	736.8				
21	12	571.3				
19	13	684.2	110	98.8	80	77

Average volume breathed, 13.3 liters per minute.

Series IV. CO_2 on and fans on.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
19	5	263.15	96	98.8	81	77
18	7	388.88				
19	10	526.2				
22	10	454.5				
22	11	500	(Accel. 8)			
21	12	571.4				
20	12	600				
25	16	640				
21	14	666.6				
22	14	636.3	104	99	84	80

Average volume breathed, 11.1 liters per minute.

November 9, 1910. Series I. R. A. R. and I. F. in chamber. Subject, R. A. R. Work done by lifting weight 12 times per minute. CO_2 absorbed and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
20	11.7	585	80	99.2	80	77.5
20	7.3	365				
22	11	500				
24	12	500				
26	9	346.1	(Accel. 20)			
28	22	785.7				
30	24	800				
30	26	866.7				
30	26	866.7				
31	28	903.3	100	99.6	83	81

Average volume breathed, 17.7 liters per minute.

Series II. CO_2 absorbed and fans on.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
22	13	509.9	80	99.6	88	83
32	18	562.5				
25	11	440				
24	11	458.3				
31	21	677.4	(Accel. 20*)			
30	21	700				
30	21	700				
28	23	821.4				
29	23	793.1				
29	21	724.1	100	100	86	85

* No more acceleration of pulse in spite of higher temperature.

Average volume breathed, 17.3 liters per minute.

CO_2 let into chamber from bag. Analysis: CO_2 3.76 per cent; O_2 17.3 per cent.

Series III. CO_2 on and fans off.

26	18	692.3	90	100.4	90	87
23	20	869.5				
28	23	821.4				
27	25	925.92				
28	25	892.8	(Accel. 42)			
28	28	1,000				
28	26	928.5				
29	27	931				
29	32	1,103.4				
30	32	1,066.6	132	100.6	93.5	92

Average volume breathed, 26.5 liters per minute.

Series IV. CO_2 on and fans on.

30	21	700	118	100.6	94	90
30	24	800				
30	28	933.3				
33	25	757.5				
34	28	823.5	(Accel. 28)			
34	28	823.5				
34	30	882.3				
34	29	852.9				
34	27	791.2				
34	27	791.2	146	101	96	91

Average volume breathed, 27.7 liters per minute. Increase, about 60 per cent.

Sample taken. Analysis: CO_2 5.3 per cent; O_2 15.44 per cent.

November 16, 1910. Series I. R. A. R. performed work by pulling on 20-kilogram weight over a pulley, for series of 10 minutes. CO_2 absorbed by soda lime and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
20	6	300	94	100	80	78
18	11	601.11				
21	14	666.6				
21	16	761.8				
24	21	875				
24	16	666.6	(Accel. 16)			
23	3	130.4				
21	18	857.1				
21	16	761.9				
20	16	800				
24	20	833.3	110	100.2	86	84

Average volume breathed, 15.7 liters per minute.

Series II. CO_2 absorbed and fans on.

22	12	545.4	98	100.2	89	85
22	10	454.5				
21	14	666.6				
22	16	727.2				
22	16	727.2	(Accel. 16)			
25	17	680				
25	18	720				
27	21	777.7				
23	22	956.5				
21	30	1,428.5	114	100.4	90	85

Average volume breathed, 17.6 liters per minute.
Pulse little more accelerated in spite of higher temperature.

November 23, 1910. Series I. H. B. W. performed work by pulling on a weight of 20 kilograms over a pulley. This was lifted 12 times per minute for 5 minutes. CO_2 absorbed and fans off.

20	24	1,200	96	98.8	87	83
21	37	1,761.9				
22	42	1,909	(Accel. 32)			
22	41	1,863.6				
24	42	1,750	128	99	90	85

Average volume breathed, 37 liters per minute. Average tidal air, 1,697 cc.

Series II. CO_2 absorbed and fans on.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
18	16	888.8	112	99.2	90	85
20	43	2,150				
19	52	2,736.8	(Accel. 14)			
21	21	1,000				
22	39	1,772.7	126	99.4	88	84

Average volume breathed, 34 liters per minute. Average tidal air, 1,709 cc.

H. B. W. said he found the work much more easily performed when the fans were on.

CO_2 let into chamber from the bag outside. Fans were put on to thoroughly mix the atmosphere and were then stopped and records taken. Sample taken. Analysis: CO_2 3.75 per cent; O_2 16.31 per cent.

Series III. CO_2 and fans off.

22	45	2,045.4	110	99.4	91	87
21	40	1,904.8				
25	52	2,080	(Accel. 70)			
24	52	2,166.6				
25	53	2,120	180	99.6	90	87

Average volume breathed, 48 liters per minute. Average tidal air, 2,063 cc.

Series IV. CO_2 and fans on.

22	46	2,090.9	118	99.4	89	85
22	51	2,318.2				
21	51	2,428.5	(Accel. 20)			
23	51	2,217.4				
24	54	2,250	138	99.6	90	87

Average volume breathed, 51 liters per minute. Average tidal air, 2,261 cc.

Sample taken. Analysis: CO_2 5.07 per cent; O_2 14.8 per cent.

December 3, 1910. Series I. R. A. R. performed work by lifting a 20-kilogram weight over a pulley, 12 times per minute for series of 5 minutes. CO_2 absorbed and fans off.

15	16	1,066.6	88	100	80	80
16	24	1,500				
17	32	1,882.3	(Accel. 26)			
19	29	1,526.3				
18	33	1,833.3	114	100.3	85	84

Average volume breathed, 27 liters per minute.

Pulse records for a few minutes afterwards: At the end of 1st minute, 104 per minute; 2d minute, 102; 4th minute, 102; 6th minute, 94. After 3 minutes of fans on: Pulse 88.

Series II. CO_2 absorbed by soda lime and fans on.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	c. c.		Degrees F.	Degrees F.	Degrees F.
17	9	529.4	96	99.6	87	85
18	23	1,277.7				
19	32	1,684.3	(Accel. 20)			
17	34	2,000				
18	34	1,888.8	116	100	88	85

Average volume breathed, 26 liters per minute. Average tidal air, 1,676.04 cc.

Pulse records: At the end of 1st minute, 110 per minute; 4th minute, 106; 6th minute, 100.

CO_2 let into chamber from bag. Fans put on to thoroughly mix the atmosphere. Sample taken. Analysis: CO_2 3.45 per cent; O_2 17.64 per cent.

Series III. CO_2 and fans off.

17	30	1,764.7	92	100	87	83
20	60	3,000				
19	32	1,684.3	(Accel. 42)			
21	46	2,190.4				
25	60	2,400	134	100.5	87	85.5

Average volume breathed, 46 liters per minute.

Pulse records: At end of 1st minute, 130 per minute; 2d minute, 114; 4th minute, 98; 6th minute, 94.

Series IV. CO_2 and fans on.

28	50	1,785.7	99	100	87	85
27	58	2,148.1				
31	58	1,871	(Accel. 21)			
31	66	2,129				
30	63	2,100	120	100	87	85

Average volume breathed, 57 liters per minute. Increased, 118 per cent.

Pulse records: At the end of 1st minute, 120 per minute; 2d minute, 110; 4th minute, 100; 6th minute, 100.

Sample taken. Analysis: CO_2 4.25 per cent; O_2 16.55 per cent.

December 14, 1910. Series I. H. B. W. lifted weight 12 times per minute for series of 5 minutes. CO_2 absorbed and fans off.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
2.33	13	12	923.1	86	99.2	87	82
2.34	13	18	1,384.6				
2.35	13	22	1,692.3	(Accel 32.)			
2.36	17	28	1,647.1				
2.37	20	28	1,400.	118	99.2	89	85

Average volume breathed, 22 liters per minute. Average tidal air, 1,407.4 cc.

Pulse records: During 3d minute, 112 per minute; 5th minute, 108; 7th minute, 89.

Series II. CO_2 absorbed and fans on.

3.15	14	16	1,142.8	108	99.2	91	85
3.16	15	18	1,200				
3.17	14	25	1,785.7	(Accel. 7)			
3.18	15	33	2,200				
3.19	16	27	1,687.5	115	99.2	90	85

Average volume breathed, 24 liters per minute. Average tidal air, 1,603.2 cc.

Pulse records: During 3d minute, 97 per minute; 5th minute, 90; 7th minute, 91.

CO_2 let into chamber and fans put on to thoroughly mix atmosphere. Sample taken and fans put off. Analysis: CO_2 3.34 per cent; O_2 17.89 per cent.

Series III. CO_2 on and fans off.

3.45	14	25	1,785.7	108	99.2	90	87
3.46	14	31	2,214.3				
3.47	16	37	2,312.5	(Accel. 32)			
3.48	13	48	3,692.3				
3.49	21	47	2,238.1	140	99.4	89	86

Average volume breathed, 36 liters per minute. Average tidal air, 2,448.6 cc.

Pulse records: During 3d minute, 120 per minute; 5th minute, 118; 7th minute, 106.

Series IV. CO_2 and fans on.

Time	Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
						Dry bulb	Wet bulb
P. M.		*Liters*	*c. c.*		*Degrees F.*	*Degrees F*	*Degrees F.*
4.5	16	31	1,937.5	110	99.2	91	87
4.6	20	39	1,950				
4.7	20	45	2,250	(Accel 20)			
4.8	22	52	2,363.6				
4.9	22	52	2,363.6	130	99.2	90	86

Average volume breathed, 44 liters per minute. Average tidal air, 2,172.9 cc.

Pulse records: During 3d minute, 115 per minute; 5th minute, 110; 7th minute, 107.

Sample taken. Analysis: CO_2 3.97 per cent; O_2 17.4 per cent.

December 21, 1910. Series I. R. A. R. lifted weight 12 times per minute for series of 5 minutes. CO_2 absorbed and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
16	13	1,125	78	99.8	87	82
18	18	1,000				
22	22	1,000	(Accel. 18)			
23	23	1,000				
25	25	1,000	96	100	88	85

Average volume breathed, 20 liters per minute. Average tidal air, 982.5 cc.

Pulse rate during 3d minute, 97 per minute; 5th minute, 82; 7th minute, 78.

Series II. CO_2 absorbed and fans on.

13	18	1,384.6	90	99.8	90	83
13	19	1,461.5				
18	21	1,166.6	(Accel. 6)			
19	4	1,263.2				
19	26	1,368.4	96	100	90	85

Average volume breathed, 22 liters per minute. Average tidal air, 1,328.86 cc.

Pulse rate during 3d minute, 96 per minute; 5th minute, 92; 7th minute, 90.

CO_2 let into chamber and fans put on to thoroughly mix the atmosphere of chamber. Sample taken. Analysis: CO_2 2.62 per cent; O_2 19.8 per cent.

Series III. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
17	28	1,647	86	99.8	89	86
19	29	1,526.3				
18	36	2,000	(Accel. 22)			
20	44	2,200				
22	47	2,136.2	108	100	89	86

Average volume breathed, 35 liters per minute. Average tidal air, 1,901.9 cc.

Pulse rate during 3d minute, 100 per minute; 5th minute, 92; 7th minute, 92.

Series IV. CO_2 and fans on.

25	41	1,640	90	99.8	90	87
27	46	1,703.7				
30	56	1,866.6	(Accel. 16)			
28	55	1,964.2				
29	57	1,965.5	106	100	90	87

Average volume breathed, 51 liters per minute. Average tidal air, 1,828 cc.

Pulse rate during 3d minute, 96 per minute; 5th minute, 94; 7th minute, 92. Sample (No. 2) taken. Analysis: CO_2 4.37 per cent; O_2 18.07 per cent.

January 9, 1911. Series I. H. B. W. lifted weight 12 times per minute for series of 5 minutes. CO_2 absorbed and fans on.

12	11	916.6	90	99.4	81	75
14	17	1,214.2				
13	20	1,538.4	(Accel. 30)			
14	23	1,642.8				
18	24	1,333.3	120	99.4	83	77

Average volume breathed, 19 liters per minute. Average tidal air, 1,329.06 cc.

Pulse rate during 3d minute, 114 per minute; 5th minute, 100; 7th minute, 80.

Series II. CO_2 absorbed and fans off.

13	15	1,153.8	92	99.4	84	80
12	16	1,333				
13	20	1,538.4	(Accel. 40)			
18	22	1,222.2				
15	25	1,666.6	132	99.4	85	82

Average volume breathed, 19.6 liters per minute. Average tidal air, 1,382.8 cc.

Pulse rate during 3d minute, 118 per minute; 5th minute, 106; 7th minute, 90.

CO_2 let into chamber. Fans put on to thoroughly mix atmosphere. Sample taken. Analysis: CO_2 2.36 per cent; O_2 17.42 per cent.

Series III. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
17	28	1,647	118	99	90	86
22	38	1,727.2				
21	40	1,904.76	(Accel. 46)			
23	44	1,913				
25	53	2,120	164	99.4	91	88

Average volume breathed, 40.6 liters per minute. Average tidal air, 1,862.39 cc.

Pulse rate during 3d minute, 138 per minute; 5th minute, 120; 7th minute, 120.

Series IV. CO_2 and fans on.

15	32	2,133.3	100	99	88	82
16	24	1,500				
17	34	2,000	(Accel. 30)			
21	35	1,666.6				
20	45	2,250	130	99	90	85

Average volume breathed, 34 liters per minute. Average tidal air, 1,909.9 cc.

Pulse rate during 3d minute, 118 per minute; 5th minute, 108; 7th minute, 100.

Sample taken. Analysis: CO_2 4.13 per cent; O_2 15.3 per cent.

August 2, 1911. Series I. R. A. R. lifted weight 12 times per minute for series of 5 minutes. CO_2 absorbed and fans off.

13	19	1,461.5	80	99.6	94	90
14	23	1,642.8				
13	26	2,000	(Accel. 32)			
15	35	2,333.3				
16	37	2,312.5	112	100	100	96

Average volume breathed, 28 liters per minute. Average tidal air, 1,950.02 cc.

Pulse rate during 3d minute, 100; 5th minute, 100.

CO_2 let into chamber from bag outside. Fans put on to thoroughly mix the CO_2 with atmosphere of chamber. Sample taken. Analysis: CO_2 2.24 per cent; O_2 18.57 per cent.

Series II. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
14	33	2,357.1	92	100	97	95
16	40	2,500				
16	51	3,187.5	(Accel. 48)			
18	39	2,166.1				
18	45	2,500	140	100.5	100	97

Average volume breathed, 41.6 liters per minute. Average tidal air, 2,542.14 cc.

Pulse rate during 1st minute, 140; 3d minute, 120; 5th minute, 110.

Air chamber cooled 14° F. (wet bulb) by means of water cooler.

Series III. CO_2 on and fans off.

17	38	2,235.3	84*	100.4	85	83
18	42	2,333.3				
19	55	2,894.7	(Accel. 26)			
20	50	2,500				
20	50	2,750	110	100.8	87	85

* Note retardation.

Average volume breathed, 48 liters per minute. Average tidal air, 2,542.66 cc.

Pulse rate during 2d minute, 100; 3d minute, 94.

Sample taken. Analysis: CO_2 5.31 per cent; O_2 16.54 per cent.

July 28, 1911. Series I. H. B. W. lifted weight 12 times per minute for series of 5 minutes. Fans off. Ordinary air in chamber breathed.

15	15	937.5	114	99.4	87	86
15	21	1,400				
20	28	1,400	(Accel. 28)			
18	23	1,277.7				
15	33	2,200	142	100	103	97

Average volume breathed, 25 liters per minute. Average tidal air, 1,443.04 cc.

Pulse rate during 1st minute, 142; 2d minute, 118.

CO_2 let into chamber from bag outside. Fans put on to thoroughly mix the atmosphere of chamber with CO_2. Analysis CO_2 5.09 per cent; O_2 16.71 per cent.

Series II. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
19	39	2,052.6	120	99.6	95	87
20	43	2,150				
22	48	2,181.8	(Accel. 28)			
24	57	3.375				
23	52	2,260.9	148	99.6	104	101

Average volume breathed, 47.8 liters per minute. Average tidal air, 2,204.06 cc.

Pulse rate during 1st minute 148; 2d minute, 144; 3d minute, 136.

Air inside the chamber cooled 22° F. by water cooler with fans on.

Series III. CO_2 on and fans off.

20	40	2,000	100*	99.6	82	79
26	50	1,923				
27	53	1,963	(Accel. 34)			
25	55	2,200				
25	54	2,160	134	99.6	81.5	79

* Note retardation.

Average volume breathed, 50.4 liters per minute. Average tidal air, 2,049.2 cc.

Pulse rate during 1st minute, 134; 2d minute, 110; 3d minute, 104.

Sample taken. Analysis: CO_2 5.5 per cent; O_2 15.57 per cent.

August 9, 1911. Series I. H. B. W. lifted weight 12 times per minute for series of 5 minutes. Fans off. Ordinary air of chamber breathed.

12	25	2,083.3	90	99.6	94	85
13	19	1,461.5				
15	24	1,600	(Accel. 26)			
14	36	1,571.4				
15	25.5	1,700	116	99.6	100	95

Average volume breathed, 26 liters per minute. Average tidal air, 1,683.24 cc.

Pulse rate during 1st minute, 116; 2d minute, 112; 3d minute, 106; 4th minute, 95; 5th minute, 100.

CO_2 let into chamber from bag outside. Fans put on to thoroughly mix the atmosphere of chamber with CO_2. Sample taken. Analysis: CO_2 3.00 per cent; O_2 18.51 per cent.

Series II. CO_2 and fans on.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
15	26	1,733.3	94	99.2	95	91
18	29	1,811.1				
20	39	1,950	(Accel. 26)			
21	41	1,952.4				
22	47	2,136.3	120	99.2	95	93

Average volume breathed, 36.4 liters per minute. Average tidal air, 1,916.62 cc.

Pulse rate during 1st minute, 120; 2d minute, 106; 3d minute, 108; 4th minute, 108; 5th minute, 106.

Sample taken: Analysis: CO_2 3.86 per cent; O_2 17.19 per cent.

Air in chamber cooled (10° F. wet bulb) by means of water cooler and fans put on.

Series III. CO_2 on and fans off.

18	29	1,611.1	92	99.2	88	85
15	42	1,800				
16	43	2,750	(Accel. 18)			
17	41	2,176.4				
18	49	2,722.2	110	99.6	88	85

Average volume breathed, 40.8 liters per minute. Average tidal air, 2,211.94 cc.

Pulse rate during 1st minute, 110; 2d minute, 92; 3d minute, 92; 4th minute, 90; 5th minute, 91.

Sample taken. Analysis: CO_2 4.56 per cent; O_2 15.95 per cent.

August 16, 1911. Series I. R. A. R. lifted weight 12 times a minute for series of 5 minutes. CO_2 and fans off.

10	18	1,800	76	99.8	95	87
12	32	2 666.6				
17	25	1,470.5	(Accel. 22)			
26	45	1,730.8				
19	23	1,210.5	98	99.8	99	93

Average volume breathed, 28.6 liters per minute. Average tidal air, 2,219.6 cc.

Pulse rate during 1st minute, 98; 2d minute, 90; 4th minute, 84; 5th minute, 80.

CO_2 let into chamber from bag outside. Fans put on to thoroughly mix atmosphere of chamber; then the fans were put off. Sample taken. Analysis: CO_2 3.52 per cent; O_2 18.5 per cent.

Series II. CO_2 on and fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
15	37	1,466.6	82	99.8	93	87
15	38	2,533.3				
17	40	2,352.9	(Accel. 36)			
18	45	2,500				
26	53	2,384.6	118	99.8	99	95

Average volume breathed, 42.6 liters per minute. Average tidal air, 2,247.48 cc.

Pulse rate during 1st minute, 118; 2d minute, 108; 3d minute, 104; 4th minute, 96; 6th minute, 96.

Water cooler put on for half an hour.

Series III. CO_2 on. Air of chamber cooled 11° to 13° F. (wet bulb).

20	30	1,500	86	99.8	87	84
19	45	2,368.4				
20	35	1,750	(Accel. 22)			
20	60	3,000				
23	50	2,173.9	108	99.8	85	82

Average volume breathed, 44 liters per minute. Average tidal air, 2,584.6 cc.

Pulse rate during 1st minute, 108; 2d minute, 96; 3d minute, 92; 4th minute, 92; 5th minute, 88.

Sample taken. Analysis: CO_2 4.63 per cent; O_2 17.50 per cent.

August 19, 1911. Series I. H. B. W. lifted weight 12 times per minute for series of 5 minutes. CO_2 off and fans on.

12	14	1,666.6	87	99.4	95	85
13	18	1,384.6				
15	25	1,666.6	(Accel. 15)			
17	30	1,764.7				
18	28	1,555.5	102	99.4	90	89

Average volume breathed, 23 liters per minute.

Pulse rate during 1st minute, 102; 2d minute, 104; 3d minute, 98; 4th minute, 90; 5th minute, 95.

CO_2 let into chamber from a bag outside. Sample taken. Analysis: CO_2 4.4 per cent; O_2 17.20 per cent.

Series II. Fans off.

Number of respirations per minute	Total volume breathed per minute	Tidal air	Pulse rate	Rectal temperature	Temperature of chamber	
					Dry bulb	Wet bulb
	Liters	*c. c.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
13	31	2,384.6	106	99.4	97	93
16	47	2,937.5				
16	39	2,437.5	(Accel. 26)			
25	48	1,920				
30	52	1,733.3	132	99.4	97	93

Average volume breathed, 43.4 liters per minute.

Pulse rate during 1st minute, 132; 2d minute, 122; 3d minute, 112; 4th minute, 115; 5th minute, 115.

Series III. Air in chamber cooled 10° F. by means of water cooler.

25	34	1,360	94	99.4	87	84
30	53	1,766.6				
27	49	1,814.8	(Accel. 18)			
28	54	1,928.5				
31	57	1,838.7	112	99.4	86	93

Average volume breathed, 59.4 liters per minute.

Pulse rate during 1st minute, 112; 2d minute, 106; 3d minute, 98; 4th minute, 96; 5th minute, 98.

Sample taken. Analysis: CO_2 5.66 per cent; O_2 16.61 per cent.

The following results summarize the effects of cooling the air:

CO_2 absorbed and fans off

Temperature of chamber		Pulse rate	Analysis of air
Wet bulb	Dry bulb		
Degrees F.	*Degrees F.*		
86 to 97	87 to 103	142 118 2d min. after work	
		CO_2 on and fans off	
87 to 101	95 to 104	148 144 2d min. 136 3d min.	CO_2 5.09 per cent O_2 16.71 per cent

Temperature of chamber		Pulse rate	Analysis of air
Wet bulb	Dry bulb		
Degrees F.	*Degrees F.*		
		CO_2 and water cooler on	
79 79	82 to 81.5	134 110 2d min. 104 3d min.	CO_2 5.5 per cent O_2 15.57 per cent
		CO_2 absorbed and fans off	
85 to 89	85 to 90	102 104 2d min. 98 3d min. 90 4th min. 95 5th min.	
		CO_2 on and fans off	
93	97	132 122 2d min. 112 3d min. 115 4th min. 115 5th min.	CO_2 4.4 per cent O_2 17.29 per cent
		CO_2 and water cooler on	
83	86	112 106 2d min. 98 3d min. 96 4th min. 95 5th min.	CO_2 5.66 per cent O_2 16.61 per cent

In a crowded room the air confined between the bodies and clothes of the people is warmed almost up to body temperature and saturated with moisture, so that cooling of the body by radiation, convection by evaporation, becomes almost impossible. This leads to sweating, wetness and flushing of the skin, and a rise of skin temperature. The blood is sent to the skin and stagnates there instead of passing in ample volume through the brain and viscera. Hence arise the feelings of discomfort and fatigue. The fans in our chamber whirled away the blanket of stationary wet air around the bodies of the students, and brought to them the somewhat cooler and drier air in the rest of the chamber, and so relieved the heat stagnation from which they suffered. The relief became far greater when we allowed cold water to circulate through a radiator placed in the chamber, and so cooled the air of the chamber about 10° F. The discomfort of crowded rooms and overwarm places of business can be entirely removed by moving and cooling the air. When work is done without over-fatigue, the frequency of the pulse, which is accelerated by work, quickly returns to normal. Our results show that increased percentages of CO_2 and diminished oxygen percentages of 2 to 3 per cent, and even 4 to 5 per cent, have little effect in modifying the frequency of the pulse, while the temperature and humidity of the air have a profound effect. The feelings of discomfort depend on the excessive heat and humidity, and are relieved by cooling and whirling the air in the chamber. If we suddenly raised the percentage of CO_2 in the chamber up to 2 per cent, we found the subjects inside were quite unaware of this. If we sat outside and breathed the air in the chamber through a tube, we felt none of the discomfort which was being experienced by those shut up inside. Similarly, if one of those in the chamber breathed the pure air outside through a tube, he was not relieved.

The pulmonary ventilation mainly depends on the percentage of CO_2 but may also be used as part of the heat-regulating mechanism.

The observations made by Pembrey and Collis[1] on the weaving mill operatives at Darwen show that the skin of the face may be 4° to 13° F. higher in the mill when the wet bulb is 71° F. than at home when the wet-bulb temperature is about 55° F. The tendency of the warm, humid atmosphere of the mill is to establish a more uniform temperature of the body as a whole (surface and deep temperatures) and to throw a tax upon the power of accommodation, as indicated by the rapid pulse and low blood-pressure.

The mill workers are wet with the steam blown into the sheds, their clothes and bodies are moist, and the long hours of exposure to such uncomfortable conditions are most deleterious to physical vigor and happiness. The operatives asked that they might be allowed to work without steam-injectors and with diminished ventilation, so that the mill rooms became saturated with moisture evaporated from the bodies of the operatives. The old regulations, while forbidding more than 6 parts in 10,000 CO_2, put no limit to the wet-bulb temperature, and this often became excessive on hot summer days. The operatives were quite right; less ventilation and a lower wet bulb is far better than ample ventilation and a high wet bulb. The permissible limit of CO_2 has now been raised to 11 parts in 10,000 and the wet-bulb temperature has been controlled within reasonable limits. (Home Office Departmental Committee Reports on Humidity and Ventilation in Cotton Weaving Sheds, 1911.)

[1] Proc. Physiol. Soc. Oct. 21, 1911; Journ. Physiol., Vol. 43.

The efficiency of workers in mills, mines, tunnels, stoke holes, etc., is vastly increased by the provision of a sufficient draught of air, so as to prevent over-taxing of the heat-regulating mechanism. 600,000 cubic feet of outside air are pumped every minute into the engine rooms of the *Lusitania*, and the temperature thus lowered from 150° to 70° and the men feel no draught and are comfortable.

The human skin, if exposed to a tropical sun, is warmed 3° to 4° C. above the normal surface temperature; a rise of body temperature is alone prevented by movement of the air and by evaporation of sweat. If the air is still and evaporation is checked by a high wet-bulb temperature, or by deficient action of the sweat glands, the body temperature rises and danger of heat-stroke arises. Rabbits, monkeys, and dogs evaporate water from the lungs and mouth, and their capacity to stand exposure to a hot sun is limited. Monkeys exposed to sunshine in Manila died within 70 to 80 minutes, while the protection afforded by an umbrella saved them from all harm. A tracheotomized dog died when exposed to the sun, for the heat regulation was inhibited and the body temperature rose to febrile heights.[1]

The experiments of J. Haldane, and others made by us on the wearers of the Fleuss dress, show that a very rapid pulse, low blood-pressure, rapid respiration, rise of rectal temperature, faintness, vomiting, and collapse result from prolonged exposure to a wet-bulb temperature of 95° F. The same symptoms result from a few minutes exposure to a hot bath (110° F.) if all the body is immersed except the face.[2] The skin is greatly flushed and the skin temperature raised. The rectal temperature may reach 103° F., the pulse rate rise to 150, the blood-pressure sink to 80, the respiratory rate rise to 30, and pulmonary ventilation to 50 liters. The symptoms are immediately relieved by a cold douche, with the exception of the rectal temperature. It is the circulation which fails, and this is immediately restored by the constriction of the skin. The rapid and dangerous sequence of events which follow exposure to these high temperatures points conclusively to the true cause of the discomfort which people feel in crowded rooms. Those who have a feeble circulation and deficient heat-regulating mechanism may collapse at a wet-bulb temperature 10° or 15° F. below that which affects a strong man, while almost all may feel discomfort and suffer fatigue.

Flügge has found in German high schools temperatures as high as 23° to 26° C. (73.5° to 79° F.). He made observations on 29

[1] H. Aron, B. M. J., 1911, II, p. 777.

[2] Hill and Flack, Proc. Physiol. Soc.; Journ. of Physiol., Vol. 38, 1909.

days in January and February in seven rooms. At the beginning of school the temperature was over 22° C. (71.5° F.) in 3 class-rooms 8 times, in one 10 times, in one 13 times, in one 16 times, in one 18 times. The temperature frequently reached 24° C. (75° F.), and even 26.5° C. (80° F.). When the windows were opened it fell to 14° or 13° C. (57° F.), a variation of over 10° C. (18° F.). Flügge says that the temperature of a public room should never be allowed to go above 21° C. (70° F.) because of the increased water vapor in the atmosphere produced by evaporation from the bodies of the occupants. He says that thermometers should be placed in every public room so that people can protest if the temperature exceeds 19° to 20° C. (66° to 68° F.). For a man wearing the usual clothing and keeping quiet a temperature of 13° to 15° C. (55° to 59° F.) suffices. In trains in winter, when warm overclothing is worn, 10° to 12° C. (50 to 53° F.) is enough.

We are of the opinion that 60° F. should be the highest temperature tolerated except for the old and infirm. The old should work in a different room and not compel the young to live in rooms heated to a tender-plant temperature.

The temperature of a school-room must be regulated by a thermometer, not by the feelings of the teacher.[1] The reduction in the number of scholars and the periodic emptying and blowing out of the room is the best way of avoiding heat stagnation.

Individual weaklings who suffer from the cold must put on more clothing. The absurd décolletée dress of women must not be made an excuse for high temperatures in rooms which are set aside for social functions.

Flügge points out that the great infant mortality occurs in the hottest summer weather. The child should be protected from heat stagnation by the cooling of its food, and exposure to open air during the cool parts of the day and night.

We may remind the reader that by absolute humidity is meant the amount of water in the air per cubic foot; by relative humidity, the percentage that this water is of the amount which the air can hold at the same temperature when saturated. The amount of water vapor varies with the temperature, but is uninfluenced by the pressure of the

[1] The thermometer does not show the rate of heat loss, which is the important thing in relation to body heat stagnation. One of us (L. H.) has recently invented *kata-thermometers*, which are empirically graduated and show the proper rate of heat loss in school rooms, factories, etc. See Lancet, May 10, 1913, p. 1290.

atmosphere. Air saturated at 18° F. holds only 1 grain of water vapor per cubic foot, while air saturated at 70° F. holds 8 grains. Thus if in winter the outside air is saturated at 18° F. and this air is heated up and driven into a room which is kept at 70° F., the air will hold the same absolute amount of moisture, but the relative humidity will only be 12.5 per cent against 100 per cent outside. Suppose the air outside is only half saturated; then the relative humidity inside will be only 6.25 per cent. This is an unusual condition of affairs in the moist and temperate climate of Britain, but a common occurrence during the rigorous winters of North America, and there the schools and dwellings are heated with this desert air.

In Britain if the air were saturated at 32° F. and raised to 60° F., the relative humidity would be only 34.9 per cent; and if the relative humidity of the outside air at 32° F. were 70 per cent, that inside would be only 24.5 per cent.

The Chicago Ventilating Commission say "it is probably safe to say that not more than 2 per cent of the public schools in the United States have any humidifying apparatus. The air, having been heated to about 100° F. and cooled to about 70° F. before it reaches the children, is superdried and seeks to obtain its proper balance of moisture from the school structure and the bodies of the children; hence shrunken furniture, dust, dry throats, parched lips, and a rapid rate of skin evaporation, rendering it necessary to maintain a high temperature for comfort." "In the high-grade installations the temperature is held at 72° F. One thousand eight hundred cubic feet of air per pupil are pumped into the room. In the older installation we frequently find the temperature well over 75° F." (Dr. Evans, Chicago). The citizens of Chicago are paying for a system which is most expensive, and no less pernicious and absurd. The dry, hot "desert" air makes the children stupid, spoils their complexions, swells up the respiratory tract and lowers the immunity.

In contrast with American women, the fresh complexion of English women, and still more of Irish women, seems to be correlated with a moist atmosphere and less indoor life.

The Chicago Commission say that in cold weather it is not possible to ventilate unoccupied rooms in that climate, except with air previously warmed, but that heating and ventilating are separate questions and must always be so considered. It is economic not only to health but to fuel to maintain a sufficient relative humidity and avoid "desert" air. We agree that the dry-bulb temperature for the schools ought not to exceed 55° to 58° F. and the relative humidity ought to be 60 per cent. This will cause the window-panes to frost in cold weather. Every three-quarters of an hour the school-rooms should be emptied and the scholars set to drill or exercise for a few minutes in the open air, or under open sheds, and the air in the rooms should be blown out by opening all the windows and doors. This lowers the bacterial count very greatly, and relieves the monotony of the conditions. The exercise invigorates the circulation of the children and antagonizes the ill effects which a sedentary occupation has on the metabolism.

The suitability of the clothing is of the greatest importance not only to the comfort but to the efficiency of man as a working machine; for example, the power of soldiers to march. On a still day the body is confined by the clothes as if by a chamber of stagnant air, for the air is enclosed in the meshes of the clothes and the skin layer becomes heated to body temperature and saturated with moisture.

The observations of Pembrey[1] show that himself and four soldiers marching in drill order on a moderately warm day (dry bulb 69° F., wet bulb 59° F.) lost more water and retained more water in their clothes than on another similar day when they worked with no jacket on (dry bulb 67° F., wet bulb 58° F.). The average figures were loss of moisture 1,600 against 1,200 grams and water retained in clothes 254 against 109 grams. With no jacket the pulse was on the average increased 28 against 41 in drill order, and rectal temperature 1° against 1.5° F. The taking off of the jacket or throwing open of the jacket and vest very greatly increases the physiological economy of a march. It is absurd that on a hot summer day boy scouts should march with a colored scarf knotted round the neck. Nothing should be worn for ornament or smartness which increases the difficulty of keeping down the body temperature. The avoidance of fatigue of the heart, the power to march, and the efficiency depend on prevention of heat stagnation.

A series of experiments carried out by one of us (L. H.) and Mr. R. H. Davis on the Fleuss rescue apparatus (for use in mines) show the danger which arises from heat stagnation in fighting fires in mines. The wearer of this apparatus breathes through a mouthpiece, fitted with inlet and outlet valves, in and out of a vulcanized rubber bag. The bag contains sticks of caustic soda, and a continuous supply of oxygen is maintained within it by means of oxygen cylinders (worn on the back) and a reducing valve. The CO_2 in the inhaled air is kept down under 0.5 per cent.

[1] War Office Committee on Physiological Effects of Food, Training, and Clothing on the Soldier, 4th report, 1908.

In using the apparatus to put out fires in the mine, the men may be exposed to high temperatures of the air and to radiant heat from the fire. The caustic soda, too, owing to absorption of CO_2 and moisture, becomes hot and this contributes greatly to the high temperature of the inspired air. The high temperature of the inspired air dries up the throat and contributes to heat stagnation and fatigue.

The following experiments were conducted on workmen wearing the Fleuss apparatus at Messrs. Siebe, Gorman & Co.'s works, in a chamber about 8 ft. long, 8 ft. high, and 5 ft. wide. In this chamber were placed two coke fire pails and the walls were splashed with boiling water kept on the top of the stove. The men wore the dress weighing about 34 lbs. and breathed oxygen. The temperature of the inspired air becomes uncomfortably hot, owing to the heat produced in the breathing bag from the caustic soda combining with CO_2 and water vapor. In order to reduce this a cooler was tried consisting of a thick felt bag filled with carbonic acid snow and placed so as to surround the inspiratory tube. Care had to be taken to prevent the inspiratory valve from freezing. The effect of this cooler in keeping down the pulse rate was excellent and much better than that of other evaporation coolers which were tried, filled with methylated spirit and water. The cool inspired air added very greatly to the comfort and endurance of the men. By acting directly on the blood going to the heart, it checks any great acceleration or failure of the heart and so prevents heat-stroke.

Chamber warmed by two coke fires with pail of water boiling on one fire.

Time	*A.* "Silence and Fun"* Wearing Fleuss dress, with carbonic acid snow cooler		*B.* "Jaw me Dead"* Wearing Fleuss dress, with methylated spirit and water cooler		Temperature of chamber	
	Pulse rate	Temp. of inspired air (wet bulb)	Pulse rate	Temp. of inspired air (wet bulb)	Dry bulb	Wet bulb
P. M.		*Degrees F.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
3.40	94		100		102	80
4.20	114	51	132	70	119	93
4.55	116	48	142	84	108	84
5.24	124	60	152	97.5	113	92
				100.4		
5.40	170	62.6	152	103.1	106	91

* Their nick-names.

A.—Lean and medium-sized but clothed.
B.—A fat, strong man stripped to the waist.

The men did some work shifting bricks to and fro and piling them up, but the work was not of a severe character.

Time	"Silence and Fun" CO_2 snow cooler		"Jaw me Dead" Methylated spirit cooler		Temperature of chamber	
	Pulse rate	Temp. of inspired air (wet bulb)	Pulse rate	Temp. of inspired air (wet bulb)	Dry bulb	Wet bulb
P. M.		*Degrees F.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
3.03	108		108		112	90.5
3.30	108	39	108	66	115	95
Bricks moved to and fro and stacked.						
4.00	138	52				
4.20	116		152	70	110	95.5
4.30	End of experiment		140			

This and the former experiment show the advantage given by the CO_2 snow cooler as seen in the pulse rate.

"Silence and Fun" Fleuss dress, with CO_2 snow cooler

Time	Pulse rate	Temp. of inspired air (wet bulb)	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Degrees F.*	*Degrees F.*	*Degrees F.*
3.45			100	
4.05			110	89
4.11	140 (Has just moved pile of bricks twice)	60		
4.22	120 (Resting)	56	108	88
4.33	134 (Has moved bricks twice)	67	115	91
5.00	(Moved bricks six times)		110	88
5.18	132	77	110	87
5.25	124		111	89
5.48	152	99	111	89

At the end of the time the snow was nearly all evaporated.

Time	"Jaw me Dead" CO_2 snow cooler		"Silence and Fun" Long tube cooler covered with wet rag		"O. K." Methylated spirit and water cooler		Temperature of chamber	
	Pulse rate	Temperature of inspired air (wet bulb)	Pulse rate	Temperature of inspired air (wet bulb)	Pulse rate	Temperature of inspired air (wet bulb)	Dry bulb	Wet bulb
P. M.		*Degrees F.*		*Degrees F.*		*Degrees F.*	*Degrees F.*	*Degrees F.*
2.40							102	83
3.15 – 3.20	120		134		112		120	92
3.45 – 3.50	128	68	148	79	140	86	119	92
4.05 – 4.10	132	74	156	87	144	95	120	98
			(Came out feeling sick and faint)					

Door opened a bit to cool off chamber a little.

4.30 – 4.35	136	80.6			148	95	119	97

The long tube probably increased the resistance to the breathing in the case of "S. & F." "O. K." was slender and much younger than "J. me D." The bricks were moved to and fro but no severe work was done.

Time	"H" Fleuss dress, with CO_2 snow cooler			
	Pulse rate	Temp. of inspired air (wet bulb)	Temperature of chamber: Dry bulb	Temperature of chamber: Wet bulb
P. M.		*Degrees F.*	*Degrees F.*	*Degrees F.*
3.45	92	32	100	82
4.15	99	47	97	86
4.45		52		

"O. K." put on the same dress and worked fairly hard moving bricks all the time.

4.50	90		108	88
5.20	124	62.5	120	92
5.45	130	90.5	120	95

The snow was mostly evaporated at the end of the time.

The following experiment kindly communicated to us was carried out by Dr. Green at Howe Bridge Rescue Station in a gallery 15 ft. long, 8 ft. wide, and 7 ft. high, heated by a stove, with walls and floor splashed with boiling water. The temperatures were taken at either end of the gallery.

Two men, "F" and "B," moved bricks to and fro continuously and stacked them. They wore the Fleuss dress, and the canvas covers of the breathing bags were wet with water, and now and again a full stream of oxygen was turned on in order to wash out the breathing bag and cool the soda.

Time	"F"			"B"			Temperature of chamber	
	Pulse rate	Temperature of inspired air (wet bulb)	Body temperature	Pulse rate	Temperature of inspired air (wet bulb)	Body temperature	Dry bulb	Wet bulb
P. M.		*Degrees F.*	*Deg. F.*		*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
2.00	62		Normal	120		Normal	85 99	80 88.5
2.30	108	67	Normal	136	64	Normal	91 101	83 88
3.00	132	68	100	136	67	100	95 105	89 94
3.30	160	79	102	172	75	102	97 100	93 100
4.00	Came out faint, sick, and done			200	82	102	100 119	93 103

The oxygen allowance was reduced to 0.75 liter per minute and found to be ample at these temperatures. The men were stripped to the waist.

"B" worked up to the end, and his pulse temperature soon returned to normal after he came out.

In the modern battle-ship men are confined very largely to places artificially lighted, and ventilated by air driven in by fans through ventilating shafts. The heat and moisture derived from the bodies of the men, from the engines, from cooking ranges, etc., lead to a high degree of relative moisture, and therefore all parts of the iron-work inside are coated with granulated cork to hold the condensed moisture and prevent dripping.

The air smells with the manifold odors of oil, cooking, human bodies, etc., and the fresh air driven in by fans through the metal conduits takes up the smell of these and is spoken of by the officers with disparagement as "tinned" or "potted" air. This air is heated when required by being made to pass over radiators. Many of the officers' cabins and offices (for example, for clerks, type-writers, etc.) in the center of a battle-ship have no port-holes and are lighted and ventilated only by artificial means. The steel nature of the structure prevents the diffusion of air which takes place so freely through the brick walls of a house. The men in their sleeping quarters are very closely confined, and as the openings of the air conduits are placed in the roof between the hammocks, the men next to such openings receive a cold draught and are likely to shut the openings. To sleep in a warm moist "fugg" would not matter if the men were actively engaged for many hours of the day on deck and were there exposed to the open air and the rigors of sea and weather. In the modern war-ship most of the crew work for many hours under deck, and many of the men, unless disciplined to do so, may scarcely come on deck for weeks or even months. Considering the conditions which obtain, it seems to be of the utmost importance that all the men in a battle-ship should be inspected at short intervals by the medical officers, so that cases of tuberculosis may be weeded out in their incipiency. The men of every rating should be compelled to deck drill for some part of every day.

In a destroyer inspected by one of us 12 men occupied quarters containing about 1,700 cubic feet of air. There was an open stove with iron pipe for a chimney, from which fumes of combustion must leak when in use, and a fan which would not work. When the men are shut down, the moisture is such that boots, etc., become mouldy and the water drips off the walls and ceilings. The cooling effect of the sea-water washing over the steel shell of the boat is very beneficial in keeping down the temperature in these confined and ill-ventilated quarters.

On the manœuvring platform in the engine room the wet-bulb temperature reaches a very high degree, owing to the slight escape of steam round the turbines.

Captain Domvile was kind enough to take the wet- and dry-bulb temperatures for us while in command of the destroyer *Lyra*.

The wet bulb was found to be never below 80° F., and sometimes reached 95° and even 98° F.

It is impossible for men to work at these temperatures without straining the heat-regulating mechanism of the body and diminishing the working capacity of the men. If such wet-bulb temperatures are unavoidable, means should be provided, such as fans, which would alleviate the discomfort and fatigue caused thereby. A cylinder of compressed air fitted with a nozzle might be arranged and used occasionally to douche the body with cool air. We have tried this plan and found it very effectual. We recommend the compressed-air bath as a substitute for a bracing cold wind.

Temperature, Fahrenheit, wet and dry bulb, on H. M. S. *Lyra*, September and October, 1911.

Date	Where taken	4 A. M. Wet	4 A. M. Dry	8 A. M. Wet	8 A. M. Dry	Noon Wet	Noon Dry	4 P. M. Wet	4 P. M. Dry	8 P. M. Wet	8 P. M. Dry
20-9-11	Engine room	...	...	...	...	...	...	87	98	85	100
	Deck	...	...	...	...	...	...	58	60	55	58
	Wind							NW		NW by N	
21-9-11	Engine room	84	96	85	97	82	95	78	96	...	...
	Deck	59	60	55	56	55	60	60	62	...	...
	Wind	SW		W by N		W by N		SW			
22-9-11	Engine room	...	...	...	...	...	...	90	110	...	...
	Deck	...	...	...	...	...	...	61	67	...	...
	Wind							NE			
25-9-11	Engine room	...	...	95	108	90	105	81	97	80	105
	Deck	...	...	57	61	62	67	62	65	60	62
	Wind			NW		S		S		Nil	
26-9-11	Engine room	...	...	80	95	85	100	85	108	...	...
	Deck	...	...	60	63	63	66	64	66	60	61
	Wind			SSW		NNW		SSE		SW	
27-9-11	Engine room	75	95	85	102	...	...	...	...	...	...
	Deck	57	58	60	63	...	...	...	...	...	...
	Wind	SW		WSW							
28-9-11	Engine room	...	...	86	105	85	105	80	100	98	105
	Deck	...	...	56	59	56	58	56	62	58	60
	Wind			NW		NNW		NW		NW	
29-9-11	Engine room	...	...	80	95	84	102	95	115	...	...
	Deck	...	...	53	55	51	59	55	61	...	...
	Wind			NW		NW		NW			
3-10-11	Engine room	...	...	85	100	86	102	85	105	...	...
	Deck	...	...	50	50	50	50	56	56	...	...
	Wind			Nil		Nil		Nil			
4-10-11	Engine room	...	...	84	100	85	100	80	96	...	...
	Deck	...	...	46	48	56	58	53	53	...	...
	Wind			N		NE		ENE			

CONCLUSIONS

The conclusions to be drawn from our experiments and those of others are, we trust, definite and well proven. They are these:

No symptoms of discomfort, fatigue, or illness result, so long as the temperature and moisture are kept low, from air rendered, in the chemical sense, highly impure by the presence of human beings.

Such air can be borne for hours without any evidence of bodily or mental depression. At 80° F. with moderate humidity, or 70° to 75° F. with high humidity, almost all persons begin to show depression, headache, dizziness, and a tendency to nausea. School children and cases of emphysema react least and those with heart troubles most. The subjective symptoms appear when the surface temperature reaches a certain height, for example, 93° to 95° F. on the forehead (89.5° to 91.5° F. in cases of heart disease), and the relative moisture of the layer of air in contact with the skin increases 20 to 30 per cent (Ercklentz). Under these conditions the normal loss of body heat is interfered with and symptoms appear which are similar in every way to those produced in stuffy, crowded rooms.

When those within the chamber are allowed to breathe from outside fresh air raised to the same temperature and degree of humidity, they experience no relief. When those outside the chamber breathe the impure air from within they experience no discomfort. The suffering of those inside the chamber can be immediately relieved by rapidly moving, cooling, or drying the air—mechanical means which enable the body to throw off its heat. On suddenly raising the percentage of CO_2 within the chamber the symptoms are not made worse, while on cooling the air relief is immediately felt.

Heat stagnation is therefore the one and only cause of the discomfort, and all the symptoms arising in the so-called vitiated atmosphere of crowded rooms are dependent on heat stagnation. The moisture, stillness, and warmth of the atmosphere are responsible for all the effects, and all the efforts of the heating and ventilating engineer should therefore be directed toward cooling the air in crowded places and cooling the bodies of the people by setting the air in motion by means of fans. The strain on the heat-regulating mechanism tells on the heart. The pulse is accelerated, the blood is sent in increased volume to the skin and circulates there in far greater volume, while we must assume that less goes through the viscera and brain. As the surface temperature rises, the cutaneous vessels dilate, the veins become filled, the arteries may become small in volume and the blood-pressure low, and the heart is fatigued by the extra work thrown upon it. The influence of the heat stagnation is shown by the great acceleration of the pulse when work is done and the slower rate at which the pulse returns to its former rate on resting.

The increased percentage of carbonic acid and the diminution of oxygen which have been found to exist in badly ventilated churches, schools, theaters, and barracks, are such that they can have no effect upon the incidence of respiratory disease and the higher death rate which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The conditions of temperature, moisture, and windless atmosphere in such places primarily diminish the heat loss, and secondarily the activity of the occupants, as also the total volume of air breathed, oxygen taken in, and food eaten. The whole metabolism of the body is thus run at a lower plane, and the nervous system and tone of the body are unstimulated by the monotonous, warm, and motionless air. At the same time, the number of pathogenic organisms is increased in such localities, and the two conditions run together,—diminished immunity and increased mass influence of infecting bacteria.

The volume of blood passing through, and of water vapor evaporated from, the respiratory mucous membrane must have a great influence on the mechanisms which protect this tract from bacterial infection. Mr. F. F. Muecke[1] and one of us (L. H.) have found that convected heat, from steam coils, closed stoves, etc., swells the mucous membrane of the nose and air sinuses, and obstructs the air-way. On the other hand, radiant heat, from an open fire or gas fire, causes the skin to sweat and does not affect the nasal mucous membrane. The swelling of the nose favors massive local infection.

We conclude that rooms should be heated by radiant heat and ventilated with cool outside air, and the conditions of a spring day—sunlight and cool breeze—approximated to as nearly as possible. The heated air of rooms is the factor which favors infection and the spread of coryza, influenza, phthisis, etc.

In the warm, moist atmosphere of a crowded place, the infection from spray, sneezed, coughed, or spoken out, is great. On passing from such an atmosphere out into the cold, moist external air the respiratory mucous membrane is suddenly chilled, the blood-vessels are constricted, and the defensive mechanism of cilia and leucocytes is checked. Hence the prevalence of colds in the winter. In the summer the infection is far less, and the sudden transition from a warm to a cold atmosphere does not occur. We believe that infection is largely determined, (1) by the mass influence of the infecting agent; (2) by the swelling of the mucous membrane of the nose, and (3) by the sudden transition from warm to cold surroundings, which checks the immunizing mechanisms. Colds are not caught by expos-

[1] Lancet, May 10, 1913, p. 1291.

ure to cold *per se*, as is shown by the experience of arctic explorers, sailors, shipwrecked passengers, etc.

We have very great inherent powers of withstanding exposure to cold. The bodily mechanisms become trained and set to maintain the body heat by habitual exposure to open-air life. The risk lies in overcrowding, so that infection becomes massive, and in overheating our dwellings and overclothing our bodies, so that the mechanisms engaged in resisting cold become enfeebled and no longer able to meet the sudden transition from the warm atmosphere of our rooms to the chill outside air of winter. The dark and gloomy days of winter confine us within doors and, by reducing our activity and exposure to open air, help to depress the metabolism; the influence of smoke and fog, diet, gloom of house and streets, cavernous places of business, and dark dwellings, intensifies the depression. The immunity to a cold after an infection lasts but a short time. When, after the summer holidays, children return to heated schoolrooms and to damp, chill autumn days, infection runs around.

The unpleasant smell of crowded rooms is sensed only by newcomers, and by them for only a short time after entering such rooms. Most men, for example, sailors, are quite indifferent to this smell and regard it no more than they regard tobacco smoke. Offensive trade smells are unnoticed by the workers in such trades. The smell nauseates sensitive educated people largely because they have been taught to believe that the smell indicates the existence of an organic chemical poison. A century or so ago, sick people went to breathe the air in crowded school-rooms on the fanciful supposition that the breath of the young and vigorous would heal their sickness. Possessed of such a fancy, the consumptive felt no nausea or loathing of the smell but breathed in the close air with faith and hope. The evidence of other workers and the experiments detailed in this paper make it certain that there is no chemical volatile poison in the exhaled air.

The history of hospital gangrene and its abolition by the aseptic methods of Lister, as likewise the history of insect-borne disease, show the great importance of cleanliness in crowded and much occupied rooms. The essentials required of any good system of ventilation are, then: (1) movement, coolness, proper degree of relative moisture of the air, and (2) reduction of the mass influence of pathogenic bacteria. The chemical purity of the air is of very minor importance and will be adequately insured by attendance to the essentials.

The reduction of spray (saliva) infection by ventilation is impossible in crowded places. It therefore behooves us to maintain our immunity at a high level, and, if possible, to diminish the spray output of those infected with colds by teaching them to cough, sneeze, and talk with a handkerchief held in front of the mouth, or to stay at home until the acute stage is past.

In all these matters, nurture is of the greatest importance, as well as nature.

A man is born with physical and mental capacities small or great, with inherited bodily characteristics, with more or less immunity to certain diseases, with a tendency to longevity of life or the opposite; but his comfort and happiness in life, the small or full development of his physical and mental capacities, his immunity and his longevity of life, are undoubtedly determined to a vast extent by nurture.

By nurture (we use the world in its widest sense, to include all the defensive methods of sanitary science), plague, yellow fever, malaria, sleeping sickness, cholera, hospital gangrene, and like diseases can be prevented by eliminating the infecting cause; small-pox and typhoid by this means, and also by vaccination; and most of the other ills which flesh is supposed to be heir to can be kept from troubling man by approximating to the rules of life which a wild animal has to follow in the matter of a simple and often spare diet, hard exercise, and exposure to the open air. "For whosoever will save his life shall lose it."

There is nothing more fallacious than the supposition commonly held that overfeeding and overcoddling indoors promotes health. The two together derange the natural functions of the body.

The body of a new-born babe is a glorious and perfect machine, the heritage of millions of years of evolution.

> "Not in entire forgetfulness,
> And not in utter nakedness,
> But trailing clouds of glory do we come."

A race-horse or a dog kept in perfect physical health and training is as clean, sweet, and beautiful as a wild animal. A pampered, ill-fed, underexercised dog becomes fat and gross, vomits on the mat, and passes offensive motions.

> "Shades of the prison house begin to close
> Upon the growing boy."

The ill-conditioned body, anæmic complexion, and undersized muscles, or the fat and gross habit, the decay of the teeth, the more offensive qualities of human evacuation, the nervous incapacity, irritability and unhappiness, are almost entirely the result of "nurture"—not nature.

In school, children may be disciplined to vigorous health. After leaving school they are set adrift to all the temptations of the world,

> "And custom lies upon them with a weight
> Heavy as frost and deep almost as life."

Monotonous work in confined places, amusement in music halls and shows in place of open air and manly exercise, injudicious diet, alcohol, and tobacco—everything which the trainer of an athlete would repel—these we should avoid.

We do not propose that all men should be athletes, but we do see that perfect physical health gives happiness and efficiency of life, and that our present methods of organizing the life of the masses in our industrial communities are such as to seriously diminish physical health and happiness and shorten life.[1]

Coal mines and chemical factories have a low rate probably because of the necessity for good ventilation. The figures show that the rate for hotel servants is ten times that of engine drivers. Massive infection, intemperance, warm, confined atmospheres, and conditions of employment are the factors. Such figures cannot be explained by differences of stock and inborn powers of resistance.

Hendhède says that out of 10,000 deaths in later life, 2,700 die in Copenhagen between the ages of 40 and 60 who would die in the country between 60 and 90.

---

[1] The *comparative* mortality figures for phthisis in Britain are:

OPEN AIR WORKERS.

Railway Engine Drivers and Stokers	63	Farm Laborers	82
Gamekeepers	73	Gardeners and Nurserymen	83
Agriculturists	79	Fishermen	96

TOWN AND FACTORY WORKERS.

Chemical Manufacturers	96	Messengers and Porters (otherwise than Railway)	368
Printers	290	Costermongers and Hawkers	516
Furriers and Skinners	314	Inn and Hotel Servants	533
Brush Makers	314	Do. Do. in London	667
Tool, Scissors, etc., Makers	353		

– Suppl. Vol. from Registrar General's 65th Annual Report, Publ. 1908.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 60, NUMBER 24

TWO NEW MAMMALS FROM THE SIBERIAN ALTAI

BY

N. HOLLISTER

(Publication 2171)

CITY OF WASHINGTON
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The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

TWO NEW MAMMALS FROM THE SIBERIAN ALTAI

By N. HOLLISTER.

The following two species of Siberian mammals complete the list of novelties obtained by the expedition organized in the interests of the National Museum and the Museum of Comparative Zoölogy, in 1912, by Prof. Theodore Lyman, of Harvard University.

APODEMUS NIGRITALUS, new species

Type from Tapucha, Altai Mountains, Siberia (125 miles southeast of Biisk, and 50 miles northwest of Ongudai). United States National Museum No. 175164, skin and skull of ♂ adult (teeth considerably worn). Collected August 6, 1912, by N. Hollister; original No. 4438.

General characters.—A member of the *speciosus-peninsulæ* group. Larger and darker colored than *Apodemus peninsulæ;* tail relatively much shorter, considerably less than head and body.

Color.—Upperparts dark brown, finely lined with blackish-brown; darker on head; nose blackish. Some specimens show considerable chestnut color on rump. Sides lighter than back, with less mixture of blackish-brown, sharply marked from the grayish-white belly. Hands and feet grayish-white, a sharply marked blackish ring around ankle separating the colors of leg and foot. Tail sharply bicolor.

Skull and teeth.—Skull like that of *Apodemus peninsulæ*, but averaging heavier and larger, the interpterygoid space constantly wider. Teeth essentially as in *peninsulæ*.

Measurements.—Type: Head and body, 122 millimeters; tail vertebræ, 102; hind foot, without claws, 25. Average of five adults from type locality, compared with average of five adults of *A. peninsulæ* from Shansi, the latter in parentheses: Head and body, 110 (87); tail vertebræ, 94 (91); hind foot, 23.4 (22.8). Skull of type: Greatest length, 29; condylobasal length, 27.5; zygomatic breadth, 14.8; palatal length, 15.2; nasals, 11.5; length of mandible, 17; upper tooth row, 4.1; lower tooth row, 4.0.

Remarks.—Two species of *Apodemus* occur together in the Altai.

Kastschenko's original description of *Mus tscherga*[1] relates wholly to the smaller species, a form of *Apodemus sylvaticus;* but in his second account of the animal[2] the two species are evidently confused, and the larger species passes as the adult of the smaller. This is plain from a number of statements, among them the measurements given for the hind feet. In the original description of *tscherga* the measurement of hind foot given is 20 millimeters. The young of the larger species, even those smaller than adults of the lesser, have the hind foot 23 or more, and in adults it ranges from 23 to 25. Aside from the greater external measurements, *Apodemus nigritalus* is readily distinguishable from *A. tscherga* by the more brownish color, the conspicuous black anklet, the larger skull with pronounced supraorbital beads, and the presence of eight mammæ instead of six. It appears to be nearly related only to *Apodemus peninsulæ,* from which species it is readily separable by its larger size and by the relative length of head and body and tail vertebræ. In *peninsulæ* the tail is about equal to, or slightly longer, than head and body. In *nigritalus* it is always considerably less. The ten specimens of *A. nigritalus,* all collected in August, have no traces of spines in the pelage, which is full and soft.

SOREX ROBORATUS, new species

Type from Tapucha, Altai Mountains, Siberia. United States National Museum No. 175436, skin and skull of ♂ adult (teeth unworn). Collected August 7, 1912, by N. Hollister; original No. 4451.

General characters.—A member of the *araneus* group, larger than *Sorex araneus borealis,* with much larger hind foot and relatively smaller teeth (molars actually smaller than in *S. a. tetragonurus*); first two upper unicuspids longer on crown than high at cone, the first nearly one and one-half times as long as high; line of posterior border sharply squared, with long shelving heel equal to posterior height of cusp; and highest point of cusp over anterior third of crown; upper cheek teeth with hypocones very much reduced and without pigment.

Color of type.—Back very dark hair brown; sides lighter, more drab; underparts anteriorly buffy-gray, posteriorly pale smoke gray. The tricolor pattern is evident but not conspicuous, and the color areas are not sharply marked. Feet drab brown; tail sharply bicolor, above dark brown, below ecru drab.

[1] Results Altai Zoölogical Expedition 1898, p. 46, Tomsk, 1899.

[2] Ann. Mus. Zoöl. Acad. St.-Pétersbourg, vol. 7, p. 301, 1902.

Skull and teeth.—Skull very much larger than that of *S. a. borealis;* braincase even considerably larger than in *S. a. tetragonurus,* broader, longer, and relatively flattened; lambdoid crest well developed in young adult. Incisors as in *araneus;* unicuspid teeth of same relative sizes as in *araneus,* but much longer crowned, the cones thus much wider apart, giving the appearance of wider spacing. The first two upper unicuspids longer than high, the first with length of crown about one and one-half times height at cone; the anterior line of profile steep; the posterior line sharply squared, with long shelving heel as long as posterior height of cusp above this shelf. The highest point of cusp of this tooth is distinctly over anterior third of crown. Second upper unicuspid with crown long, but considerably shorter than in first; third, fourth, and fifth much as in *araneus.* Large upper premolar with hypocone obsolete; first and second upper molars with hypocones much reduced, hardly noticeable, and without pigment. These teeth are in contact only on extreme outer edge, with wide spaces between centers and inner corners. Third upper molar with well developed pigmented protocone. Lower teeth much as in *tetragonurus,* but smaller, the molariform teeth much compressed laterally.

Measurements of type.—Head and body, 74 millimeters; tail vertebræ, 41; hind foot, without claws, 14. Skull: (Condylobasal length, estimated from broken skull, 22); breadth of braincase, 9.8; depth of braincase, 5.5; length of mandible, 10.8; length of upper molariform tooth row, 4.5; length of entire mandibular tooth row, 8.3.

Remarks.—In a series of ten shrews from the Altai Mountains, nine of which represent the *Sorex araneus borealis* of Kastschenko, this single specimen is conspicuous by its large size, dark color, large hind foot, and peculiar dental structure. Though of the "araneus group" it clearly represents a distinct species, which is readily recognizable in the flesh from the subspecies of *araneus* found in the same forests. The skull was broken by the trap, but the braincase is perfect and the dentition complete.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 25

DIAGNOSIS OF A NEW BEAKED WHALE OF THE GENUS MESOPLODON FROM THE COAST OF NORTH CAROLINA

BY

FREDERICK W. TRUE

(Publication 2172)

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DIAGNOSIS OF A NEW BEAKED WHALE OF THE GENUS MESOPLODON FROM THE COAST OF NORTH CAROLINA

By FREDERICK W. TRUE

A beaked whale sixteen feet long stranded in the outer bank of Bird Island Shoal in the harbor of Beaufort, North Carolina, on July 26, 1912. The occurrence was reported to the Fisheries Laboratory at noon the same day. When examined, soon afterward, the specimen had been badly mutilated, and in the end only the head, tail, and one of the pectoral fins were preserved. These parts were turned over to the U. S. National Museum by the Bureau of Fisheries, and, upon examination, showed that the animal belonged to an undescribed species of *Mesoplodon*. In order to make it known to science a diagnosis is here given.

MESOPLODON MIRUM, new species

Type specimen.—Cat. No. 175019, U. S. National Museum. A skull with mandible, and partial skeleton of an adult female 16 feet long, which stranded in Beaufort Harbor, North Carolina, July 26, 1912. Collected by the U. S. Bureau of Fisheries Laboratory, Dr. Lewis Radcliffe, director.

Teeth at the extremity of the mandible, small, entirely concealed by the integuments (in the adult female); mandibular symphysis one-fourth the length of the mandible; no basirostral groove. External free border of the lachrymal bone one-half the length of the orbit; its anterior end curved upward and appearing on the superior surface of the skull where it joins the antero-external angle of the frontal plate of the maxilla; maxillary prominences short and directed obliquely outward anteriorly, the extremity close to the maxillary notch. Maxillary foramina behind the premaxillary foramina; frontal plates of the maxillæ approximately one-half as broad as long.

The following measurements and data relative to coloration were furnished by Dr. Radcliffe:

	Feet	Inches
Total length	16	0
Width of flukes, about	4	8
Tip of snout to origin of dorsal fin	9	0
Tip of snout to origin of pectoral fin	3	8
Tip of snout to vent	11	0
Length of pectoral	1	8
Greatest depth of body	3	5

Back, slate-black; lower side, yellow-purple, flecked with black; median line of belly somewhat darker; a grayish area in front of vent; fins the color of the back.

A mold of the head was made at the U. S. National Museum, after which the skull was extracted and cleaned. The dimensions of the latter are as follows:

Dimensions of the type-skull.—Total length, 810 mm.; length of rostrum, 496; length from tip of rostrum to posterior end of pterygoids in median line, 618; greatest height from vertex to inferior border of pterygoids, 301; breadth across centers of orbits, 325; breadth between zygomatic processes, 345; breadth between bases of anteorbital notches, 210; breadth at middle of beak, 60; breadth across occipital condyles, 125; breadth of expanded proximal ends of premaxillæ behind anterior nares, 142; least breadth of premaxillæ opposite anterior nares, 118; breadth of premaxillæ opposite premaxillary foramina, 68; least breadth of anterior nares, 56; least distance between maxillary foramina, 92; distance from posterior border of maxillary foramen to end of maxillary protuberance, 63; length of portion of vomer visible on palate, 162; length of mandible, 668; length of symphysis, 193; greatest height of mandible opposite coronoid process, 117.

This species belongs to the section of the genus in which the basirostral groove is lacking. It differs from all known species, except *hectori*, in that the mandibular teeth are at the extremity of the jaw. From *hectori* it differs in the greater breadth of the cranium, the size and shape of the maxillary ridges, or prominences, and anteorbital notches, the much shorter vertex, and other characters.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 60, NUMBER 26

NOTICE OF THE OCCURRENCE OF A PLEISTOCENE CAMEL NORTH OF THE ARCTIC CIRCLE

BY

JAMES WILLIAMS GIDLEY
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(PUBLICATION 2173)

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NOTICE OF THE OCCURRENCE OF A PLEISTOCENE CAMEL NORTH OF THE ARCTIC CIRCLE

By JAMES WILLIAMS GIDLEY
ASSISTANT CURATOR OF FOSSIL MAMMALS, U. S. NATIONAL MUSEUM

While collecting recent mammals for the U. S. National Museum during the summer of 1912, along the Yukon-Alaskan boundary, Mr. Copeley Amory, Jr., Collaborator in Zoölogy, U. S. National Museum, obtained a small lot of Pleistocene mammal bones from a locality about 50 miles from the mouth of Old Crow River, in the Yukon Territory. This little collection proves to be of more than ordinary interest and importance, since it contains one of the phalanges of a camel. The association of this specimen with isolated foot bones and teeth of *Elephas primigenius, Equus,* and *Bison,* with which it agrees exactly in color and degree of fossilization, pretty definitely determines it as Pleistocene in age.

The specimen in itself is insignificant, yet its presence in the collection proves beyond question the former existence of camels in this far north country. Hitherto the northern limit of their range in America was not known to extend beyond the Silver Lake (Christmas Lake), Oregon, locality, which place is but little north of the 43d parallel, although camels of several large species were very abundant on this continent during both the Pliocene and Pleistocene periods.

The finding of camel remains in the Pleistocene deposits of the Alaskan peninsula is not altogether unlooked for, but their occurrence so far within the Arctic Circle was scarcely to be expected. This verification of their former presence in that region, therefore, is of especial interest in that it vastly extends the known geographic distribution of this important group of mammals in America during the Pleistocene, while incidentally it adds proof in support of the supposition that milder climatic conditions prevailed in Alaska during probably the greater part of the Pleistocene period. It is also one more bit of evidence confirming the theory of the existence of a wide Asiatic-Alaskan land connection of comparatively recent date, which for a very considerable length of time served as a great highway for the free transmigration of mammals between America and the Old World.

While this phalanx, a left of the proximal pair, is characteristically tylopoid and absolutely unmistakable as regards its group reference, it is not specifically determinable. It agrees approximately in size and proportions with the corresponding element in *Camelops kansasus* Leidy, as that species is at present understood, but is flatter, and in this respect more nearly resembles the phalanges seen in the living genus *Camelus*.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 27

AN EXTINCT AMERICAN ELAND

(WITH ONE PLATE)

BY

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Assistant Curator of Fossil Mammals, U. S. National Museum

(PUBLICATION 2174)

CITY OF WASHINGTON

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AN EXTINCT AMERICAN ELAND

By JAMES WILLIAMS GIDLEY
ASSISTANT CURATOR OF FOSSIL MAMMALS, U. S. NATIONAL MUSEUM

(WITH ONE PLATE)

While making a preliminary investigation in October, 1912, of some recently discovered Pleistocene cave deposits near Cumberland, Maryland, the writer secured, among other new and interesting mammal remains,[1] a series of five upper cheek teeth representing an extinct species of antelope, apparently very closely allied to the eland now living in Africa. This important specimen furnishes the basis of the present communication and constitutes the type of a new species which is described below.

TAUROTRAGUS AMERICANUS, new species

Plate 1

Type.—The upper cheek-teeth of the right side except p_2. (No. 7622 U. S. National Museum).

Description.—Teeth progressively hypsodont, rapidly narrowing from base to summit transversely, and sharply constricted anteroposteriorly at base, as in the living species of this genus; meta- and parastyles less developed than in *Taurotragus oryx;* metastyle of last molar slightly recurving outward, not extending backward beyond the posterior border of the tooth crown;[2] mesostyles of the molars somewhat more strongly produced than in the living species; premolars simple, but with a tendency to angulation of the inner posterior wall of the inner crescent, as in the bongo.

These teeth are of a young adult specimen in which the last molar had just come into use, hence they are at the stage in growth when their characters can be studied to the best advantage. They bear a most striking resemblance to the corresponding teeth of the living

[1] A report of the discovery with brief description of the other material secured is now under preparation for publication at an early date.

[2] This character is common to the species of this group and distinguishes them sharply from the Ovibovines in which the last upper molar has a conspicuous posterior pillar formed by the backward extension of the metastyle.

eland, *T. oryx,* differing from them only in minor details which, except for their somewhat larger size, mark them as slightly less progressive than those of the African species. These differences, however, do not seem sufficient to be regarded as of generic importance. Since, therefore, judged from the material in hand, there is no obvious reason for separating the American fossil species from the living genus *Taurotragus*, except perhaps the insufficient one of the seeming absurdity and improbability of the case, I have here referred it to that genus, although more complete material may later show this reference to be unwarranted. Whether properly belonging to the African genus or not, it is undoubtedly not only strepcisserine in its affinities, but seems especially closely allied to the living species of this group. Its occurrence, therefore, in the Pleistocene of the eastern United States is most unexpected, and seems to have a special significance in reference to the probable migrations and world distribution of these large antelopes during the Pleistocene period. It suggests that the strepcisserine group of the antelopes were comparatively recent migrants to that portion of Africa south of the Great Sahara Desert, where alone they now survive, the common center of dispersion in Pleistocene times being somewhere in central or southern Asia, as it certainly seems to have been at the beginning of the Pliocene, when several now extinct species of the group inhabited India and others invaded northern Africa and Europe. Much later, apparently, still other members of the group crossed directly into lower Africa, probably by way of some then existing land connection south of the Red Sea, while one species at least migrating northeastward from this same Asiatic center, evidently found their way across the Pleistocene Alaskan land bridge into America and thence southeastward to the eastern United States. The fact that no remains of this animal have been found in any of the Pleistocene deposits of the west, which deposits are better exposed and have been so much more thoroughly explored than those of the east, suggests that the time of this migration to America was possible during one of the interglacial epochs, when there was a route open to the north of the Great Lakes by which they may have reached the eastern coast region without traversing the plains country. It is possible that the moose, carabou, cervalces, and perhaps some of the other Pleistocene and present-day mammals common to the eastern coast region, may also have found their way from the Old World by some such direct route. However, far more data than are now available would be necessary to establish the truth of such an hypothesis.

While not constituting the only discovery in America of remains representing Old World antelopes, such occurrences are very rare, and this seems to be the only one in which the relationship is apparently especially close. Heretofore only two forms of seemingly undoubted Old World affinities have been reported, and these from a single locality as follows: *Ilingoceros alexandrae* Merriam and *Sphenophalos nevadanus* Merriam, lower Pliocene of Virgin Valley, Nevada, founded on a few fragments including portions of horn-cores.[1] These antelopes exhibit seemingly undoubted strepcisserine affinities, but as yet no associated material including teeth is known. A possible Hippotragine antelope, *Neotragocerus improvisus* Matthew,[2] lower Pliocene of western Nebraska, founded on a horn-core, probably records a second occurrence, although this form may prove, when better known, to belong rather to the goats than to the antelopes. A third form referred to the antelopes, but which apparently is more antelocaprine in affinities, is the small artiodactyl from the famous Pleistocene deposits of the La Brea ranch recently described by Taylor as doubtfully belonging to the genus *Capromeryx*.[3] This species is certainly not closely related to any of the living antelopes.

The exceeding rarity in American deposits of any fossil remains of Old World antelopes makes the more startling and unlooked-for this appearance in Pleistocene deposits of the eastern United States of the remains of an antelope apparently not generically distinguishable from the eland, now living only in Africa south of the Great Sahara Desert.

[1] Geol. Bull. Univ. Calif., Vol. 5, No. 22, 1909, pp. 319-330.

[2] Bull. Amer. Mus. Nat. Hist., Vol. 26, 1909, p. 413.

[3] Geol. Bull. Univ. Calif., Vol. 6, No. 10, 1911, pp. 191-197.

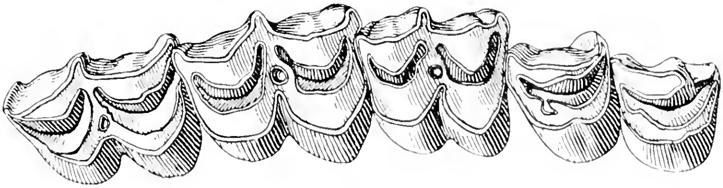

FIG. 1

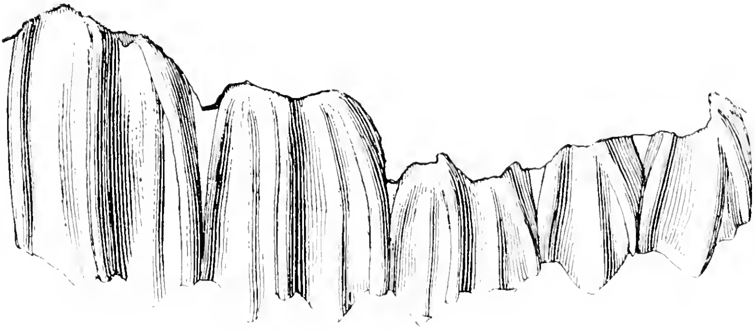

FIG. 1a

UPPER CHEEK TEETH OF TAUROTRAGUS ORYX

Fig. 1. Crown view. Fig. 1a. Outer view. No. 162015

¾ nat. size

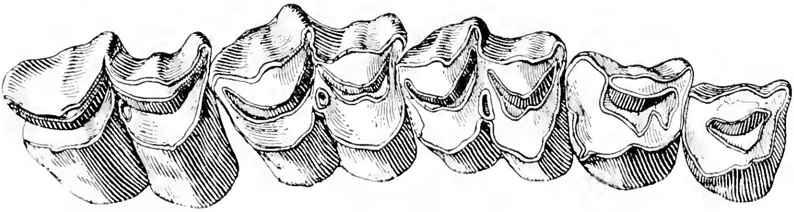

FIG. 2

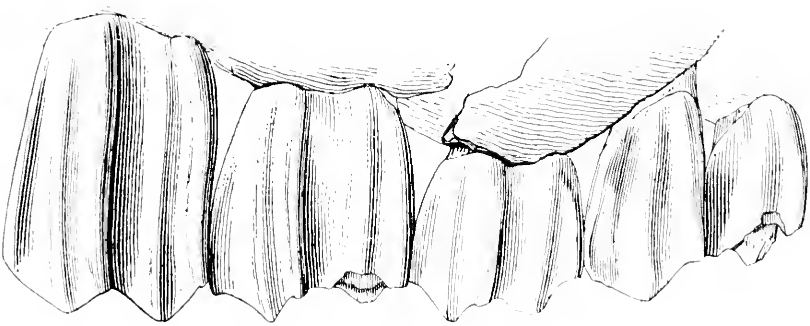

FIG. 2a

UPPER CHEEK-TEETH OF TAUROTRAGUS AMERICANUS TYPE

Fig. 2. Crown view. Fig. 2a. Outer view. No. 7622 U. S. N. M.

¾ nat. size

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 60, NUMBER 28

A NEW VOLE FROM EASTERN MONGOLIA

With One Plate

BY

GERRIT S. MILLER, Jr.

(Publication 2175)

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A NEW VOLE FROM EASTERN MONGOLIA

By GERRIT S. MILLER, Jr.

(With One Plate)

On his return to Tientsin from a recent expedition to the region in eastern Mongolia, north of Kalgan, Mr. Arthur de C. Sowerby, who has for several years been making zoölogical explorations in the interests of the Smithsonian Institution, wrote me as follows concerning a peculiar yellowish species of *Microtus:*

> In addition to *Microtus angustus* Thomas, obtained by Anderson in the same region, I obtained several specimens of what I take to be a new vole. This animal I found to be an inhabitant of the open country, where it lives in holes in the walls of the camps and huts; at least, it was only around buildings that I could catch any. This is probably the reason why Anderson did not secure any, as he collected in exactly the same locality as I did. If you find it to be a new species would you mind naming it after my assistant Warrington, who "spotted" it first? He was sitting in our tent and heard a noise. On looking up he saw the little animal run out under the flap. We promptly got traps out, and inside an hour had two or three specimens. This vole is diurnal while *M. angustus* is nocturnal.

The animal proves to be a hitherto undescribed member of the subgenus *Phaiomys*, forming with *M. brandti* (Radde) a group in some respects intermediate between typical *Phaiomys* and true *Microtus*. In compliance with Mr. Sowerby's request it may be known as:

MICROTUS WARRINGTONI, new species

Type.—Adult male (skin and skull) No. 175861 U. S. National Museum. Collected at Tabool, Mongolia (altitude 4,000 feet), 100 miles north of Kalgan, August 13, 1912, by Arthur de C. Sowerby. Original number, 508.

Diagnosis.—Like *Microtus* (*Phaiomys*) *brandti* (Radde) in color and in its combination of the external and dental peculiarities of *Phaiomys* with an unmodified, true-*Microtus*-like skull; size considerably greater than in *M. brandti*, the difference between the two species about like that existing between *M.* (*Phaiomys*) *mandarinus* and *M.* (*P.*) *johannis.*

Color.—Upperparts cream-buff faintly but evidently "lined" with blackish and irregularly darkened by appearance at surface of the blackish-slate hair bases (2.5 mm.), the general effect not far from slate-color; cheeks, inner surface of ears, and lower portion of sides clearer and more buffy; underparts not strongly contrasted, pale cream-buff much clouded by the slate-gray basal color; feet and tail whitish cream-buff, the tail just perceptibly more yellowish above than below.

Skull and teeth.—In general form the skull (plate 1, fig. 1) differs notably from that of *Microtus blythi* (plate 1, fig. 2), *M. raddei, M. mandarinus* (plate 1, fig. 3) and *M. johannis* in its narrower, more angular braincase, less spreading zygomata, relatively greater depth at region of anterior zygomatic root, deeper, shorter rostrum, and essentially perpendicular upper incisors.[1] In lateral view the profile does not differ appreciably from that of *Microtus agrestis*, though the skull is obviously broader than in the European species. As compared with a skull of *Microtus mandarinus* with same condylobasal length that of the type of *M. warringtoni* has the zygomatic breadth 2 mm. less, the interorbital breadth .6 mm. less and the depth at front of m^1 .6 mm. greater. Auditory bullæ large and inflated, with wide meatus, their form much more as in *M. agrestis* than as in *M. mandarinus*. Interorbital region narrow but not abruptly constricted, with two low ridges in the type, these joined to form a low median crest in an older individual. Palate normal, as in *M. mandarinus*. Teeth with the usual *Phaiomys* pattern; m_1 with 5 closed triangles and a very short, rounded, anterior loop.

Measurements.—Type and adult female (No. 175859), the latter in parenthesis: head and body, 117 (123) millimeters; tail, 28 (29); hind foot, (s. u.) 19 (19); ear, 11.5 (11.5); condylobasal length of skull, 27.2 (27.4); zygomatic breadth, 15.2 (16.0); interorbital constriction, 3.2 (3.0); occipital breadth, 12.8. (12.8); occipital depth, 7.0 (7.2); nasal, 7.8 (7.8); diastema, 8.2 (8.6); depth at anterior edge of alveolus of m^1, 8.2 (8.6); mandible, 17.2 (18.2); maxillary toothrow (alveoli), 6.2 (6.4); mandibular toothrow (alveoli), 6.4 (6.4).

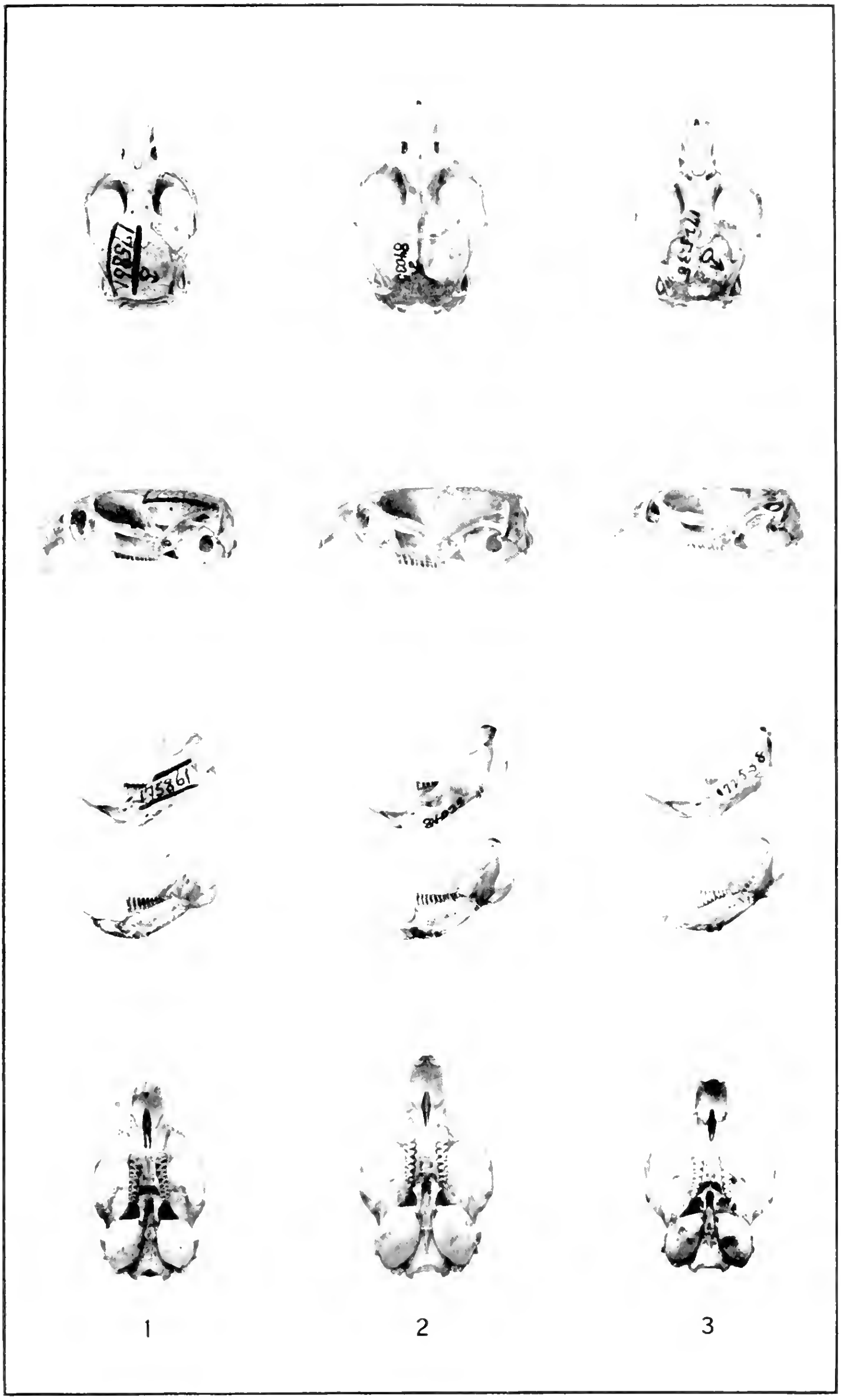
Specimens examined.—Six, all from the type locality.

Remarks.—The color, skull, and teeth of this vole are exactly as in *Microtus brandti* as described and figured by Büchner[2] from material collected in the same region of northeastern Mongolia as Radde's original specimens. The large size of *M. warringtoni* is, however, immediately diagnostic.

---

[1] This character is approached in *M. johannis.*

[2] Wissensch. Resultate Przewalski Cent. Asien Reisen, zoöl., Vol. 1, pp. 117-120, pl. 10, figs. 4-6.



SKULLS OF:

1 Microtus warringtoni (type) 2 Microtus blythi 3 Microtus mandarinus

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 60, NUMBER 29

VOLCANOES AND CLIMATE

BY

C. G. ABBOT and F. E. FOWLE

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VOLCANOES AND CLIMATE

By C. G. ABBOT and F. E. FOWLE

During the summer of 1912 we were engaged, respectively, at Bassour, Algeria, and at Mount Wilson, California, in measuring with the pyrheliometer and spectrobolometer the intensity of the radiation of the sun. On June 19 Mr. Abbot began to notice in Bassour streaks resembling smoke lying along the horizon, as if there were a forest fire in the neighborhood of the station. These streaks continued all summer, and were very marked before sunrise and after sunset covering the sky then towards the sun nearly to the zenith. After a few days the sky became mottled, especially near the sun. The appearance was like that of the so-called mackerel sky, although there were absolutely no clouds. In the months of July, August, and so long as the expedition remained in September, the sky was very hazy, and it was found that the intensity of the radiation of the sun was greatly decreased by the uncommonly great haziness. Mr. Fowle noted similar appearances at Mount Wilson especially noting the streakiness beginning with June 21. Publications in European journals and elsewhere have indicated that this haziness was world-wide. We adopt the view expressed by Dr. Hellmann[1] that the haze in question was due to the eruption of the volcano of Mount Katmai in Alaska in June, 1912. In the present paper we give the effects of the haze on the quantity and quality of the solar radiation as determined by our measurements, and also the effect which the presence of the haze and that of similar occurrences in former years appear to have had on the climate of the earth.

Before passing to the numerical results it will be interesting to recall briefly the circumstances attending the eruption of Mount Katmai and of other extraordinary volcanic outbreaks which resulted in periods of prolonged haziness similar to that of the summer of 1912.

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[1] Zeitschrift für Meteorologie, January, 1913.

SOME GREAT VOLCANIC OUTBREAKS

Captain K. W. Perry, U. S. R. S., reported that on June 6, 1912, the Revenue Steamer "Manning" being moored at the wharf at St. Paul, Kodiak Island, he observed about 4 o'clock a peculiar looking cloud rising to the southward and westward. Ashes began to fall about 5 p. m., and after this thunder and lightning became very intense and the wireless apparatus refused to work. Volcanic matter continued to fall rapidly until 9 a. m., June 7, when five inches of ashes had fallen. About noon precipitation began again, and by 2 o'clock it was pitch dark. Although all ashes of the previous day had been removed, yet the decks, masts, and yards were again heavily laden, and the men stumbled about, colliding with one another in their efforts to free the decks with shovels and streams of water. It was not until 2 p. m., June 8, that the fall of ashes decreased, the sky assumed a reddish color, and finally objects became dimly visible. The average depth of the ashes at Kodiak Island, 100 miles from Mount Katmai, was nearly or quite 1 foot. It seems doubtful, however, if the fall of ashes in other directions from the volcano was as great as in the direction of Kodiak Island.

It is natural to compare this eruption of Mount Katmai with the extraordinary explosion of Krakatoa in the Strait of Sunda in the year 1883, which formed the subject of the exhaustive report of the Krakatoa Committee of the Royal Society of Great Britain. After a quiescent period of more than 200 years a sharp eruption on the Island of Krakatoa began in May, 1883, and a slight quantity of ash fell as far away as Batavia, Java. Parties landed several times on the island during the summer of 1883, and found much activity there, and destruction of the vegetation. Still nothing very extraordinary had occurred until on August 26, when a succession of frightful explosions began, lasting until the morning of the 28th. The most violent occurred on the morning of the 27th, when the northern and lower portion of the Island of Krakatoa was blown away, leaving a vertical cliff. Instead of a mountain 1,400 feet high, which previously existed, there was now left a submarine cavity reaching 1,000 feet below sea level.

The wave caused by this explosion was upwards of 50 feet deep when it reached the shores of Java and Sumatra, and a Dutch warship was carried about 2 miles inland, and left 30 feet above sea level. Nearly 40,000 people perished by the overwhelming of their villages. The wave was still several feet high when it reached the Cape of Good Hope, and was thought to be noted by the tide gauges of the English Channel. The noise of the explosion was heard as far as the Island of Rodriguez, 3,000 miles away, and it is believed that the noise was heard over an area of one-thirteenth the entire surface of the globe. The air-waves caused were noted by meteorological observers to have made seven complete passages of the globe, four going out from the volcano to the antipodes, and three in return. The cloud of dust sent up from the volcano was measured on the day before the greatest explosion to be 17 miles high. For many months thereafter a cloud of dust, which at the beginning was believed to have an elevation of about 20 miles, and which after a year had descended to 10 miles, surrounded the whole world. This dust caused extraordinary sunset glows, and the increased length of the twilight. Other effects from it will be noted later.

It is obvious that the violence of the explosion of Krakatoa far exceeded that of Mount Katmai, for no such reports of the noise of the explosion have reached us in 1912. On the other hand the quantity of ash which fell at Kodiak Island, 100 miles from the volcano of Mount Katmai, exceeded by many fold the quantity which fell at similar distances from Krakatoa. According to Verbeek the depth of the ashes at 100 miles from Krakatoa averaged less than 1 centimeter.

In connection with their report of the extraordinary atmospheric conditions which followed the Krakatoa eruption, the Krakatoa Committee published accounts of various earlier periods of haziness associated with great volcanic action. From these we glean the following.

In the year 1783 occurred the eruption of Asamayama, Japan, stated to be the most frightful eruption on record. Immense rocks were hurled in all directions, and towns and villages buried. One stone said to be 264 feet by 120 feet fell into a river and looked like an island. The (if possible) still more extraordinary eruption of Skaptar Jökull in Iceland, also occurred in the same year beginning near the end of May, and with the most violent eruptions on June 8 and 18. Arago records that the dry fog of 1783 commenced about the same day, June 18, at places distant from each other, such as Paris and Avignon, Turin, and Padua. It extended from the north coast of Africa to Sweden, and lasted more than a month. The lower air did not seem to be its vehicle for at some places the fog came on with a south, at others with a north wind. Abundant rains and the strongest winds did not dissipate it. In Languedoc its density was such that the sun was not visible in the morning up to

17° altitude above the horizon. The rest of the day the sun was red and could be observed with the unprotected eye. At the time of new moon the nights were so bright that the light was compared to that of full moon, even at midnight.

In 1814 occurred the great eruption of the volcano of Mayon in the Philippine Islands, and on April 7 to 12, 1815 the extraordinary outbreak of Tomboro, Sumbawa, of which it is said this eruption was the greatest since that of Skaptar Jökull in 1783. For three days there was darkness for a distance of 300 miles. After these extraordinary volcanic outbreaks there were noted in Europe streaky skies, haziness, long twilights and red sunsets, so that the year 1815 is the most remarkable as regards sunset lights recorded up to that date.

Passing on to the year 1831 there occurred three moderate eruptions, and three more of the very first magnitude. Thus Graham's Island was thrown up, and eruptions took place in the Babujan Islands and at Pichincha. Arago says "the extraordinary dry fog of 1831 was observed in the four quarters of the world. It was remarked on the coast of Africa on August 3, at Odessa on August 9, in the south of France and at Paris on August 10, in the United States on August 15. The light of the sun was so much diminished that it was possible to observe its disk all day with the unprotected eye. On the coast of Africa the sun became visible only after passing an altitude of 15° or 20°. M. Rozet in Algeria and others in Annapolis, United States, and in the south of France, saw the solar disk of an azure, greenish, or emerald color. The sky was never dark at night, and even at midnight in August small print could be read in Siberia, Berlin, Genoa, etc. On August 3 at Berlin the sun must have been 13° below the horizon when small print was legible at midnight."

MOUNT KATMAI AND THE SOLAR RADIATION

In the following table we give the transmission of the atmosphere for the solar radiation as determined by the pyrheliometer, and for the separate wave-lengths by the spectrobolometer. In the first column we have the ratio of the mean values of the total intensity of the solar radiation (as determined by the pyrheliometer) compared with the intensity of the radiation which would be obtained outside the atmosphere, on the moon, for instance. The results are grouped with regard to time as indicated in the side headings. Pyrheliometer measurements of the different days have been reduced to the values which would have obtained if the sun had been at 48° from the zenith (air mass 1.5) and if the earth's distance from the sun had been at its mean value. The remaining columns of the table give the vertical transmission coefficients[1] at different wave-lengths in the spectrum. The values in the first line, corresponding to May and early June, are in close accordance with similar values obtained in former years when the atmosphere was of normal transparency. Accordingly the values in subsequent lines indicate by comparison with the first line the average effect of the volcanic dust in diminishing the transparency of the air.

TABLE 1. ATMOSPHERIC TRANSMISSION, 1912.

Time.	Total radiation.[1]	Wave-lengths in microns.[2]								
		0.34	0.36	0.40	0.50	0.60	0.80	1.00	1.50	2.00
a. MOUNT WILSON, CALIFORNIA.										
Early June	0.77	...	.645	.741	.866	.890	.967	.974	.967	.960
Late June	0.77	...	.644	.733	.851	.887	.970	.974	.971	.955
July	0.69	...	.549	.654	.782	.835	.919	.937	.956	.938
August	0.64	...	.536	.623	.738	.785	.872	.898	.931	.931
Haziest days	0.59	...	.467	.528	.639	.677	.774	.808	.883	.876
b. BASSOUR, ALGERIA.										
Early June	0.72	.557	.606	.696	.832	.869	.951	.964	.956	.947
Late June	0.71	.558	.607	.696	.832	.872	.946	.962	.955	.955
July	0.59	.487	.514	.598	.709	.747	.833	.856	.876	.904
August	0.59	.496	.527	.597	.707	.754	.830	.863	.842	.895
Haziest days	0.51	.406	.439	.495	.604	.656	.737	.767	.887	.872

[1] The values in this column give the ratios of the pyrheliometer readings at a solar zenith distance 48° (air mass 1.5), and reduced to mean solar distance, compared to the solar constant of radiation, taken as 1.93 calories per sq. cm. per minute.

[2] The values in these columns give the transmission coefficients for the wave-lengths named for celestial bodies in the zenith (air mass 1.0).

In further illustration of the effect of the haze we give Table 2, which is computed to represent the condition of the solar radiation transmitted obliquely through the atmosphere, at a solar zenith distance of about 48° (corresponding to air mass 1.5). In the first column are given the mean values of the total radiation per square centimeter per minute. In the second and third columns respectively, are the fractions transmitted and the fractional decrease in the intensity of the total solar radiation in passing from the outside of the atmosphere to the surface of the earth. The remaining columns give the

[1] By vertical transmission coefficient we mean the fraction of the intensity of a beam of rays from a celestial body in the zenith which reaches the ground.

fractional decrease in the intensities of different wave-lengths found by comparing them with the values which were found for them during May and early June.

Some results of the haziness are plainly shown by the accompanying illustrations, Fig. 1 and Fig. 2. Fig. 1 gives the march of the pyrheliometry and of the transmission of green light (at wave length 0.5 μ) from June until September. It is computed for the

TABLE 2. ILLUSTRATING OPACITY DUE TO VOLCANIC MATTER.

Time.	Total radiation.[1]			Percentage depletion.[2] Wave-lengths in microns.						
	Values in calories.	Ratio to early June.	Percentage depletion.	0.34	0.36	0.40	0.50	0.60	1.00	2.00
a. MOUNT WILSON, CALIFORNIA.										
Early June	1.49	1.00	0	...	0.0	0.0	0.0	0.0	0.0	0.0
Late June	1.48	0.99	1	...	0.2	1.6	2.7	0.5	0.0	0.7
July	1.33	0.89	11	...	21.6	16.9	14.5	9.0	5.8	3.4
August	1.24	0.83	17	...	24.3	23.0	21.4	17.3	11.7	4.3
Haziest days	1.13	0.76	24	...	38.5	39.7	36.5	33.7	24.9	13.0
b. BASSOUR, ALGERIA.										
Early June	1.39	1.00	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Late June	1.37	0.99	1	−0.2	−0.2	0.0	0.0	−0.5	0.4	−1.4
July	1.14	0.82	18	18.3	21.9	20.3	21.3	20.1	16.4	6.6
August	1.14	0.82	18	15.9	18.7	20.7	21.7	19.0	15.2	7.9
Haziest days	0.99	0.71	29	38.0	38.4	40.1	38.1	34.2	28.9	11.6

[1] These values relate to pyrheliometer measurements at a solar zenith distance of 48° (air mass 1.5) and mean solar distance.

[2] These values relate to atmospheric transmission for solar zenith distance of 48° (air mass 1.5) and depend on spectro-bolometric measurements at the wave-lengths named. The percentage depletion indicates the loss of direct radiation attributable to the volcanic haze, assuming none was present in early June.

solar zenith distance of 48° corresponding to air mass 1.5. The values are given for both Mount Wilson and Bassour. In Fig. 2 are given the vertical transmission coefficients of the haze itself for various times and wave-lengths. Curves representing this are shown corresponding to the latter part of June, to July, to August, and to some days when the transparency was especially low. These data are also given for both Mount Wilson and Bassour.

From these results we may draw the following conclusions:

(1) The haze produced by the volcano of Mount Katmai began to affect measurements in Algeria on or about June 19, and those of Mount Wilson on or about June 21.

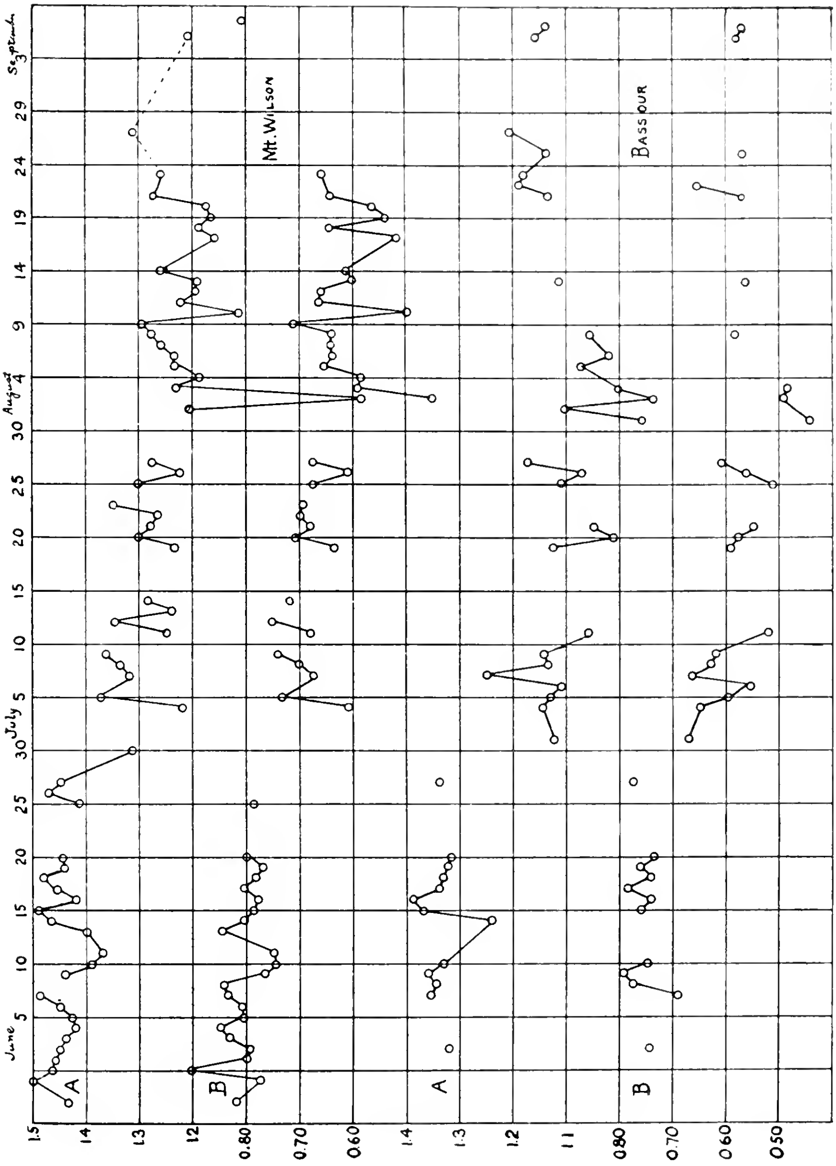

FIG. 1.—Effect of dust on solar radiation and atmospheric transmission at Mount Wilson, Cal. and Bassour, Algeria.
AA Pyrheliometer results at solar zenith distance 48° (air mass 1.5).
BB Atmospheric transmission for green light ($\lambda = 0.5\mu$) at zenith distance 48°.

(2) The effect increased during July, and had reached its maximum for Bassour by the middle of August, but seemed still increasing at Mount Wilson to the end of August.

(3) The maximum decrease of the total solar radiation attributable to the haze seems to have reached nearly or quite 20 per cent at each station.

(4) It would appear from inspection of the transmission coefficients for different wave-lengths that the peculiarities of the sky in the latter part of June produced no marked decrease of the transparency of the air.

(5) As regards the different wave-lengths of the spectrum, the effect of the haziness is greater for visible rays than for infra-red ones, but the difference of transmission does not increase so greatly towards the violet as one would expect. Indeed for the Bassour results there was nearly uniform effect throughout the whole visible and ultra-violet spectrum. The Mount Wilson results, however, show somewhat increasing effects towards the shortest wave-lengths. This circumstance is very noteworthy and indicates to us that the size of the particles which produced the scattering of light was on the whole much greater than the size of the particles which produced the ordinary blue light of the sky. Lord Rayleigh has shown that for particles small as compared with the wave-length of light the scattering effect is inversely proportional to the fourth power of the wave-length. It is from this extraordinarily rapid increase of the scattering towards the shorter wave-lengths that we owe the very blue character of the sky. The haze, on the other hand, produced a whitish appearance on account of the larger size of the particles concerned.

As Bassour is at a lower altitude (1,160 meters) than Mount Wilson (1,730 meters), it may be that the atmosphere above Bassour included on the average grosser particles than the atmosphere above Mount Wilson. This may account for the fact that the haze effect for Bassour did not increase toward short wave-lengths as rapidly as that for Mount Wilson. There is even a tendency toward smaller effects at Bassour for the extreme ultra-violet than for the visible rays. If this be real we think it may be due to a selective action of the dust due to its composition of volcanic glass and sulphur.

Mr. Fowle collected on Mount Wilson some dust which fell upon the mirror of the coelostat, and this dust has been very kindly

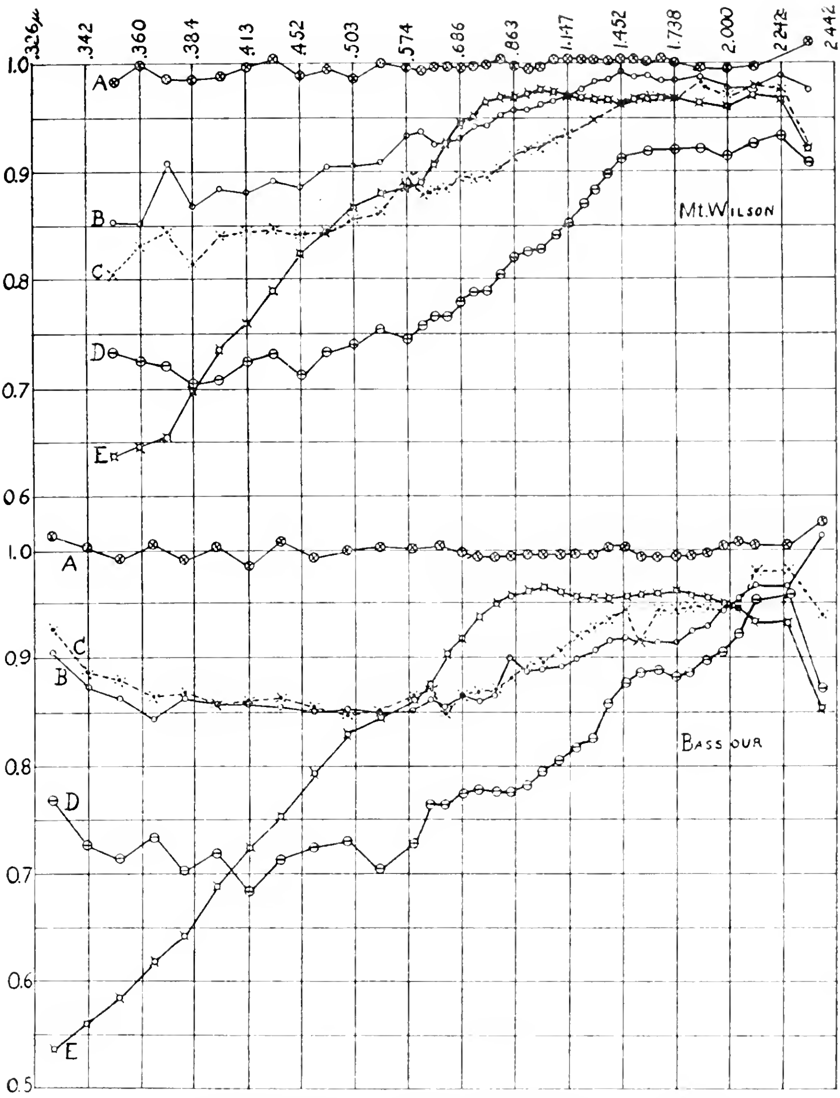

FIG. 2.—Effect of dust on atmospheric transmission at Mt. Wilson, Cal., and Bassour, Algeria.

EE Vertical transmission of atmosphere early June, 1912.
AA Transmission ratio: late June to early June.
BB " " all July to early June.
CC " " all August to early June.
DD " " haziest days to early June.

analyzed for us by Dr. Merrill of the United States National Museum, who writes:

Dr. Pogue has reported on the dust left by you this morning as being composed of fragments of volcanic glass, quartz, feldspar and kaolin. Volcanic glass is a common constituent of volcanic dust, as is also feldspar. Quartz would occur only rarely, and kaolin scarcely at all. On account of the decomposed condition of much of the glass, and the presence of kaolin, we are both of us inclined to regard the dust as probably from the plains, and not as derived directly from the volcano, although the glass would suggest an ultimate volcanic origin.

DECREASE OF HEAT AVAILABLE TO WARM THE EARTH

In the passage of the beam of sunlight from the outer limit of the atmosphere to the soil, losses of energy occur in the direct beam as follows: (1) Absorption by the gases and vapors of the atmosphere, principally in the infra-red water-vapor bands. (2) Scattering of light towards the ground from the direct solar beam by the molecules and dust particles of the atmosphere, thus producing the light of the sky. This loss in the direct solar beam is made up to us by the sky-light. (3) A fraction of the solar beam is scattered by the molecules and dust particles of the air in such a direction as to go out to space, and thus be lost to the earth for heating purposes. To this may be added the quantity of radiation (if any) which is absorbed in the higher atmosphere.

The question arises how much the third loss, by diffuse reflection and scattering to space and higher atmospheric absorption, was increased owing to the presence of the dust cloud of 1912. It is not possible to determine this loss by direct measurements. However, knowing the solar constant of radiation, the intensity of the direct solar beam at the earth's surface, the intensity of the sky radiation, and the quantity of absorption by atmospheric vapors, the loss by high atmospheric absorption and by reflection of the atmosphere to space may be approximately computed. We obtain the value of the solar constant of radiation, the intensity of the direct solar beam at the earth's surface, and the loss of radiation by absorption in the vapors of the lower atmosphere, on each day of observation. In order to determine the total intensity of the sky radiation Mr. Abbot devised and constructed at Bassour two pieces of apparatus, and made measurements for this purpose.

The first contrivance was a bolometer with a somewhat wide receiving strip. This bolometer was made with a wooden case, and rough interior construction, but it was found to answer the purposes for which it was designed fairly well. It had an alt-azimuth mounting, and measurements were made with it of the intensity of the sky radiation at all parts of the sky as compared with the intensity of the direct beam of the sun. In this comparison the direct solar beam was reduced in intensity by means of a rotating sector diaphragm, and a series resistance was inserted for diminishing the sensitiveness of the galvanometer when the sun was observed. Measurements were made with this bolometer on the brightness of the sky on September 5, 6 and 7, 1912.

The other apparatus used was a device originally intended for measuring the nocturnal radiation, and was similar in principle to the Ångström Compensation Pyrheliometer. The two blackened metal strips, instead of being side by side, were placed one above and the other beneath a thin horizontal plate of brass, and were so protected by strips of horn that the metal strips could not give off radiation except from their outward surfaces. The radiation from the outward surface of each strip was free to go in any direction within a hemisphere. In the use of this instrument a blackened screen was placed beneath it so that the lower strip was exchanging radiation only with this screen, which subtended a whole hemisphere. The upper strip was exchanging radiation with the whole sky.

In the use of the bolometer mentioned above, the instrument was protected from exchanges of radiation of great wave-length by means of a plate of glass. The nocturnal radiation instrument, on the other hand, had no plate of glass in front of it. Accordingly while the bolometer measured only the radiation of the sky transmissible by glass (that is to say, the radiation coming indirectly from the sun), the nocturnal instrument, on the other hand, measured the combined effect of rays of all wave-lengths. Accordingly a correction had to be applied in the latter measurements for the radiation which the instrument would have sent out if the sun had been in eclipse. Of course this correction could not really be measured, but Mr. A. K. Angström had made measurements at Bassour of the nocturnal radiation on the morning and evening of each of the days in question and these he has kindly permitted us to use. Assuming that the nocturnal radiation would have had the mean of these morning and evening values at mid-day if the sun had been eclipsed, we may thus estimate and correct the results for the exchange of long-wave rays between the blackened strip and the sky. Thus we determine the solar radiation scattered from the sky to the observer as indicated by the nocturnal radiation apparatus. The experiments of all three days with this instrument indicated that the scattered solar radiation received from the sky was in excess of the long-wave radiation lost to the sky.

The bolometric observations at different parts of the sky were reduced by graphical methods so as to give the mean brightness of the various zones, and these were summed up with regard to their relative areas, so as to give the total effect of the sky on a horizontal surface. The values given are for noon observations, and are stated in calories per square centimeter per minute. In the daylight observations with the nocturnal radiation apparatus the sun was screened away by a broom held at about 2 meters distance. The results represent therefore the whole sky except a part very close to the sun. The results of both kinds of observations are collected below:

Table 3. Radiation of the Sky. Bassour, 1912.

	Intensity.			
	Date.			Mean.
	Sept. 5.	Sept. 6.	ept. 7.	
a. BOLOMETRY OF SKY RADIATION.				
Direct solar beam in calories	1.24	1.25	1.25	1.25
Fraction added by the sky	0.267	0.126	0.129	0.174
Sky radiation in calories	0.331	0.158	0.161	0.217
b. MEASUREMENTS OF SKY RADIATION BY NOCTURNAL APPARATUS.				
	calories.	*calories.*	*calories.*	*calories.*
Before sun-rise	—0.169	—0.205	—0.208	—0.194
Noon	+0.062	+0.092	+0.047	+0.067
After sun-set	—0.208	—0.225	—0.220	—0.218
Total sky radiation in calories	0.250	0.307	0.261	0.273

Although the results show a large divergence in percentage, it is not great in calories; and the mean result of all experiments, namely 0.245 calories per square centimeter per minute, probably represents the total sky radiation to within 0.05 calories.

We will now give, as a mean for the three days, noon measurements of the three quantities of radiation: (1) That which reaches the earth in the direct beam of the sun. (2) That which reaches a horizontal surface by scattering from the whole sky. (3) That which is absorbed from the direct beam of the sun and from the sky radiation by the vapors of the atmosphere.

These quantities are as follows:

Direct solar beam	1.250	cal.	per	sq.	cm.	per	min.
Total sky radiation	0.245	"	"	"	"	"	"
Absorbed radiation	0.175	"	"	"	"	"	"
Sum	1.67	"	"	"	"	"	"
Solar constant	1.95	"	"	"	"	"	"
Difference	0.28	"	"	"	"	"	"

The difference between the solar constant and the sum of the three parts of the solar radiation, received at the earth's surface or absorbed in the lower atmosphere, gives approximately the combined loss by diffuse reflection from the atmosphere to space and by absorption in the higher atmosphere. This quantity is about 0.28 calories per square centimeter per minute. Experiments of similar nature have been made at Mount Wilson and Mount Whitney in former years, and their result has always indicated that the combined higher atmospheric absorption and the reflection of the atmosphere to space was not more than about 0.05 calories per square centimeter per minute. Accordingly the difference of 0.20 calories in round numbers seems to be attributable to the uncommon haziness which prevailed in the higher atmosphere during the summer of 1912. This difference is about 10 per cent of the solar constant of radiation.

It might be expected that if so great a decrease as this in the heat available to warm the earth's surface should continue indefinitely, the mean temperatures recorded at meteorological stations would thereby be lowered by about 7° centigrade. But it is not certain that the effect of this considerable diminution of heat was not counteracted by some change in the average cloudiness, or in the nocturnal radiation of the earth to space. It is conceivable that the cloud of haze prevented the escape of radiation of the earth to space in the same manner that it prevented the incoming of radiation from the sun to the earth, so that the decrease of heat available to warm the earth may have been in part or in whole compensated by a decrease in the rate of escape of heat from the earth, owing to the presence of the haze.

Mr. Ångström has kindly communicated to us some measurements of the nocturnal radiation which he made at Bassour in the summer of 1912. Unfortunately these measurements were not begun until after the haze from the volcano had reached a considerable density, but Mr. Ångström has arranged his values with reference to the degree of haziness which prevailed, as indicated by pyrheliometric measurements of the direct beam of the sun during the successive days. In this way he has divided his measurements of nocturnal radiation into two groups, one group being taken on the nights of the days in which the transparency of the atmosphere had been above the average, and the other group taken on the nights of the days in which the transparency of the atmosphere had been below the average. The number of days in each group is 17. He finds that the average nocturnal radiation was about 0.15 calorie per square centimeter per minute, and that the nights corresponding to days of more than usual transparency of the atmosphere gave a nocturnal radiation 0.001 calorie above the normal, while those nights corresponding to days of less than usual transparency gave a nocturnal radiation 0.001 calorie below the normal. This difference, 0.002 calorie, between the hazy days and the clearer ones is so small that Mr. Ångström is doubtful if it be a real effect, or only an accidental error of measurement.

However, it would not be expected that the effect due to a difference of haziness between the two groups of days would be so great as the effect due to the haziness produced by the volcano; and it can also be shown that the effect which might be expected from the volcano itself would not be very great, measured by thousandths of a calorie.

It is shown by us[1] that the direct radiation of the earth to space is not, perhaps, greater than 10 per cent of the total radiation of a body at the temperature of the earth. Mr. Angström's measurements incline him to think that the transmission of direct radiation to space is somewhat greater than this, perhaps 15 or 18 per cent. Suppose that we should assume it to be the latter. A perfect radiator at the temperature of the earth emits about 0.5 calorie per sq. cm. per minute. Taking 18 per cent of this we have 0.09 calorie. Then we assume that of the 0.15 calorie representing the nocturnal radiation, 0.09 calorie would be transmitted from the earth's surface to space and the remaining 0.06 calorie would be the counter-radiation of the cooler atmosphere towards the earth. Let us further suppose that the volcanic haze (which produced a decrease, as we have found, of 10 per cent in the incoming energy) produced a decrease of 5 per cent in the transmission of the higher atmosphere to the radiation sent out by the earth. This effect of course will influence Mr. Angström's results only on the 0.09 calorie supposed to be transmitted from the soil through the atmosphere to space. Five per cent of 0.09 calorie is 0.0045 calorie; so that if it should be found that the nocturnal radiation experienced a decrease of 0.0045 calorie

[1] Annals Astrophysical Observatory, Vol. 2, pp. 167-172.

per square centimeter per minute owing to the volcanic haze of 1912, the 10 per cent loss of heat incoming from the sun, due to the reflection of this haze to space, would be half compensated. The value 0.0045 calorie is so near the difference, 0.002 calorie, found by Mr. Angström to exist between his clear and hazy days, that it seems impossible to say as yet whether the decrease of heat available to warm the earth was not in considerable measure compensated as we have described.

INFLUENCE OF FORMER HAZY PERIODS ON THE SOLAR RADIATION

It is only since just before the Krakatoa eruption of 1883 that we have had measurements of the intensity of solar radiation comparable to those that were available in 1912. From a paper of Prof. H. H. Kimball[1] we copy the data for the top line of the accompanying Fig. 3, which shows the departures of the annual solar radiation received at the earth's surface, as measured at Montpelier and other stations. The smoothed curve (A) of the figure is formed from the combination of these results by adding to twice the value for the year in question the value for the year next preceding and the value for the year next following, and dividing the sum by 4. It is apparent that very great departures from the usual intensity of solar radiation occurred from 1883 to 1887, from 1888 to 1893, and from 1902 to 1904 respectively. The departure which followed the Krakatoa eruption is only what we should have expected, but it is interesting to find, if we can, the causes of the diminished solar radiation having minima in 1891 and 1903 respectively.

Considering first the period 1888 to 1893, undoubtedly the greatest eruption of this period occurred in northern Japan. Bandai-San is a mountain about 5,800 feet high which had shown no sign of activity for about 1,100 years. A subordinate peak called "Little Bandai-San" arose on its northeastern side. On the morning of July 15, 1888, with only a few minutes earthquake as a preliminary warning, Little Bandai-San was blown completely into the air and obliterated. The debris buried and devastated an area of at least 30 square miles. An estimate based on the depth of the material in this area indicated that the quantity of earth, rocks and volcanic material reached 700,000,000 tons, and that doubtless the true figure would be much greater still. About 600 people perished horribly, and many more were reduced to destitution. It was with one possi-

[1] Bulletin of the Mount Weather Observatory, Volume 3, Part 2.

ble exception the most terrible volcanic disaster which had occurred in Japan since the famous explosion of Asamayama in 1783. The force of an explosion capable of tearing a mountain to bits and distributing it over an area of 30 square miles may well have been sufficient to blow the column of ashes high enough into the air to have been carried over the earth like those ejected from the crater of Krakatoa in 1883.

An eruption took place of the volcano Mayon in the Philippine Islands, December 15, 1888. Vast columns of ashes ascended from the crater, and in a short time the darkness was so intense that, though it was mid-day, lights had to be used in every house in Manila. Violent eruptions were also reported from other volcanoes in the Philippine Islands.

The activity of the Island of Vulcano, near the coast of Sicily, lasted 20 months from August 3, 1888 to March 22, 1890. The most violent explosions occurred on August 4, 1888, December 26, 1889 and March 15, 1890. An eruption on January 6, 1889, was observed by Prof. A. Ricco from the Observatory of Palermo to be sending a column of smoke to the height of 10½ kilometers.

In February, 1890, there was the volcanic eruption at the island of Bogoslof in the Bering Sea. Three small islands were created in the immediate vicinity, and the island was raised 1,000 feet. Ashes were collected in Unalaska, about 40 miles distant.

On June 7, 1892, by a great outbreak of a volcano near the capital of the island of Great Sangir, South of the Philippines, some thousands of people were killed and immense quantities of ashes fell all over the island. The noise of the explosion was heard at Sandakan, 500 miles from Great Sangir.

An eruption of Mount Etna began on the night of July 8 and 9, 1892, and continued with more or less intensity all the month, and occasional outbreaks occurred afterwards. The eruption was notable for the enormous quantities of smoke and sand emitted.

Passing now to the period 1902 to 1904, the question whether the frightfully destructive eruption of Mt. Pelée, Martinique, May 8 and 20, 1902, and the simultaneous great activity of Soufriere, St. Vincent, produced a widely distributed haze in the earth's atmosphere cannot be certainly answered. On the one hand the measurements made at the Astrophysical Observatory of the Smithsonian Institution on the transmission of the earth's atmosphere in 1901, 1902 and 1903 show that during the latter part of 1902 and the whole of 1903 the transparency of the atmosphere was very decidedly below the normal. On the other hand, a measurement of the total intensity of the solar radiation made at this Observatory in Washington on October 15, 1902, gives a value of the intensity of 1.40 calories per square centimeter per minute, which is among the very highest observations of this kind which have been made at this station. It is of course possible, though unlikely, that the haze due to the eruption of Mount Pelée was not so quickly distributed towards the more northern latitudes as that of Mount Katmai in Alaska was this year towards more southerly ones, so that perhaps the effect reached Washington later than October 15, 1902. However, there were other volcanoes active about this time.

On October 24, 1902, there occurred the eruption of Santa Maria in Guatemala. The ashes from this volcano covered an area of more than 125,000 square miles. Pumice stone and ashes fell to a depth of eight inches or more in a region extending over about 2,000 square miles, within which the houses and farm buildings were crushed under the weight of the ejected material, and in some cases totally destroyed. Six thousand persons are believed to have been killed. The cloud from the volcano reached 18 miles in height and the sound of the explosion was heard at Costa Rica, 500 miles away. The whole side of the mountain was blown away, exposing a cliff, nearly perpendicular, 7,000 feet in height, and forming a crater three-quarters of a mile wide, seven-eighths of a mile long, and 1,500 feet deep.

In February and March, 1903, not less than 12 maximum eruptions took place from the very high and beautiful volcano of Colima in southern Mexico (altitude about 13,000 feet).[1] A photograph taken on March 7 shows the column of smoke projected to a height of about 17 miles.

From these records it seems to us probable that the decreased solar radiation of 1888 to 1893 was caused by the volcano of Bandai-San supplemented by Mayon, Vulcano Island and others, and that the depression of solar radiation whose maximum was in 1903 may be attributed to the volcano of Santa Maria in Guatemala, supplemented by that of Colima in Mexico.

Observations were made in 1901, 1902 and 1903 at the Astrophysical Observatory in Washington on the transmission of the atmosphere for different wave lengths. We take the following data from a summary of these measurements published by Mr. Abbot in 1903.[2]

[1] See Journal of Geology, Vol. 11, for a finely illustrated description.

[2] Smithsonian Miscellaneous Collections (Quarterly Issue), Vol. 45, p. 79.

TABLE 4. COEFFICIENT OF ATMOSPHERIC TRANSMISSION FOR RADIATION FROM ZENITH SUN.

Date.	Transmission coefficients for unit air mass. Wave-length.										
	0.40 μ	0.45 μ	0.50 μ	0.60 μ	0.70 μ	0.80 μ	0.90 μ	1.00 μ	1.20 μ	1.60 μ	2.00 μ
October 25, 1901	....	....	0.81	0.82	0.89	0.94	....	0.95	0.96	0.95	....
November 2, 1901	....	....	0.80	....	0.87	0.92	....	0.94	0.95	0.94	....
March 21, 1902	....	....	0.83	0.80	0.84	....	....	....	....	0.87	....
May 8, 1902	....	....	0.89	0.77	0.90	0.94	....	0.95	0.94	0.91	....
September 11, 1902	....	....	0.80	0.78	0.87	0.89	0.92	0.92	0.94	0.93	....
October 9, 1902	....	....	0.70	0.78	0.84	0.87	0.89	0.90	0.91	0.93	....
October 15, 1902	....	....	0.73	0.78	0.86	0.89	0.90	0.91	0.93	0.96	0.94
October 16, 1902	....	....	0.50	0.58	0.79	0.82	....	0.86	0.90	0.91	....
October 22, 1902	....	....	0.84	0.82	0.88	0.91	0.93	0.94	0.94	0.95	....
November 15, 1902	....	....	0.75	0.79	0.83	0.89	0.91	0.92	0.93	0.95	0.96
February 19, 1903	0.67	0.64	0.66	0.72	0.76	0.80	0.83	0.85	0.86	0.90	0.92
February 25, 1903	0.48	0.60	0.66	0.68	0.74	0.83	0.88	0.90	0.93	0.93	0.92
March 3, 1903	0.40	0.48	0.66	0.73	0.79	0.84	0.87	0.89	0.92	0.96	0.96
March 25, 1903	0.47	0.50	0.57	0.66	0.72	0.76	0.79	0.81	0.84	0.88	0.89
March 26, 1903	0.52	0.58	0.62	0.68	0.77	0.80	0.81	0.83	0.85	0.89	0.90
April 17, 1903	0.55	0.60	0.69	0.77	0.80	0.82	0.87	0.90	0.94	0.97	0.97
April 28, 1903	0.39	0.52	0.56	0.64	0.71	0.74	0.76	0.78	0.82	0.88	0.89
April 29, 1903	0.46	0.49	0.56	0.66	0.72	0.76	0.77	0.80	0.83	0.88	0.90
July 7, 1903	0.42	0.60	0.66	0.69	0.77	0.82	0.85	0.86	0.88	0.89	0.86
General mean	0.484	0.557	0.700	0.730	0.808	0.847	0.856	0.884	0.903	0.920	0.919
Mean of 1901-2	....	....	0.765	0.769	0.857	0.897	0.910	0.921	0.933	0.930	0.950
Mean of 1903	0.484	0.557	0.627	0.692	0.753	0.797	0.825	0.847	0.874	0.909	0.912
Percentage difference between mean of 1903 and that of 1901-2	....	....	20%	10%	13%	12%	10%	8.4%	6.5%	2.3%	4.1%

It appears that in 1903 as in 1912, the presence of volcanic haze caused a decrease of the transparency of the atmosphere, productive of nearly as much effect in the infra-red as in the visible spectrum.

VOLCANOES AND TERRESTRIAL TEMPERATURES

We have made some preliminary study to determine if the haziness produced by volcanoes causes a decreased temperature at the earth's surface.

Taking the year 1912, we find from the international ten-day mean values published by the German Marine Observatory that the high altitude stations of southwestern Europe, namely: Pic du Midi, Puy de Dôme, Brocken, Schneekoppe, Säntis, and Hoch-Obir give a very marked indication of a decrease in temperature with respect to the normal beginning about the middle of July. The seven stations named are very consistent with one another in this indication as shown in the table on page 20.

In order to see if a similar effect was caused by the dust cloud emanating from Krakatoa in 1883 we have studied the temperature departures for Pic du Midi, Puy de Dôme and Schneekoppe for the years 1882 to 1884 inclusive, but there does not appear to have been at that time any such marked decrease of temperature following the eruption of Krakatoa, August 27, 1883, as occurred in July, 1912. Nevertheless at Pic du Midi there was a very well marked decrease in the daily temperature range beginning with September, 1883. We have found for some other stations a similar decrease of the daily temperature range following the volcano of Krakatoa.

In table 6 temperature departures are given for seven stations of the United States for 1912. The stations selected are from the most cloudless region of the country. They are arranged in two groups with regard to whether they show a tendency to lower temperatures during and after July. Leadville and Flagstaff, two high stations, agree in this respect with the European high stations.

The temperature of the earth is a function of so many variable quantities that general or cosmical effects are often greatly obscured by local ones. From studies which have been made by various authors it appears, however, that there is a periodicity of terrestrial temperature corresponding in time to the sun-spot cycle of about eleven years. Koppen, Arctowski, Nordmann, Newcomb, Abbot and Fowle, and others have found that there is an increased temperature at the time of minimum sun spots. The increase of temperature is in fact

TABLE 5. TEMPERATURE DEPARTURES,[1] 1912. HIGH STATIONS S. W. EUROPE.

Station.	February.			March.			April.			May.			June.			July.		Mean.
	Decade.			Decade.			Decade.			Decade.			Decade.			Decade.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	
Pic du Midi	+1.6	+1.9	+6.6	+1.0	0.0	+4.8	+0.1	−0.7	−0.9	+3.2	+6.3	−1.4	−2.5	+1.1	+2.7	−2.3	+0.6	+1.24
Puy de Dôme	+1.5	+2.8	+7.1	+0.8	+0.1	+4.1	−0.6	−1.9	−0.3	+2.9	+6.2	−1.4	−2.0	+0.6	+0.6	−2.0	+2.9	+1.26
Brocken	−0.6	+5.4	+5.5	+3.1	+2.4	+2.4	−1.1	−2.1	+0.6	−0.7	−0.3	−3.1	+1.3	−2.4	+0.2	−1.0	+4.4	+0.82
Schneekoppe	0.0	+5.0	+4.7	+4.1	+0.9	+1.4	−2.4	−4.9	−1.6	−2.1	+0.1	−1.6	+1.4	−1.8	−0.3	−2.0	+1.1	+0.12
Säntis	+0.5	+2.6	+7.0	+1.4	−0.1	+2.0	−1.5	−3.6	−0.8	−0.4	+2.1	−0.9	−0.4	−0.7	+0.2	−1.2	+3.9	+0.60
Hoch-Obir	+1.2	+2.6	+4.4	+2.3	+1.2	+2.4	−0.3	−6.3	−2.5	.....	+2.3	−0.4	.....	−0.5	.....	−1.9	−0.3	+0.30
Mean of all	+0.70	+3.58	+5.88	+2.12	+0.75	+2.85	−0.97	−3.22	−0.92	+0.48	+2.78	−1.47	−0.52	−0.62	+0.57	−1.73	+2.10	+0.69

Station.	July.			August.			September.			October.			November.			December.		Mean.
	Decade.			Decade.			Decade.			Decade.			Decade.			Decade.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	
Pic du Midi	.....	.....	−2.8	−3.3	−3.5	−1.4	−1.2	−1.6	−2.6	−0.6	+1.0	−0.3	+1.1	−5.6	−1.0	.....	.....	−1.68
Puy de Dôme	.....	.....	−1.3	−3.4	−4.5	−2.6	−5.3	−3.6	−2.9	−2.7	+0.3	−0.3	−2.9	−4.4	−2.4	.....	.....	−2.77
Brocken	.....	.....	+1.5	−2.4	−3.7	−2.1	−5.1	−2.6	−4.4	−3.9	−0.3	+0.5	−3.0	−0.9	−0.4	.....	.....	−2.06
Schneekoppe	.....	.....	+0.1	−1.6	−3.2	−3.4	−6.3	−6.9	−6.4	−4.5	−2.7	+0.1	−5.2	−3.0	−0.8	.....	.....	−3.37
Säntis	.....	.....	−0.7	−1.0	−3.8	−3.1	−6.2	−5.3	−5.4	−0.9	−0.2	−1.0	−4.5	−4.8	−2.3	.....	.....	−3.02
Hoch-Obir	.....	.....	−1.6	−1.8	−3.3	+1.0	−5.8	−6.6	−7.9	−2.9	.....	−0.5	−6.2	−2.8	−2.1	.....	.....	−3.38
Mean of all	.....	.....	−0.80	−2.25	−3.58	−2.10	−4.98	−4.43	−4.93	−2.58	−0.38	−0.25	−3.45	−3.58	−1.50	.....	.....	−2.68

[1] Centigrade Scale.

greater than would be caused directly by the darkening of the sun by sun-spots, so that it is supposed that there is accompanying the spots some secondary influence affecting terrestrial temperatures. General fluctuations of temperature have also occurred which are not fully accounted for by the march of the sun-spots. We have endeavored to see whether a combination of the sun-spot influence with the effect of the volcanic haze on solar radiation will produce

TABLE 6. TEMPERATURE DEPARTURES[1] 1912. CLOUDLESS REGIONS, UNITED STATES.

Station.	Month.						Mean.
	Jan.	Feb.	March.	April.	May.	June.	
Leadville, Colo.	+0.5	−2.0	−0.6	−4.1	−0.5	−2.7	−1.57
Flagstaff, Ariz.	+1.6	+1.8	−1.7	−4.0	−1.9	−0.9	−0.85
Tucson, Ariz.	+0.7	−1.6	−2.9	−6.8	−2.4	+1.1	−1.98
Pueblo, Colo.	−3.0	+0.5	−7.2	−1.7	+0.1	−4.0	−2.55
Dodge, Kans.	−9.3	+0.9	−11.1	−1.6	+2.3	−5.0	−3.93
Santa Fe, N. Mex.	+0.4	−1.8	−1.8	−5.3	−1.3	−3.8	−1.93
El Paso, Tex.	+1.6	−2.5	−1.9	−4.7	−0.6	−1.8	−1.65

Station.	Month.						Mean.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Leadville, Colo.	−2.2	−1.8	−7.2	−1.8	+0.2	.....	−2.56
Flagstaff, Ariz.	−3.8	−1.6	−3.2	−0.9	+2.3	.....	−1.44
Tucson, Ariz.	−5.1	−2.7	−3.6	−3.8	−0.9	.....	−3.22
Pueblo, Colo.	−1.4	−0.1	−7.0	−0.9	+2.2	.....	−1.44
Dodge, Kans.	+0.9	0.0	−4.2	+1.6	+4.5	.....	+0.56
Santa Fe, N. Mex.	−0.5	+0.2	−2.5	−1.0	+1.0	.....	−0.56
El Paso, Tex.	+0.5	−0.8	−1.7	−0.2	−1.6	.....	−0.76

[1] Fahrenheit Scale.

a more exact correspondence between the solar phenomena and the temperature of the earth.

Referring to Fig. 3, the curve *A* is a smoothed representation of the average intensity of the direct solar radiation. The method of smoothing the curve is as follows, taking for example the year 1895: Add to the value for 1894 twice that for 1895 and that for 1896, and divide by 4. Curve *B* is the smoothed sun-spot curve as given by Wolfer. The sun-spot numbers run from 0 to about 80. Curve

C is a combination of *A* and *B*. They are taken in the following proportions: Multiply the percentage departure of radiation shown in *A* by 6[1] and subtract from it the sun-spot number for the given year. Curve *D* represents the departures of mean maximum temperature for 15 stations of the United States distributed all over the country. It is smoothed in the same manner as curve *A*. Curve *E* represents the departures of temperature for the whole world, also smoothed in the same manner as curves *A* and *D*. The data for the curves *D* and *E* are taken from Annals, Astrophysical Observatory, Vol. 2, p. 192, and from the *Monthly Weather Review*.

Although there is a considerable degree of correspondence between curve *B* and curve *D* yet it is not hard to see that there is also much discordance. For example, the sun-spot maximum of 1893 was greater than that of 1883 or 1906, yet the temperature curve *D* indicates a gradual increase of temperature for the three periods. Also the temperature had begun to fall in 1890, although sun-spots were still at the minimum; and the temperature had begun to rise in 1892, although sun-spots had not yet reached their maximum. Similar discrepancies occur in other parts of the curves.

When, however, we compare the curves *C* and *D*, that is to say, the combination of the effects of sun-spots and volcanic haze with the mean maximum temperature for the United States, the correspondence of the curve is most striking. It seems to us in consideration of this, that there can be little question that the volcanic haze has very appreciably influenced the march of temperature in the United States. When we take the march of temperature for the whole world the correspondence, though traceable, is not so striking; but in this case there are so many conflicting influences at work that it is perhaps too much to expect so good an agreement.

In view of this slight preliminary study of temperatures, it seems to us that the question of the effect of volcanic haze on terrestrial temperature is well worth serious consideration. Although a large group of stations may by their contrary local influences mask the influence of the haze, we believe it may be found eventually that temperatures are influenced, perhaps as much as several degrees, by great periods of haziness such as those produced by the volcanoes of 1883, 1888 and 1912.

[1] Perhaps a better result would have come if 5 instead of 6 had been used.

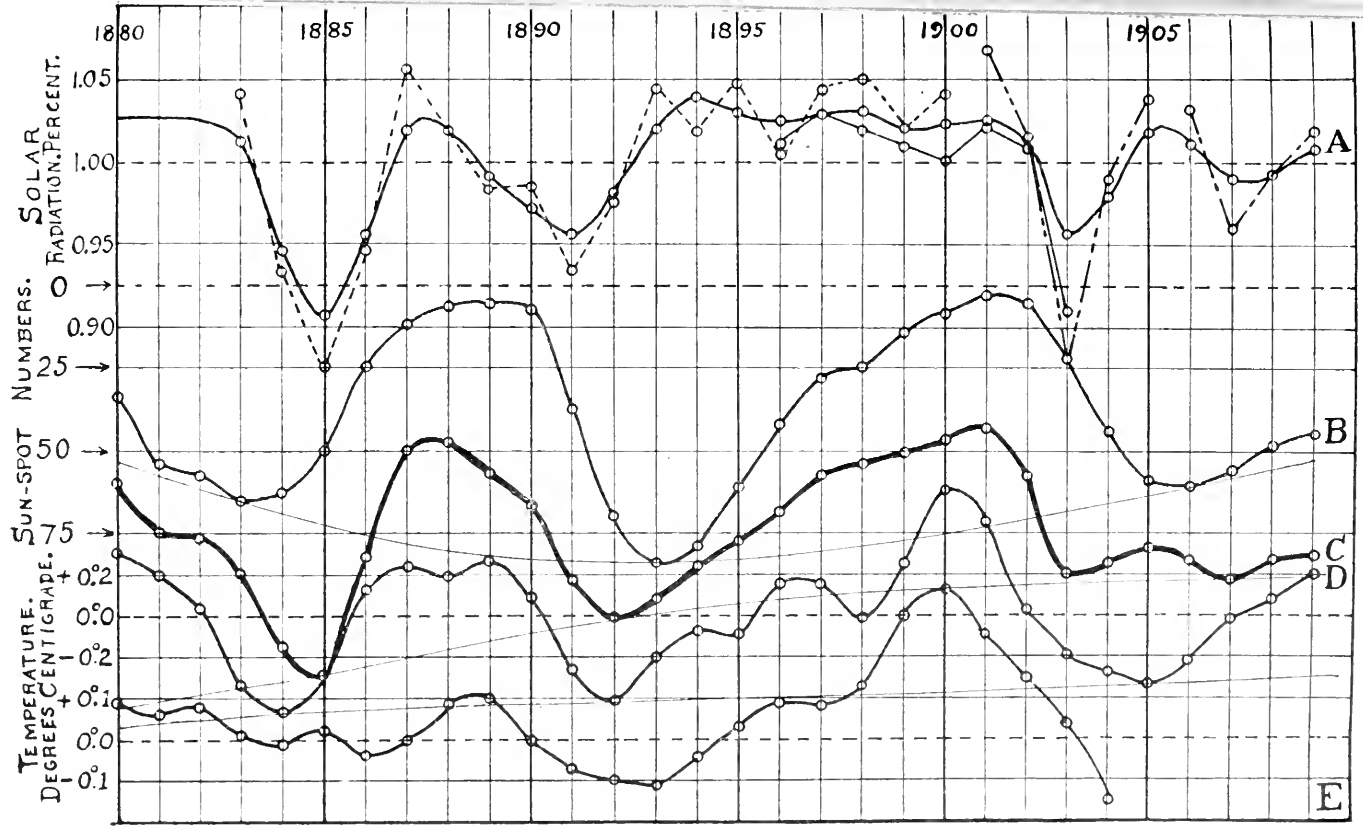

FIG. 3.—Solar radiation, sun-spots and temperatures.

A Observed and smoothed mean, annual, noon, solar radiation. (Kimball.) Volcanic effects, 1885, 1891, 1903.
B Wolfeis smoothed sun-spot numbers.
C Combined solar radiation and sun-spot numbers.
D Smoothed annual mean departures, United States maximum temperatures (15 stations).
E Smoothed annual mean departures, world temperatures (47 stations).

SUMMARY

The transparency of the atmosphere was much reduced in the summer of 1912 by dust from the volcanic eruption of Mount Katmai, June 6 and 7.

Evidence of the dust appeared at Bassour, Algeria, on or before June 19, and at Mount Wilson, California, on or before June 21.

The total direct radiation of the sun was reduced by nearly or quite 20 per cent at each of these stations when the effect reached its maximum in August.

In the ultra-violet and visible spectrum the effect was almost uniform for all wave-lengths, but was somewhat less in the infra-red.

From Bassour experiments, including measurements by two methods of the radiation of the sky, it appears that the quantity of heat available to warm the earth was diminished by nearly or quite 10 per cent by the haze. There is, however, some indication that this was in part counterbalanced by a decrease in the earth's radiation to space, caused by the haze.

Similar periods of haze followed great volcanic eruptions in former years. The influence of Krakatoa, Bandai-San, Mayon, Santa Maria, and Colima seems to have been recorded by measurements of solar radiation, and caused pronounced decrease in the direct solar beam from 1883 to 1885, 1888 to 1894, and 1902 to 1904.

Evidence is presented that the dust layer of 1912 affected terrestrial temperatures, especially of high stations.

A remarkable correspondence is found between the average departures of the mean maximum temperature for 15 stations of the United States and a curve representing a combination of the sunspot numbers of Wolfer and the departures from mean values of the annual march of direct solar radiation from 1883 to 1909.

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1912

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1912

In 1912, as in preceding years, The Smithsonian Institution carried on field-work in various parts of the world by means of small allotments from its funds, and by coöperating with institutions and individuals engaged in similar activities. Several friends of the Institution contributed funds for special work, or provided opportunities for participation in explorations which they had undertaken personally or through the aid of others.

All these operations resulted in extending the boundaries of knowledge, and in several cases added important material to the collections of the National Museum. The Institution is obliged every year to forego opportunities for important work in many fields. With larger means it could engage in more extensive field operations which could confidently be expected to yield rich returns both in increase of knowledge and in additions to the national collections.

Most of the information contained in this account has been furnished by those who participated in the various expeditions.

About twenty different parties were in the field during 1912, and the regions visited comprised British East Africa, Abyssinia, Algeria, eastern Siberia and Mongolia, the Altai Mountain district, Borneo, St. Lawrence Island, Alaska, British Columbia, Alberta, Newfoundland, Labrador, the Panama Canal Zone, the Bahama Islands, the West Indies, and many parts of the United States.

Some of the work done in 1912 was in continuation of operations initiated in previous years, and described in the article on explorations published by the Smithsonian some months ago.[1] As regards the Government branches of the Institution, it should be said that the Bureau of American Ethnology engages largely in field-work as a

[1] Expeditions Organized or Participated in by the Smithsonian Institution in 1910 and 1911, Smithsonian Misc. Coll., Vol. 59, No. 11, 1912.

part of its regular activities. The National Museum has no special funds for exploration, and on that account can embrace only a few of the opportunities which are presented for enlarging its collections

FIG. 1.—A native of Borneo. Photograph by Streeter.

through field-work. The Astrophysical Observatory occasionally obtains funds from Congress for observations outside the United States. The functions of the other branches—the National Zoölogical Park, the International Exchanges, the Regional Bureau of the

International Catalogue of Scientific Literature—are not of such a character as to involve work of the kind now under consideration.

A ZOÖLOGICAL AND ETHNOLOGICAL EXPEDITION TO DUTCH EAST BORNEO, MAINTAINED BY DR. W. L. ABBOTT

As a result of the zoölogical and ethnological explorations carried on for many years by Dr. W. L. Abbott in the East Indies, the National Museum, through his generosity, contains the largest and most important collections from that part of the world to be found in any museum. Having discontinued the work himself, he was, nevertheless, desirous that collections should be made in Dutch East Borneo, a region which he had not visited, and with much liberality he provided the means for sending Mr. H. C. Raven into that territory to procure characteristic mammals as well as any ethnological material that might prove of interest. A letter from Mr. Raven, who left the United States about March 1, 1912, and is still in the field, announces that he has had a successful trip and has made a large collection.

MR. D. D. STREETER'S EXPEDITION TO BORNEO

Mr. Daniel Denison Streeter, Jr., of Brooklyn, N. Y., offered his services as a volunteer collaborator for the National Museum. He sailed from New York about April 15, 1912, and returned to the United States in December. He passed from Sarawak into Dutch Borneo by ascending the Rejang River and crossing the mountains on the dividing line to the Kajan River. He then ascended to the head of this river, and crossed another range to the head-waters of the Mahakam River which he descended to the Strait of Macassar. A small but interesting collection of mammals was secured, including two skulls of the Rhinoceros.

FIG. 2.—Kuching, Sarawak, Borneo. Photograph by Streeter.

FIG. 3.—Kuching, Sarawak, Borneo. Photograph by Streeter.

Fig. 4.—View in Sarawak, Borneo. Photograph by Streeter.

Fig. 5.—View of the interior of town of Kuching, Sarawak, Borneo. Photograph by Streeter.

MR. GEORGE MIXTER'S COLLECTING TRIP TO LAKE BAIKAL

Another collaborator of the National Museum, Mr. George Mixter, of Boston, Massachusetts, an experienced big-game hunter, volunteered to collect large mammals for the Museum in the vicinity of Lake Baikal, Siberia, during the summer of 1912. The main object of Mr. Mixter's trip was to secure specimens of the native bear and of the seal peculiar to Lake Baikal, neither of which was represented in the collections of the National Museum. He succeeded

FIG. 6.—Skull of a Siberian bear, from near Lake Baikal, collected by Mr. Mixter. Photograph by National Museum.

in obtaining good specimens of both. The bear skull shown in figure 6 is from his collection.

DR. W. L. ABBOTT'S OPERATIONS IN CASHMERE

Dr. W. L. Abbott, to whom reference has already been made, returned to Cashmere early in the spring of 1912, when he interested himself in trapping and studying the habits of the smaller mammals of that country. He sent to the National Museum many valuable specimens and much interesting information.

THE ZOÖLOGICAL EXPEDITION OF DR. THEODORE LYMAN TO THE ALTAI MOUNTAINS, SIBERIA AND MONGOLIA

By the invitation of Dr. Theodore Lyman, of Harvard University, the National Museum was enabled to participate, in coöperation with the Museum of Comparative Zoölogy, in a zoölogical expedition to the Altai Mountains of Siberia and Mongolia. As this region was unrepresented by specimens in the National Museum, the opportunity afforded was an exceptionally important one. The expedition was under the personal direction of Doctor Lyman who

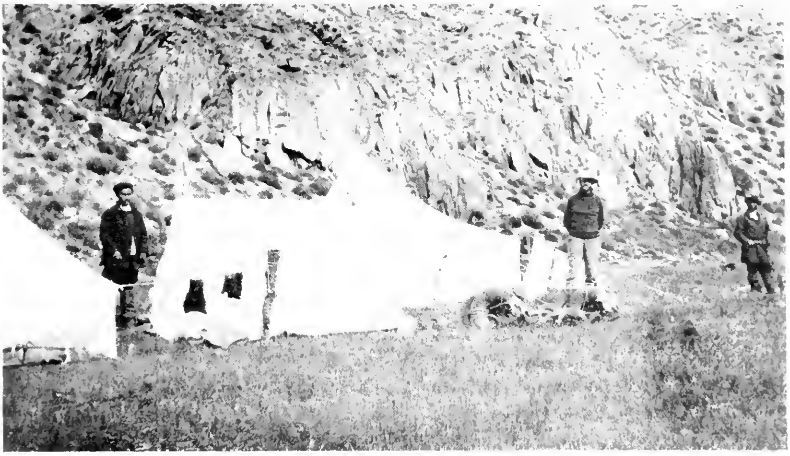

FIG. 7.—Collecting camp in the Altai Mountains near the Mongolian border. Photograph by Hollister.

devoted his time chiefly to the collecting of large game. The National Museum was represented by Mr. N. Hollister, assistant curator of mammals, who had as his assistant in the work of collecting the smaller vertebrates, Conrad Kain, of Vienna, Austria.

The party left America in May, 1912, and returned in September of the same year. It entered Asia by way of the Trans-Siberian Railroad. The railway was left at Novonikolaevsk, on the Obi River, and the long journey southward to the last Russian post near the Mongolian border was made by river boat and tarantass in 17 days. At this outpost, Kosh-Agatch, Kalmuk and Tartar guides and packers were secured, and the frontier range to the southward was then explored for a month. The collecting was done chiefly on the Siberian side of the range, but expeditions were made to the Mongolian slopes for great game, and down to the Suok

FIG. 8.—Kirghiz marmot-hunter; the white tail in his right hand is waved to hold the marmot's attention until the gun is in position for the shot. Photograph by Hollister.

FIG. 9.—The collecting party breaking camp on the Tchegan Burgazi River. Photograph by Hollister.

Plains, in the country of the Kirghiz. All this region is absolutely without trees or shrubs and, owing to its great altitude, is cold and stormy. A singular meteorological phenomenon in these mountains is the frequent occurrence of electrical hail storms. The severity of these storms and the display of electricity accompanying them is terrific. During the entire trip the party enjoyed only three days without rain or snow. The average altitude of camps here was from 8,500 to 9,000 feet, and above this plane the mountains rise to snow and glacier covered peaks of 12,000 feet or more. The country is wild, barren, and desolate; and the only inhabitants, the nomadic Kirghiz and Kalmuks, are engaged in following their herds of yaks, horses, and goats.

FIG. 10.—Skull of a wild sheep, collected on the Altai expedition by Doctor Lyman. Photograph by the National Museum.

On the return trip, stops were made on the Chuisaya Steppe and in the heavily forested Altais between the desert and the great Siberian plains. Three different physiographical regions are represented in the collections, which include an almost complete series of the mammals and birds of this little-known part of central Asia. Chief among the specimens of great game are four fine rams of *Ovis ammon*, the largest of all wild sheep. There are also specimens of two species of ibex and a gazelle. Thirteen forms of mammals collected are new to science, and some twenty others taken were not before represented in the collections of the National Museum. In all, about 650 mammals and birds were secured, and will be divided between the two institutions concerned.

A SEARCH IN EASTERN ASIA FOR THE RACE THAT PEOPLED AMERICA

During the summer of 1912, Dr. Aleš Hrdlička visited, partly under the auspices of the Smithsonian Institution and partly in the interest of the Panama-California Exposition of San Diego, certain portions of Siberia and Mongolia in search for possible remains of the race that peopled America, whose home, according to all indications, was in eastern Asia.

FIG. 11.—A family of Yenisei Ostiaks. Photograph from the Ethnographical and Anthropological Museum of Peter the Great, St. Petersburg.

The journey extended to certain regions in southern Siberia, both west and east of Lake Baikal, and to Mongolia as far as Urga. It furnished an opportunity for a rapid survey, from the anthropological standpoint, of the field, and was made in connection with a prolonged research into the problems of the origin of the American aborigines carried on by Dr. Hrdlička on both parts of the American continent.

The studies of American anthropologists and archeologists have for a long time been contributing to the opinion that the American native did not originate in America, but is the result, speaking geologically, of a fairly recent immigration into this country; that he is physically and otherwise most closely related to the yellow-brown peoples of eastern Asia and Polynesia; and that in all probability he represents, in the main at least, a gradual overflow in the past from northeastern Siberia.

If these views be correct, then it seems that there ought to exist to

FIG. 12.—A Giliak woman from Sachalin.
Photograph donated by Prof. J. Talko-Hryncewicz.

this day, in some parts of eastern Asia, archeological remains and possibly even actual survivals, of the physical stock from which the American aborigines resulted, and every later publication that dealt with archeological exploration in eastern Asia, or brought photographs of the natives, has in one way or another strengthened these expectations.

A visit was made to certain parts of southeastern Siberia and to northern Mongolia. It included Urga, the capital of outer Mongolia, which encloses two great monasteries, and is constantly visited by a large number of the natives from all parts of the country. Besides the field observations an examination was also made of the anthropological collections in the various Siberian museums within the area covered. The results were unexpectedly rich.

Dr. Hrdlička saw or was told of thousands upon thousands of burial mounds or "kourgans," dating from the present time back to the period when nothing but stone implements were used by man in

FIG. 13.—Oroczi, on the stream Koni, Eastern Siberia. Photograph donated by Prof. J. Talko-Hryncewicz.

those regions. And he saw and learned of numerous large caverns, particularly in the mountains bordering the Yenisei River, which yield human remains and offer excellent opportunities for investigation.

In regard to the living people, there were opportunities of seeing numerous Buriats, representatives of a number of tribes on the Yenisei and Abacan Rivers, many thousands of Mongolians, a number of Tibetans, and many Chinese, with a few Manchurians. On one occasion alone, that of an important religious ceremony, 7,000 natives could be seen assembled from all parts of Mongolia.

Among all these people there are visible many and unmistakable traces of admixture or persistence of what appears to have been the older population of these regions, pre-Mongolian and especially pre-Chinese, and those best representing these vestiges resemble to the point of identity the American Indian. These men, women, and children are brown in color, have black straight hair, dark brown eyes, and facial as well as bodily features which remind one most forcibly of the native Americans. Many of them, especially the women and children, if introduced among the Indians, and dressed to correspond, could by no means at the disposal of the anthropologist be distinguished apart. The similarities extend to the mental make-up of the people, and even to numerous habits and customs which new contacts and religions have not as yet been able to efface.

As a result of what he saw, Dr. Hrdlička expresses the belief that there exist to-day over large parts of eastern Siberia, and in Mongolia, Tibet, and other regions in that part of the world, numerous remains of an ancient population (related in origin perhaps with the latest paleolithic European), which was physically identical with and in all probability gave rise to the American Indian.

RESULTS OF MR. PAUL J. RAINEY'S EAST AFRICAN HUNTING EXPEDITION

Mr. Rainey's hunting trip was mentioned in the account of the Smithsonian expeditions of 1911.[1] He returned to America in December of that year, but Mr. Edmund Heller, who accompanied him as Smithsonian naturalist and collector, remained some time longer in British East Africa. The itinerary given last year was somewhat incorrect, as the original plan was changed after the party was organized.

The expedition arrived at Mombasa on March 22, 1911, and immediately proceeded by train over the Uganda Railway to Nairobi. The preparations for hunting and collecting were made there, and as soon as the safari was organized the expedition began active field operations. Proceeding southwestward from Nairobi, the safari passed over a high, rolling plateau to the Loita Plains, or Sotik District. Game was found here in great abundance. Many lions were living in the district, having been attracted by the great herds of antelopes and zebras. Six months were spent in hunting lions with dogs, and in making collections of the large and small mammals.

[1] Op. cit., p. 2.

Twenty-eight lions were secured during this time, and the expedition returned to Nairobi over the same route by which it had entered the district. After a short delay at Nairobi, the safari proceeded northward to the desert region on the Abyssinian frontier. Only the northern edge of this desert could be explored owing to the lack of camels for transportation, as all these animals had been recently acquired by the government for military purposes. The route from Nairobi lay directly northward to Fort Hall, thence along the west slope of Mount Kenia to Nyeri. From this station the party traveled along the north slope of the great mountain for a few days and then struck directly northward into the low, dry, thorn brush desert. This desert extends several hundred miles northward to the Abyssinian Highlands, but only the southern part of it was visited. It is a very dry, hot region, of limited water supply, and long journeys are often necessary between waterholes or springs. Hunting operations were confined chiefly to the immediate vicinity of some of these waterholes since a fairly large per cent of the game animals inhabiting the district require water and visit the springs daily for their supply. The fauna here is identical with that of Somaliland in character, and very different from that of the East African highlands. Specimens of nearly all the species of mammals of this country were secured, including a cow elephant with record tusks.

Mr. Heller explored faunally two of the high mountains in the desert region. The highest of these was Mount Garguez which has an altitude of 8,000 feet, and is isolated by many miles of desert from its nearest neighbors. Its summit is covered by a dense forest similar to that found on Mt. Kenia. Previous to this trip the mountain had never been visited by a naturalist, and several new races of mammals were secured in the forest on its summit. Mr. Heller also visited another isolated mountain, Tololakin, a mountain somewhat lower and not so thickly forested, which showed a less specialized mammal fauna. After completing the survey of these two mountains, he proceeded to the Guaso Nyiro River and followed its course westward to the station of Nyeri, whence his route lay over the high plateau of the Aberdare Range and then down to Naivasha Station.

Mr. Rainey, in the meantime, had trained a second pack of hounds and in two months bagged over forty lions, sixteen of which were obtained in one day.

Mr. Heller then proceeded down the Uganda Railroad to Voi, which is the chief station in the Taita District, where he spent two weeks exploring the Taita Hills. Many rare mammals were secured in the forests on the summits of these high ranges. After leaving the Taita Mountains he continued down the Uganda Railroad to the station of Maji-ya-chumvi in the Tarn Desert, a region very little known owing to its dryness and lack of game animals. Many small mammals were secured, most of which were new to the national collection. Another month was spent in the moist coast belt, which has quite a distinct fauna from the Tarn Desert or the highlands.

At the beginning of 1912 collections were made in the Kakumega Forest which lies on the northeast side of the Victoria Nyanza. It represents the easternmost extension of the Congo Forest, which pushes its way across Uganda and along the northern shore of the Victoria Nyanza to the Kakumega district. A great many Congo mammals were secured here, the most remarkable forms being the sloth-like tailless lemur, the Congo forest duiker, the Congo Colobus monkey, and several rare forest monkeys. Mammals and reptiles were found very abundant in the forest, and great numbers of specimens were preserved.

The zoölogical work done by the expedition added about a dozen genera and many species to the National Museum, and supplemented the work done by the Smithsonian African Expedition to an important degree. The described new species number about forty. Many new facts concerning the distribution of animals were secured by the exploration of new fields which was made possible by Mr. Rainey's liberality. In all, some 4,000 specimens of mammals were secured. Of these about 400 are large or may be counted as "big game." Birds were collected only in the unexplored territory, but the collection consists of some 400 specimens. The reptiles number more than 1,000, and the landshells are about equally numerous. Some 200 specimens of plants were also collected as accessory material in the study of the distribution of the fauna. The gathering of so large a collection was made possible through the large corps of native assistants which was furnished Mr. Heller by Mr. Rainey.

THE SMITHSONIAN EXPEDITION TO ALGERIA FOR THE STUDY OF THE HEAT OF THE SUN

Mr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory, was engaged for five months in an astronomical expedition to Bassour, Algeria, with the object of confirming or disproving the supposed variability of the sun. The Astrophysical Observatory has been for seven years making observations on Mt. Wilson, in

California, on the daily quantity of solar heat. The observations are arranged in such a manner as to indicate not only the quantity of solar heat reaching the earth, but also the quantity of heat which would reach a body with no atmosphere, like the moon.

So far the observations have indicated that the sun is probably a variable star having a range of variation amounting to from five to ten per cent within an irregular interval of from five to ten days.

FIG. 14.—Mr. Angström and the solar-constant apparatus at Bassour. Photograph by Abbot.

In 1911 Mr. Abbot, assisted by Prof. F. P. Brackett, observed in Algeria, while his colleague, Mr. Aldrich, observed on Mt. Wilson, in California. The object of thus duplicating the measurements was to avoid any errors due to local atmospheric conditions which might have affected Mt. Wilson observations. As nearly one-third of the circumference of the earth lies between Mt. Wilson and Bassour, it could not be expected that a similar local disturbance could affect both stations at the same time and in the same manner. The observations of 1911 strongly supported the belief that the sun is variable, but owing to cloudiness their number was not sufficient to fully establish this point. Hence, it was thought best to return to Algeria in 1912 for further data.

In this expedition Mr. Abbot was assisted in Algeria by Mr. Anders Knutson Angström, of Upsala, Sweden.

The observations made by the Smithsonian party in Algeria in 1912 were on the whole very satisfactory. They occupied 64 days, and on more than 50 of these days Mr. F. E. Fowle made similar

FIG. 15.—River scene at M'Sila, Algeria, an oasis of the Sahara. Photograph by Abbot.

observations on Mt. Wilson, in California. Much volcanic dust from the eruption of Mt. Katmai in Alaska, June 6 and 7, 1912, was diffused in the upper atmosphere, and greatly reduced the intensity of solar radiation observed at both stations. Many otherwise excellent days were spoiled by it. However, it did not prove fatal to the success of the expedition.

The results of the work of 1911 and 1912 thoroughly establish the supposed variability of the sun.

ANTHROPOLOGICAL RESEARCHES ON ST. LAWRENCE ISLAND, ALASKA

In the month of April, 1912, Dr. Riley D. Moore proceeded to St. Lawrence Island on behalf of the Panama-California Exposition

FIG. 16.—A portrait of "Korringoktikuk" (something gathered together) and child, showing the usual method of carrying children. Photograph by Moore.

of San Diego and the National Museum, the necessary funds being furnished by the former. The expedition work was planned by Dr. Aleš Hrdlička, curator of the Division of Physical Anthropology of

FIG. 17.—Summer home of Oghoolki. Walrus meat drying on the storage rack to the left. The bead in Oghoolki's hair is a sign of mourning. Photograph by Moore.

Fig. 18.—Three "strong men" of St. Lawrence Island, and the rocks they practice lifting. Photograph by Moore.

the National Museum, and the success of the undertaking was materially increased through courtesies extended by the Treasury Department and the Bureau of Education. Dr. Edward O. Campbell, a former teacher on St. Lawrence Island, also gave valuable advice regarding necessary supplies and equipment.

The journey from San Francisco to the island was made on the U. S. Revenue Cutter *Bear*. Iliuliuk, on the island of Unalaska, was the first stop, where the cutter remained for several days to clean boilers, thus permitting some measurements and observations of the natives. Later, visits were made to the Eskimo villages at Nome and St. Michael, and the graveyard near a deserted village on Golovin Bay was examined.

While lying at anchor in the Nome roadstead, word was received that two ships were caught in the ice off the Yukon Flats, and it was necessary to go at once to their relief. They were, however, out of the ice before the arrival of the *Bear*. While cruising about to learn the condition and extent of the ice, a radiogram brought the information that Kodiak was buried under four feet of volcanic ash and that the wireless telegraph station at Wood Island had been destroyed, and presently orders were received to proceed at once to Kodiak.

At a distance of two hundred miles from the scenes of disaster the *Bear* began to pass through large fields of volcanic ash, many acres in extent, which covered the ocean like a thick greyish-yellow cream. At Karluk, on the northwest coast of Kodiak Island, the deposit of ash was approximately a half inch in depth, but at the village of Kodiak, on the east shore of the island, there was a layer twelve to eighteen inches deep of very fine volcanic dust.

After remaining at Kodiak about three days the party returned to the Island of Unalaska where a stay of nearly a week made further researches possible. The vessel then proceeded to St. Lawrence Island, which was reached July 1, sixty-five days after taking ship at San Francisco.

This island is situated in the northern part of Bering Sea about forty miles from the Siberian coast which was plainly visible on the few clear days during the summer. The average summer temperature is about 40° Fahrenheit, and on the warmest day the past summer was 54°.

Work was started on July 6, and proceeded smoothly, though not always as rapidly as was desired, for nothing could induce these easy going Eskimos to hurry or to keep an appointment.

During the four months sojourn on St. Lawrence, considerable data of anthropometrical, physiological, and ethnological interest were obtained, besides plaster masks and photographs of men and women. Detailed accounts of religious, funeral, and other ceremonies, and a large collection of folk tales were also procured.

HUNTING AND TRAPPING ON THE ALASKAN-CANADIAN BOUNDARY

Mr. Copley Amory, Jr., of Cambridge, Massachusetts, a collaborator of the National Museum, accompanied the Coast Survey

FIG. 19.—Joe Creek, tributary of the Firth River. Photograph by Amory.

party which was engaged in surveying the Alaskan-Canadian boundary in the summer of 1912. He reached New Rampart House on July 11, and with a trapper and three dogs, packed over the mountains for 60 miles to the base of supplies on the Old Crow. He then went north to Joe Creek, a tributary of the Firth. After two weeks he returned to Old Crow and was joined by Mr. Thomas Riggs, Jr., with whom he travelled some 40 miles to the southwest in the caribou country, returning to the station on the Old Crow on August 23. There a canvas boat was built and a trip was made down to the mouth of the river, a distance of about 300 miles.

Mr. Amory obtained about 60 mammal skins, including a series of caribou, and also 30 bones of fossil mammals, among which was a camel-like ungulate.[1] He made observations on the distribution of

FIG. 20.—Leaving Rampart House, July 11, 1912. Photograph by Amory.

FIG. 21. Crossing the headwaters of the Firth River a few miles from the Arctic divide on the Alaska-Yukon boundary. Photograph by Amory.

various species, including caribou, beaver and other rodents, foxes, wolves, weasels, etc.

[1] This specimen, which proved to be a Pleistocene camel, is described by Mr. James W. Gidley in Smithsonian Misc. Coll., Vol. 60, No. 26, 1913.

GEOLOGICAL EXPLORATION IN THE CANADIAN ROCKIES

In continuance of his investigation of the Cambrian geology in the main range of the Rocky Mountains of Alberta and British Columbia, Canada, Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, visited the region of the Yellowhead Pass, through which two great transcontinental railway lines, the Grand Trunk Pacific, and the Canadian Northern, are now building toward the Pacific coast.

FIG. 22.—Kodak view of Phillips Mountain with the névé and ice of Chushina Glacier, which extends down the slopes a mile where it overhangs the drainage line from Snowbird Pass. Photograph by Walcott, 1912.

After outfitting at Fitzhugh, east of the Yellowhead Pass, on the line of the Grand Trunk Pacific, the party crossed over the Pass on the Continental Divide and turned north from the line of the railway at Moose River, 17 miles west of the Pass. The Moose River was followed up to its head in Moose Pass, and a camp made at the head of Calumet Creek, which is a tributary of the Smoky River. The farthest camp out was made at Robson Pass, between Berg and Adolphus Lakes. Side trips were made from two camps in Moose

River valley, the Moose Pass camp and the Robson Pass camp. Many fine photographs were secured, and a reconnoissance section made of the great block of Cambrian and Ordovician strata from which the mountains of this region have been formed by uplift and erosion.

The most beautiful scenery was met with in the vicinity of Robson Peak. From a point 1,800 feet above the Robson Pass camp, one of the most interesting and superb views is obtained (fig. 27). The

FIG. 23.—Kodak view of a storm gathering over the Robson massif. In the foreground Smoky River flowing out of Lake Adolphus. Above the latter Robson Pass and then Berg Lake. The three glaciers Hunga, Blue, and Chupo, are seen in profile on the left. Photograph by Walcott, 1912.

horses in the photograph are near the edge of a cliff overlooking and rising 1,700 feet above the lake. Robson Peak rises cliff on cliff from the lake 7,000 feet (2,136 meters) to the summit, where the vapors from the Pacific gather nearly every day of the year. On the western side the slope is 8,800 feet (2,679 meters) from the summit to the floor of the valley above Lake Kinney. On the east and southeast the upper 3,000 feet are very precipitous, but below the slope is more gentle, forming the névé of the great Hunga (chief) Glacier. One of the remarkable features of Robson Peak on the north is Blue Glacier. It is two miles in horizontal distance, and 7,000 feet in vertical fall between the snow cornices of Robson Peak and the foot of the glacier where the ice breaks off to float away as small bergs. Blue Glacier is a wonderful stream of falling, shearing, blue, green, and white ice. As seen in figure 24 the details of its marvelous descent are finely shown.

Iyatunga Mountain and Titkana Peak form the gateway to the great Hunga Glacier which is literally a river of ice. In figure

FIG. 24.—Kodak view of Blue Glacier, with Robson Peak concealed by mist. Photograph by Walcott, 1912.

27 three miles of its lower length is shown; the upper part is exhibited by figure 28, where the gathering fields of snow are seen on the slopes of Robson Peak and Mount Resplendent, and below the flow of the glacier over the cliffs where it merges into the broad river-like extension below.

The geological section was measured from Moose Pass (figure 30) southwestward over Tah Peak, Mount Mahto, Titkana Peak, and across by Phillips Mountain and the ridges of Lynx Mountain to Robson Peak.

Glacier covered with rock debris.

Mt. Gendarm (9,007 feet)

Shoto Mountains

Chapa Point

Figs. 25 and 26.—Panoramic view of Mural Glacier. In lower cliff to left above camp-fire, a new locality of Lower Cambrian fossils was found. Enter ... Photographs by Walcott, 1912.

Fig. 27.—Panoramic view of the Robson massif, from a point on the ridge south of Mumm Peak.

Fig. 28.—Panoramic view of the Robson massif and adjoining mountains; great Hunga Glacier in foreground. Taken from point nearly

FIG. 29. Panoramic view in continuation eastward of Fig. 28, showing almost the entire section of the Upper Cambrian rocks.

FIG. 30. Panoramic view of Moose Pass. The strata of mountains on the right of the Pass are of Lower Cambrian age, and those on the left of Upper Cambrian age. A fault line with a throw of about 9,000 feet has thrust the Lower Cambrian over the Upper Cambrian on the line of the Pass. Photographs by Walcott, 1912.

FIG. 31.—Surface of Hunga Glacier where the stream flowing over the ice parts so that the branch flowing to the left of the young man (Sidney S. Walcott) goes out to Berg Lake and thence to the Pacific, and that on the right to Lake Adolphus and the Arctic Ocean. At this point the Continental Divide is a hummock of ice upon which the man is standing. Photograph by Walcott, 1912.

FIG. 32.—An outdoor bed room in the Canadian Rockies. Photograph by Walcott, 1912.

The stratigraphic section was found to contain approximately 12,000 feet of Cambrian rocks and 3,000 feet of Ordovician, the transition between the two systems of rocks occurring in Billings Butte (figs. 28, 29), which projects upward beside Hunga Glacier. At the northern base of Mumm Peak (figs. 25, 26), above Mural Glacier a new sub-fauna of the Lower Cambrian was discovered, the fossils being beautifully preserved.

FIG. 33.—Harry H. Blagden and Sidney S. Walcott preparing ptarmigan skins for shipment to the Smithsonian Institution. Photograph by Walcott, 1912.

Dr. Walcott was accompanied by Mr. Harry H. Blagden, of the Smithsonian Expedition of 1911, and his son Sidney S. Walcott. The two young men secured a number of fine mammal skins, which have been added to the collections of the National Museum. The collections of the Museum were also enriched by a fine series of fossils from the Burgess Pass quarry, reference to which was made in the report on the expeditions of the Smithsonian Institution of 1910 and 1911 (Smithsonian Miscellaneous Collections, Vol. 59, No. 11, pages 39-43).

FIELD-WORK OF THE BUREAU OF AMERICAN ETHNOLOGY IN 1912

Ethnological Investigations of Dr. J. Walter Fewkes in the West Indies

One of the most important and interesting lines of research conducted by the Bureau of American Ethnology is that which has been under the immediate supervision of Dr. J. Walter Fewkes, for many years an ethnologist in the Bureau, who has conducted important investigations on the archeology of the West Indies.

The need of making a comprehensive study of the archeology of the West Indies in order to determine the position of the original inhabitants of those islands among the American aborigines was realized several years ago, and the investigation of this field was assigned to Doctor Fewkes who prepared several papers on the results of his work, including "Aborigines of Porto Rico and Neighboring Islands," published in the Twenty-fifth Annual Report of the Bureau. Subsequently Doctor Fewkes's attention was diverted to other fields, but last year Mr. George G. Heye made it possible to resume research in the West Indies, and in October Dr. Fewkes sailed for Trinidad, after spending some time in New York City for the purpose of studying the noteworthy collections of West Indian objects in the Heye museum. On his arrival in Trinidad, Doctor Fewkes made an examination of certain caves near Port of Spain, but found no indication of former troglodytes (cave dwellers). At Erin, a hamlet of French negroes, he found a large shell-heap, the contents of which indicated a high development of the aboriginal occupants, especially in the manufacture of pottery. This pottery has relief decorations, and is painted red, while one of several entire vessels is decorated with incised figures. Doctor Fewkes also recovered about a hundred animal heads of clay, some of which are well modeled, together with typical stone axes and other utilitarian objects.

As objects adequately illustrating the artistic ability of the prehistoric inhabitants of Trinidad are unknown in the museums of Europe or the United States, the collection of beautiful pottery made by Dr. Fewkes in the shell heaps at Erin, opens a new chapter in the history of West Indian culture and immigrations. While it is yet too early to interpret the bearing of these objects on our knowledge of the culture of the prehistoric people dwelling about the Caribbean Sea, it is evident that the prehistoric culture of this island is closely allied to that existing in ancient times on the neighboring coast of Venezuela and quite distinct from the so-called Carib of St. Vincent, Grenada and the more northern islands. The indications are that the people who made the shell heaps at Erin were not Caribs, but belonged to a stock allied to that of prehistoric Porto Rico of which there were several subdivisions in the West Indies.

Detailed reports of Doctor Fewkes's excavations have not been received in time for incorporation in this article, but to judge from the results obtained during the short period spent in Trinidad prior to the time his report was received, there is every prospect that the study will meet with great success, both from the point of view of subjective material and in collections obtained. At last account, Doctor Fewkes had departed for St. Vincent for the purpose of continuing his studies.

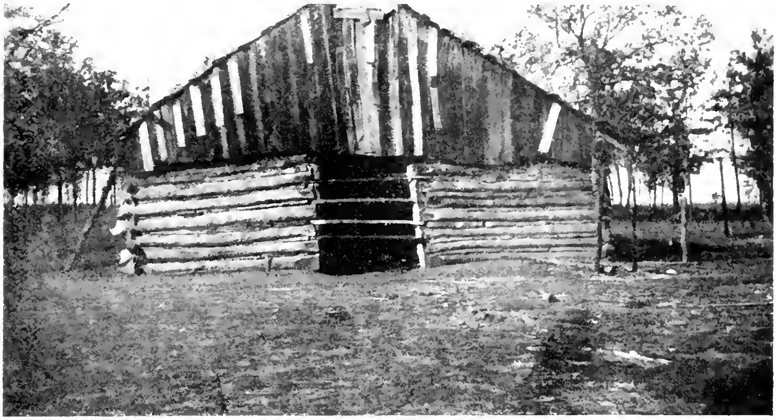

Fig. 34.—A Delaware meeting house, near Copan, Oklahoma in which the Annual Ceremony, the most sacred institution of the Delawares, is held. Photograph by Michelson.

Observations on the Fox Indians of Iowa, and Other Tribes, by Dr. Truman Michelson

In January, 1912, Dr. Michelson visited the Carlisle non-reservation Indian School to obtain information on several Algonquian languages, and in July went among the Fox Indians at Tama, Iowa, from whom a large body of mythological data was obtained. The notes made during this season and the preceding one cover some seven thousand pages. When completely translated, it will make available one of the most exhaustive collections of the mythology of any American Indian tribe. It is noteworthy that these tales differ stylistically from those gathered by the late Dr. William Jones, and this fact helps to bring out more clearly how necessary it is that all myths should be collected in the original Indian language. The tales collected are exceedingly important in showing the dissemination of myths.

Work was also continued on the social and ceremonial organization. Especially full notes were obtained on the Religion Dance.

FIG. 35.—A Fox woman and her husband. He is one-quarter Fox, one-quarter Potawatomi, and one-half Winnebago. Photograph by Michelson.

All the songs of one of the drums were recorded on a dictaphone, as were some of a second drum. Several photographs of a ball game, were obtained and it is probable that photographs of other ceremonies may be had later.

On leaving Tama, Dr. Michelson proceeded to the non-reservation Indian school at Lawrence, Kansas (Haskell Institute), for the purpose of obtaining notes on several Indian languages.

After a brief stay there, he went among the Munsee of Kansas, where some new information regarding the language was obtained. He then visited the Delaware Indians of Oklahoma, and was gratified to find that many of their ancient customs were preserved almost intact. Elaborate notes were taken of several dances, and observations on the social organization were made.

FIG. 36.—Fox Indians about to start the ball-game, Tama, Iowa. Photograph by Michelson.

On his return east, he stopped at Tama, Iowa, to obtain additional notes on the Fox Indians, as well as to arrange for the purchase of some of their sacred packs, in which work he was successful.

STUDIES OF THE TEWA INDIANS OF THE RIO GRANDE VALLEY BY MRS. M. C. STEVENSON

Mrs. M. C. Stevenson, who is making a comparative study of the Pueblo Indians, devoted much time in 1912 to investigations into the life of the Tewa people of the Rio Grande valley. She finds that these Indians hold tenaciously to their peculiar beliefs and rituals. Like the Zuñi, they believe in a supreme life-giving power, the symbol and initiator of life and life itself, pervading all space, and called by them "Wowayi." This superior power is the sky. The Tewa conception of this supreme power is similar to the Grecian conception of Athena, and identical with the Zuñi and Taos belief.

The Tewa have religious associations with every mountain peak surrounding them. The most sacred, except Sierra Blanca, is Tsi'komo, or "loose rock," which is a day's journey on foot from San Ildefonso Pueblo. There is a shrine on the summit of the mountain and a large tree trunk is planted and firmly supported by a mound of rock, as a token that Tsi'komo is the greatest of all mountains, except Sierra Blanca, and is the companion of this great peak in southern Colorado.

One of the most interesting ceremonies associated with the moun-

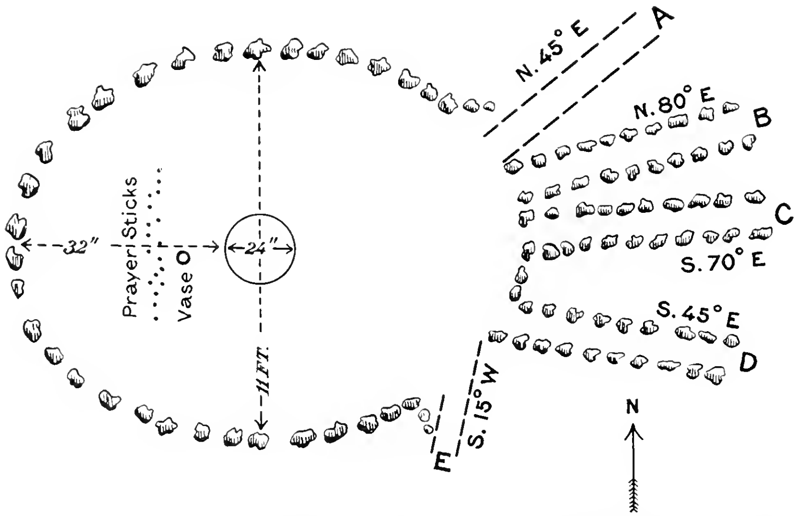

FIG. 37.—Shrine on Mt. Tsi'komo, showing circle of stones, lines of trails to pueblos, vase and prayer-sticks.

tain Tsi'komo is the voluntary initiation of the youth into the fraternities in the kiva, or ceremonial chamber.

Like the Taos, the Tewa are divided into Sun and Ice people. Each group has a kiva, and there is a third room for the accommodation of both parties.

After the initiates and priests have spent four days and nights in the kiva, they make a pilgrimage to the mountain Tsi'komo. Upon reaching a spring far up on the mountainside the party rests for refreshment, which consists only of wafer-like bread. After the repast, the rain priest with his associates, and the elder and younger bow priests, ascend to the shrine where the ceremonies are conducted. Space will not permit a detailed account of the ceremonies of this ancient ritual.

There is perhaps not a man among the Tewa who can boast of having taken a scalp, but the bow priesthood, or fraternity of warriors, survives, since this organization has important duties to perform aside from going to battle and taking scalps. One of these is to conduct the celebration of the feast of the harvest which occurs only when the people are blessed with bountiful crops, for the ceremony is a rejoicing over the harvest of plenty. The dance on this occasion is called the "throwing out." Gifts are thrown in great profusion by the dancers to the populace as evidence of the prosperity of the people.

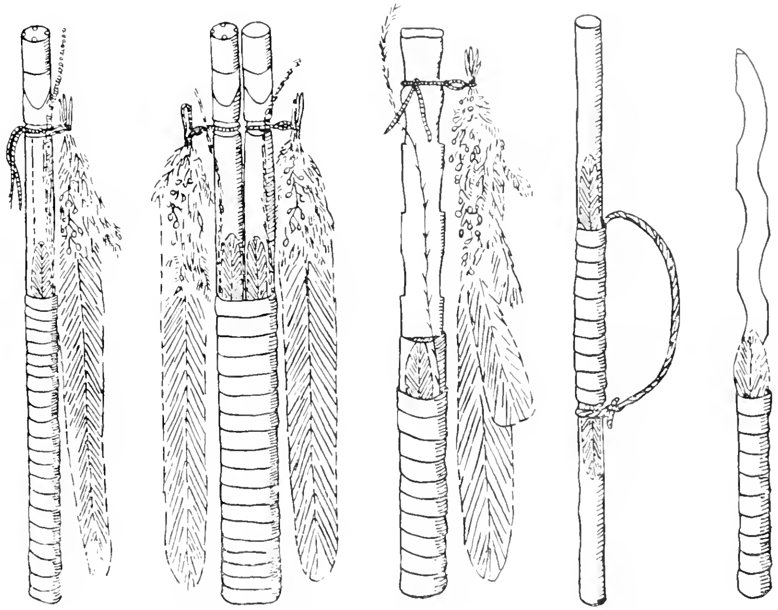

FIG. 38.—Prayer-sticks used in the shrine on Mt. Tsi'komo.

Another purely aboriginal dance of the Tewa is a dramatic representation of the huntsmen returning with game, and is called the buffalo dance. It includes extremely attractive impersonations of buffalo, deer, and antelope. The costumes are most elaborate. This feast usually occurs on the twenty-third of January, but occasionally it is omitted, as was the case in the present year

FIG. 39.—Harvest Dance of San Ildefonso. Photograph by Mrs. Stevenson.

FIG. 40.—Harvest Dance of San Ildefonso. Photograph by Mrs. Stevenson.

FIG. 41.—Buffalo Dance, showing Indians representing deer, antelopes, and buffaloes. Photograph by Mrs. Stevenson.

FIG. 42.—Indians executing the Buffalo Dance; San Ildefonso. Photograph by Mrs. Stevenson.

Fig. 43.—Eagle Dance. Photograph by Mrs. Stevenson.

Fig. 44. Eagle Dance. Photograph by Mrs. Stevenson.

The most graceful figures ever observed by Mrs. Stevenson among any people are those of the eagle dance. Two men impersonate eagles, and the songs are sung by a choir which follows the dancers. The first song refers to the spotted mesa, the second to the white elk, the third to the white eagle, and the fourth to the black eagle.

FIG. 45.—Eagle Dance.
Photograph by Mrs. Stevenson.

INVESTIGATIONS AMONG THE INDIANS OF OKLAHOMA AND TEXAS BY DR. JOHN R. SWANTON.

From January to May, and again in November and December, 1912, Dr. John R. Swanton was engaged in researches in Oklahoma and Texas. In March he visited a number of places in Texas in the hope of finding remnants of the numerous small Indian tribes that originally lived, or were temporarily located, in various parts of that State. Some information was obtained regarding the fate of the

Bidai Indians of Grimes and Montgomery counties. During the same trip a considerable body of ethnological information and a number of texts were added to what had been collected from the Alabama

FIG. 46.—Sweat house at Chiaha busk ground, Seminole Co., Oklahoma. Photograph by Swanton.

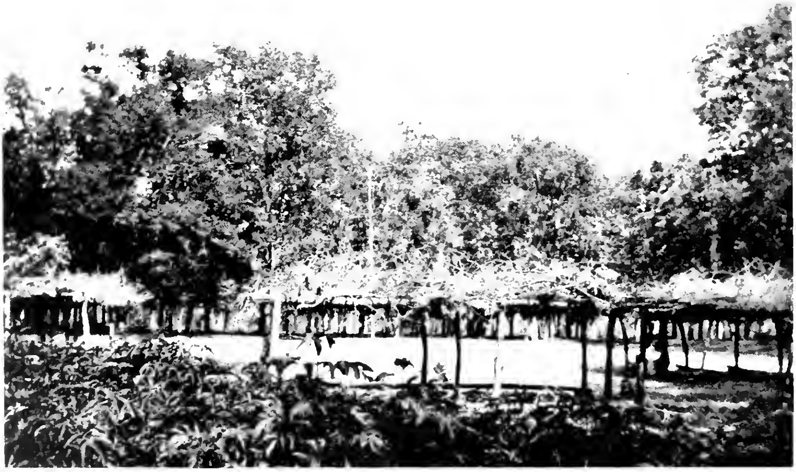

FIG. 47.—Pakan talahassi busk ground, near Hanna, Oklahoma. Photograph by Swanton.

Indians of Polk County, Texas, in 1910. In May he also visited one of the four surviving speakers of the Natchez language, near Braggs, Oklahoma, and added considerably to the material, ethnological and philological, collected there in 1908 and 1910. He now has about 260 manuscript pages of text, besides a large vocabulary of this rapidly dying language.

In the fall Dr. Swanton visited the Alabama Indians again, made further ethnological investigations, and recorded many pages of texts in the Alabama and Koasati languages, besides correcting some which had been previously taken down. A short trip was also made at this time to the Caddo Indians to determine the number of dialects still spoken among them. It was learned that the only two still in use are Nadako and Kadohadacho, which vary very little, although

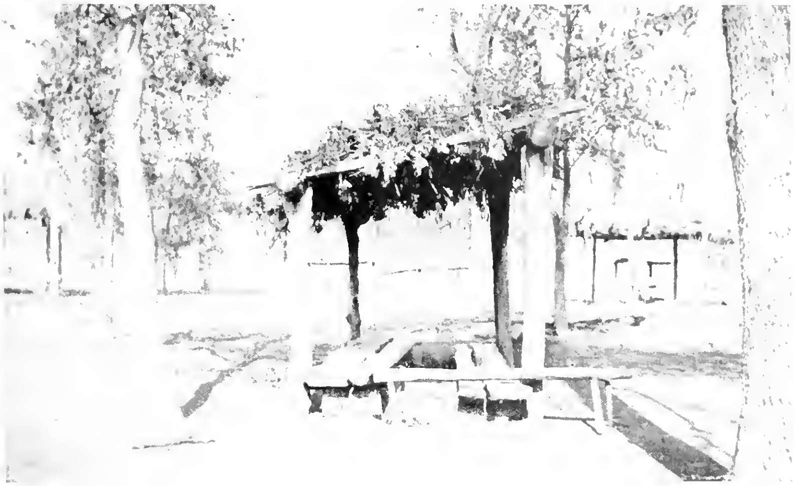

FIG. 48.—West cabin, Chiaha busk ground. Photograph by Swanton.

considerable is remembered of Natchitoches, and a number of Natchitoches words were recorded. In December he began recording texts in the Hitchiti language, formerly spoken over most of southern Georgia, but now represented by only 20 or 30 speakers among the Creeks and Seminoles of Oklahoma, besides a few Seminoles still in Florida. Among the Creek Indians proper, most of his time was devoted to an investigation of the ancient town and clan organizations, especially as those were represented in the annual "green corn dance" or "busk." Of the 40 or 50 towns originally constituting the Creek confederacy and observing this ceremony, 12 still carry it out in some form or other, but it is scarcely more than a shadow. Nevertheless, with the help of those old men who can remember the ceremonials as they existed before they were broken up by the internal troubles incident to our Civil War, it has been possible to add a great deal to our knowledge of the ancient Creek confederacy.

Studies Among the Osage Indians by Mr. Francis La Flesche

During the year 1912 Mr. Francis La Flesche continued his ethnological studies among the Osage Indians, and his search for articles illustrative of their past life, for preservation by the Smithsonian Institution.

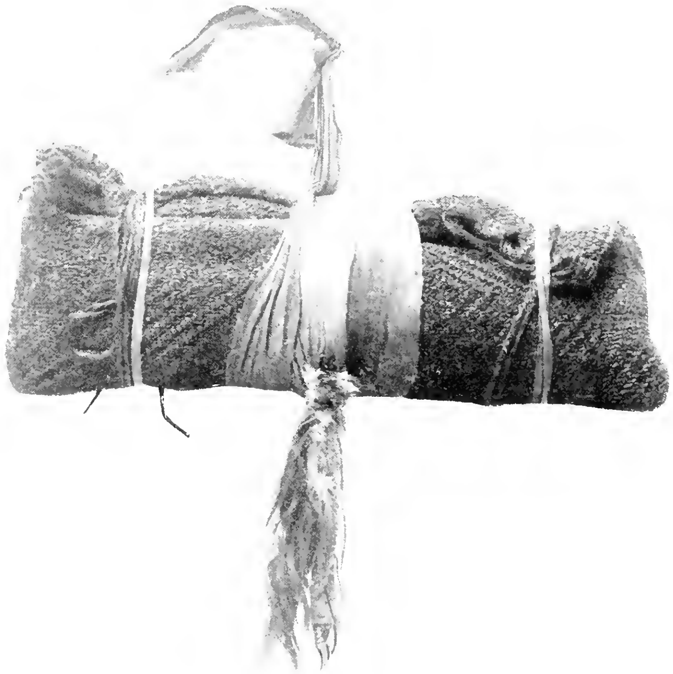

Fig. 49.—Sacred Osage pack. Photograph by Bureau of American Ethnology.

Before contact with the white race, the Osage Indians maintained a tribal organization, and the story of the means agreed upon for its conservation has been transmitted in rituals, songs, and ceremonies, and in certain articles consecrated for use in tribal rites. These rituals, songs, and dramatic acts had to be kept in their original sequence without variation, and a ceremony frequently requires from 18 to 20 hours of continuous effort on the part of the officiating priest.

Among the articles consecrated for use in the tribal rites are two that are regarded by the Osage Indians as the most sacred and significant in their meaning. These are the "burden strap of the woman," and the "sacred bird-hawk of the man."

The Osage tribe is composed of two great divisions, one of which occupies the north side of the tribal encampment, and the other the south side. The divisions are made up of sub-groups, each of which has its part of the general story contained in the tribal rites, and also its sacred article which is kept in ceremonially prepared cases, making a "bundle."

Mr. La Flesche was so fortunate during his stay among the Osage Indians in 1912, as to obtain for the Institution seven specimens of the sacred burden straps, some of which are very old and made of buffalo hide, having been handed down as heirlooms. He also obtained three of the sacred "bundles," one of which is of peculiar interest.

The transferring of this "bundle" to Mr. La Flesche was accompanied by a scene which gave evidence of the reverence with which these ancient and sacred objects are still regarded. Although, in this particular instance, the keeper of the "bundle" and his wife have abandoned the customs and religion of their forefathers and have accepted a new faith, yet the act of parting with this relic of the past awakened the memory of former beliefs in its power for good and ill. When about to give up the "bundle," the wife of its keeper took it outdoors and, standing in the early sunlight, lifted the ancient object to the sun, and while holding it aloft uttered a prayer for its safety, at the same time making an appeal that no harm should befall her household for her act in surrendering forever a sacred charge.

OBSERVATIONS ON BIRDS AND THEIR NESTS, IN NEWFOUNDLAND AND LABRADOR, BY MR. A. C. BENT

Mr. A. C. Bent spent the months of June, July, and August, 1912, in Newfoundland and Labrador, for the purpose of gathering further information and material for the work on the life histories of North American birds, of which the Smithsonian has issued two volumes. During the first month he travelled alone or with a guide, in Newfoundland. A week was occupied in visiting Dr. Leonard C. Sanford's camp on the west coast of the Fox Island River, where he collected a series of crossbills which proved to be a new sub-species.

Mr. Bent then explored the so-called mountains near Gafftopsail in central Newfoundland, a desolate, barren, rocky region, including the highest land on the island, the breeding ground of ptarmigan and greater yellowlegs. He also explored the Humber River, below Deer Lake, visited Grand Lake, collecting about the north end, and spent a week exploring the Sandy River region, including Little Deer Lake and Sandy Lake, which is heavily timbered and good bird country. A number of water birds, such as loons, glaucous and great black-backed gulls, mergansers, and golden-eyes were found

FIG. 50.—Okak, Labrador. Photograph by Bent.

breeding in this region, as well as various interesting forest-loving species of land birds. The remainder of the time, until July 3, was spent in collecting land birds about Bay of Islands.

The trip to Battle Harbor, Labrador, was made by steamer, where the rest of the party, consisting of Mr. Donald B. MacMillan and Mr. J. C. Small, was found waiting with a small power launch. A short run was made southward to St. Peter's Bay to visit some breeding colonies of eiders and other sea birds, after which the party started northward and explored the whole coast, somewhat hurriedly, of course, as far north as Cape Mugford, beyond Okak.

FIG. 51.—The Labrador coast. Photograph by Bent.

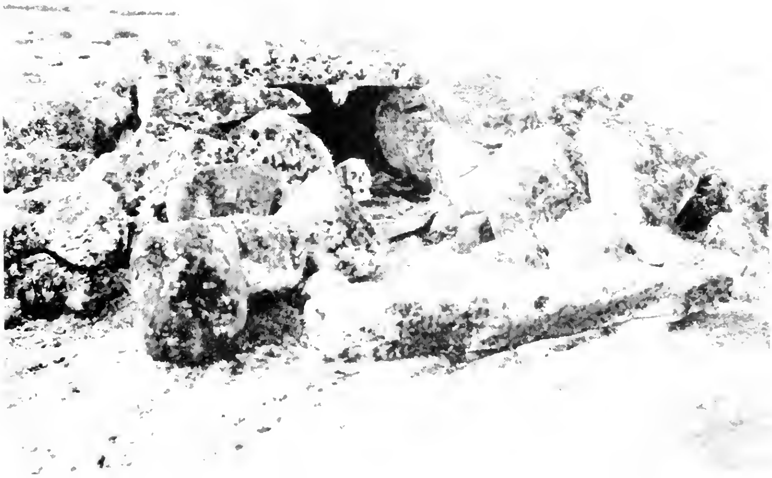

FIG. 52. Ancient Eskimo grave, Okak, Labrador. Photograph by Bent.

Some little time was spent near Hopedale, ten days on the way down and a week on the return trip. A trip was also made inland for a distance of thirty-five miles, and some of the outer islands were visited.

The sea birds on the Labrador coast have been sadly reduced in numbers by many years of constant persecution and persistent egging. The Alcidæ have nearly all disappeared, except the black guillemot,

FIG. 53.—Nests of Northern Eider, Labrador. Photograph by Bent.

which lays its eggs in inaccessible crevices in the rocks. Eiders are still locally common, but are rapidly disappearing; only one large breeding colony was found. Scoters are still abundant in large flocks about the heads of the bays.

Glaucous gulls still breed on the high rocky cliffs where their nests are inaccessible. Great black-backed gulls and herring gulls are still fairly common. Land birds are nowhere abundant, with the possible exception of the white-crowned sparrow, which is a common dooryard bird everywhere. Horned larks, pipits, juncos, Labrador jays, tree sparrows, and redpolls are fairly common.

A NEWLY-DISCOVERED CAVE DEPOSIT NEAR CUMBERLAND, MARYLAND

In October, 1912, Mr. J. W. Gidley, assistant curator of fossil mammals, in the National Museum, made a preliminary examination of some cave deposits containing bones of Pleistocene age near Cumberland, Maryland, which had previously been discovered and reported by Mr. Raymond Armbruster, a citizen of Cumberland.

Fig. 54.—South side of railroad cut, near Cumberland, Maryland, showing upturned ledge of Helderbergian (Devonian) limestone, partly covered with stalactitic material; bone-bearing deposits seen at base. Photograph by Gidley.

The results were very satisfactory considering the limited time available, upwards of a hundred specimens being secured representing about 24 species of mammals, most of them either extinct or now living only in localities very remote from the mountains of Western Maryland.

The fauna proves very interesting, and the "find" promises to be most important in that it will throw much additional light on our knowledge of the Pleistocene mammals of the eastern United States, or, in other words, those immediately preceding the existing ones. Among the objects of especial interest collected are a few fragmentary jaws representing a new species of dog as large as the largest living wolves, but with more the character of the fox, or jackal; and a series of upper cheek teeth representing a large extinct species of antelope very closely related to the eland now living only in Africa and the largest of all the antelopes.[1] The deposits were not exhausted and it is intended to continue the examination as further exploration will doubtless add new treasures to the list.

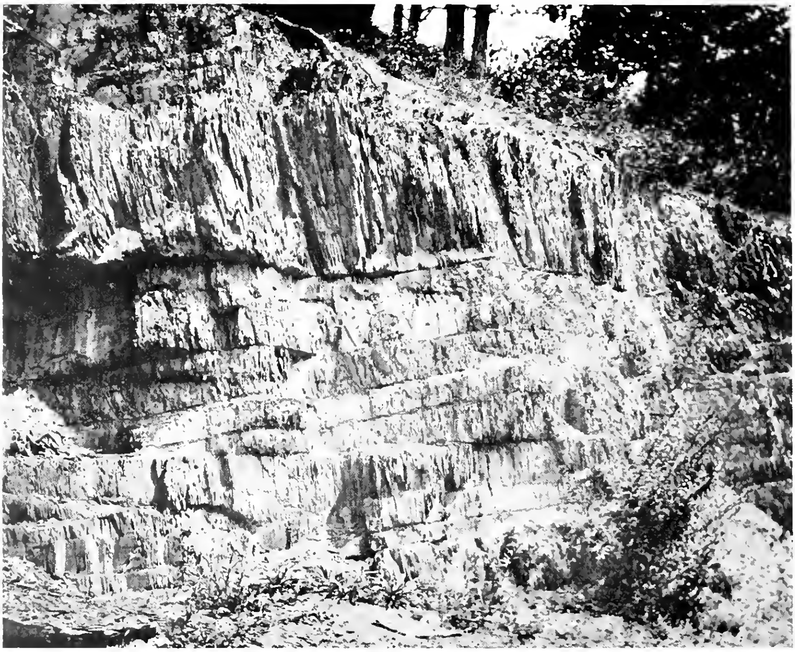

FIG. 55.—Upper Ordovician shales, showing bedding and cleavage, Western Maryland Railroad, west of Williamsport, Md. Photograph by Bassler.

MAPPING THE GEOLOGICAL STRATA AND COLLECTING FOSSILS IN THE VALLEY OF THE APPALACHIAN MOUNTAINS

During the summer of 1912, Dr. R. S. Bassler, curator of paleontology in the U. S. National Museum, spent eight weeks in the Appalachian Valley of Pennsylvania, Maryland, and Virginia, in mapping the rock-strata and collecting fossils. The principal object of this work, which was under the joint auspices of the Maryland

[1] Mr. Gidley's description of this extinct American Eland is to be found in Smithsonian Miscellaneous Collections, Vol. 60, No. 27, March 22, 1913.

Geological Survey and the U. S. National Museum, was to obtain material for volumes on the Cambrian and Ordovician strata of Maryland, to form a part of the series of memoirs published by that State.

This work was done in such detail that it was possible to map the Hagerstown and Williamsport quadrangles of western Maryland, embracing all of the Appalachian Valley in that State. The various formations making up the great Shenandoah limestone series were

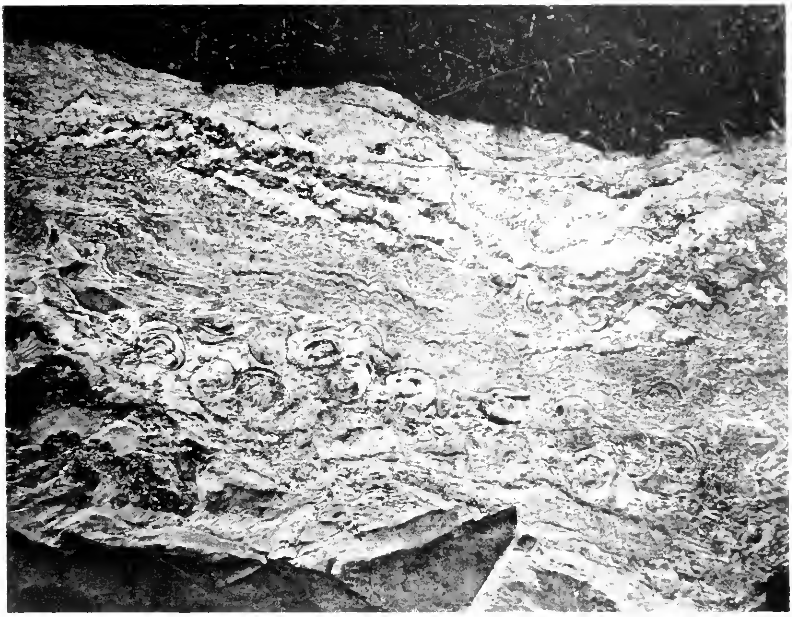

FIG. 56.—Fossil alga, *Cryptozoon*, exposed along the railroad near Antietam Station, Md. Photograph by Bassler.

first studied, with the result that eight distinct formations, aggregating 10,000 feet in thickness, were recognized and mapped. During the process of the mapping, large collections of both rocks and fossils, illustrating all the formations of the Shenandoah limestone, were obtained.

In addition, numerous photographs were taken, showing some of the more interesting features of the geology. Two of these are here reproduced. Figure 56 illustrates a reef of the hydrocoralline or calcareous alga, *Cryptozoon*, as shown on Antietam Battlefield. This reef may be noted wherever the base of the Upper Cambrian (Conococheague) limestone is exposed, and the rock crowded with rounded heads of *Cryptozoon* affords a unique building stone known as "bull's eye" marble. In figure 55 the cleaved condition of the Upper Ordovician slates illustrates the difficulty of securing well preserved fossils in such a formation, for, as shown here. the cleavage is at right angles to the bedding planes along which the fossils are to be found.

COLLECTING FOSSIL ECHINODERMS IN THE APPALACHIAN VALLEY AND IN MISSOURI

Important discoveries of fossil echinoderms, especially of those known as cystids and crinoids, were made during a long field season in 1912, under the direction of Mr. Frank Springer, associate in paleontology in the U. S. National Museum. Mr. Springer's private collector, Mr. Frederick Braun, started early in the season and made careful researches for crinoids in certain Ordovician formations of the Appalachian Valley which had hitherto received very little study. Localities in Virginia and Tennessee were thoroughly searched, resulting in the discovery of a number of new species and genera, especially of cystids. These are deposited in the National Museum and will form the subject of a monograph by Mr. Springer. Many of the other fossils of these formations were gathered at the same time and have been presented to the Museum by Mr. Springer.

Later in the summer Mr. Braun was detailed to examine certain Lower Devonian strata outcropping along the banks of the Mississippi just north of Cape Girardeau, Missouri, where crinoid stems had been previously noted associated with a peculiar bulb-like organism known as *Camarocrinus*. These bulbs had been considered as free floating organisms of an echinoderm nature, similar in habit to the recent jellyfish, and it was Mr. Springer's wish to ascertain if complete stalks of crinoids could not be discovered in connection with them. After a protracted search for miles along the bluffs facing the Mississippi River, Mr. Braun succeeded in locating the crinoid layer at an accessible point and carried on quarrying operations there for several weeks. The work resulted not only in the recovery of some of the most remarkable specimens of fossil crinoids ever obtained, but in settling finally the fact that *Camarocrinus* is only the bulbous root of the fine crinoid to which the name *Scyphocrinus* has been given in Europe. Four large slabs were obtained having an aggregate weight of 4,500 pounds. Two of these fit together so as to form a single slab 4 feet by 7 feet, and containing the most important specimens. The locality being several miles distant from any station or landing, it was necessary after crating

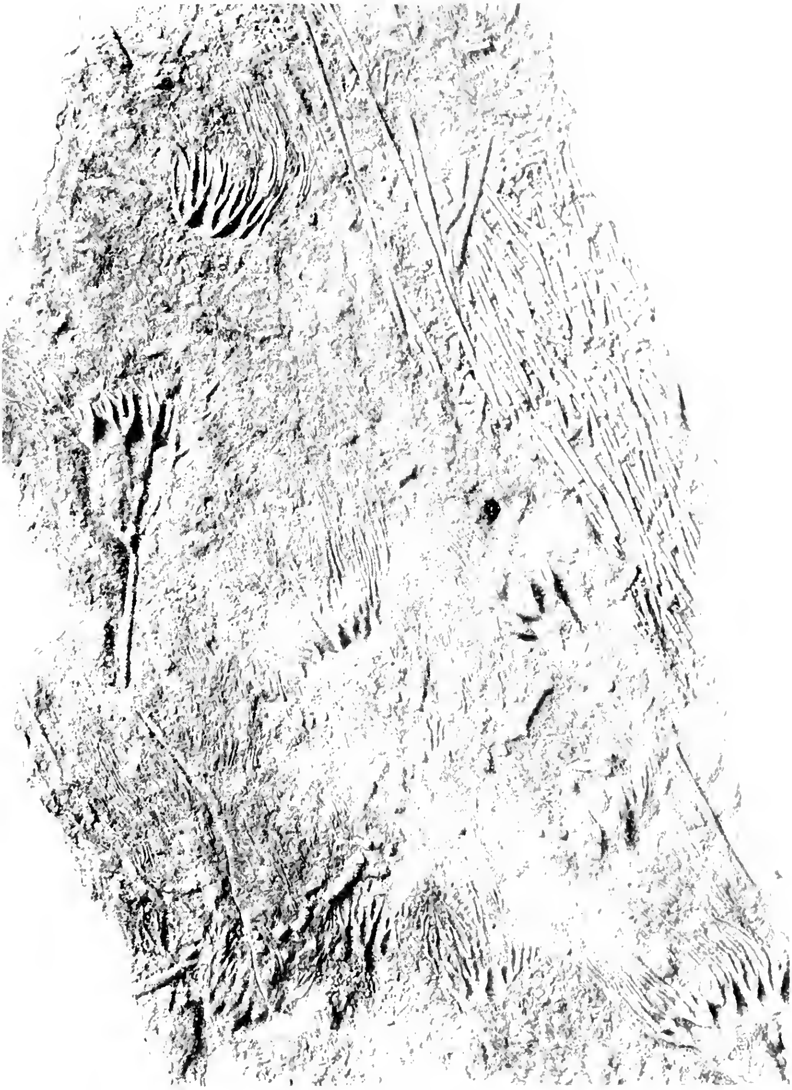

FIG. 57.—Slab filled with remains of the very large Crinoid *Scyphocrinus elegans*. Found near Cape Girardeau, Missouri. Photograph by Springer.

the slabs to construct a chute by which they were lowered to the river's level from a rock levee about 35 feet in height. This was done successfully and the slabs shipped safely to the National Museum, where they are now being prepared for exhibition in the hall of paleontology.

FIELD-STUDIES ALONG THE PATUXENT AND POTOMAC RIVERS, CHESAPEAKE BAY, AND THE NORTH CAROLINA COAST

Collections of fishes for the National Museum were made during 1912 in the Potomac River and its tributaries from Plummer's Island to Mattawoman Creek, in branches tributary to the Patuxent

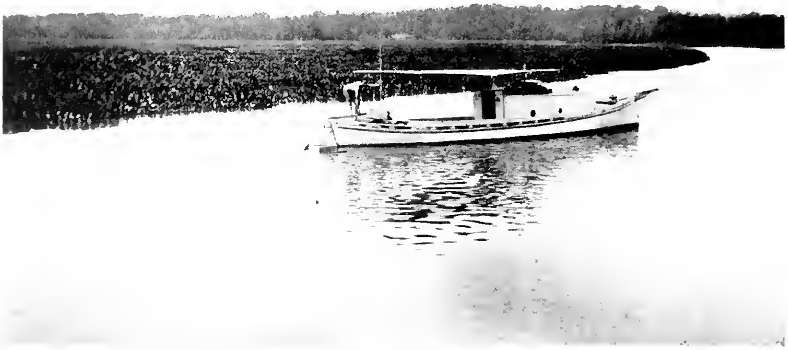

FIG. 58.—Power launch *Yorkspit*, and view across Mattawoman Creek, Maryland, one mile above Indian Head docks, a good collecting ground. Photograph by Bean and Weed.

River, and in Chesapeake Bay several miles south of Chesapeake Beach. They were made without expense to the Museum, for the most part by members of the Museum scientific staff while on leave of absence, and were mainly for addition to the exhibition series.

On a one day excursion to Mattawoman Creek, and nearby points on the Potomac, something like 450 specimens representing 26 species were collected. Included among these are specimens of black bass, white and yellow perch, darters, roach, shiners, silver sides, herring, young shad, mummychogs (bull or pike minnows), "spawn-eaters," "smelt" of the Potomac, common eels, catfish, little "mad toms," American sole or hog-choakers, sunfish, or "tobacco-boxes," and other varieties of sun-fish, namely, common, long-eared, and blue-spotted.

Several trips were made to Plum Point, on Chesapeake Bay, by Messrs. William Palmer and A. C. Weed, resulting in the collection

Fig. 59.—Mr. Wm. Palmer on the beach near Plum Point, Chesapeake Bay. Photograph by Weed.

of a number of interesting fishes common to the salt and brackish water of the region. Mr. Palmer also spent some time in digging for fossil cetaceans in the marl banks along the bay.

As in previous years, Mr. Ernest B. Marshall made very interesting collections in small streams tributary to the Patuxent, near Laurel, Md. Messrs. Bean and Weed participated in several of these trips. Through the generosity of Mr. J. B. Peyton, Jr., the collecting parties were conveyed to various points along the Potomac River in his power launch *Yorkspit*.

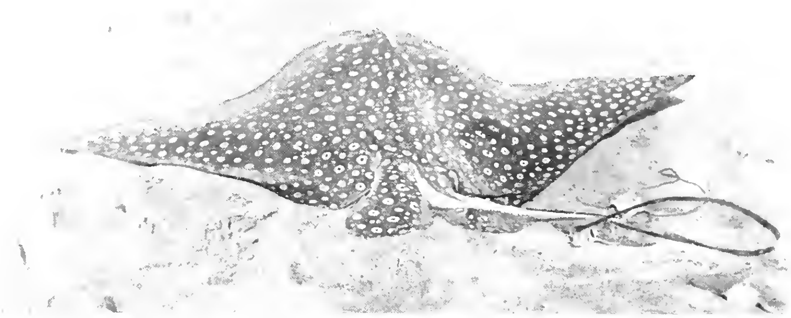

FIG. 60.—Dorsal view of a Spotted Sting-Ray, and young, taken at Bight of Cape Lookout, N. C. Photograph by Coles.

FIG. 61.—Ventral view of a Spotted Sting-Ray and young, taken at Bight of Cape Lookout by Russell J. Coles. Photograph by Coles.

Mr. Russell J. Coles, of Danville, Virginia, who made collections around Cape Lookout, North Carolina, sent to the Museum some very interesting fishes, and several photographs, among them an especially interesting picture of a large spotted ray and its young, (figs. 60, 61).

FIG. 62.—Parker Creek, about three miles south of Dare's wharf, Maryland, where specimens of fish were taken. Photograph by Weed.

FIG. 63.—Preparing to haul a seine along the shore of Mattawoman Creek, one mile above the docks at Indian Head, Maryland. Photograph by Weed.

FIG. 64.—Mr. Wm. Palmer digging for fossils on Chesapeake Bay. Photograph by Gronberger.

OBSERVATIONS ON MOLLUSKS AMONG THE BAHAMA ISLANDS AND THE FLORIDA KEYS

On the invitation of Dr. Alfred G. Mayer, director of the Department of Marine Biology of the Carnegie Institution, Dr. Paul Bartsch of the National Museum joined an expedition on the steamer *Anton Dohrn* to the Bahama Islands, the main object being a study of the marine mollusks of that region in their natural surroundings, with special reference to the boring and nestling organisms associated with corals.

Incidentally a trip was made by motor boat up the Miami River, and along the Everglade drainage canal; as well as several visits to the off-lying keys. Collections were made in all these places and careful notes bearing upon faunal associations were taken upon all the material gathered. The region about Miami is extremely well suited for observations of this kind, as it presents many different conditions in the narrow space between the main shore and the outer beach of the off-lying keys, each of which is occupied by a peculiar faunal assemblage.

On April 28, 1912, the party crossed the Gulf Stream and proceeded to Nassau, New Providence, where collections were made of living mollusks, and a fine series of the fossil mollusk, *Cerion agassizi* Dall, was obtained.

The party then went to Andros Island. Here the marine mollusks proved rather disappointing, there being but few species and these,

FIG. 65.—The laboratory, "White House," near Sharp Rock Point, Andros Island. Photograph by Bartsch.

as a rule, were few in number. The land shells were far more interesting, the genus *Cerion* in particular offering some most interesting problems.

Andros Island is a collective term applied to a whole host of minor keys that are separated by tortuous channels of varying width and depth. Practically every key examined, no matter how small, provided it bore vegetation, was found to be inhabited by Cerions of the *C. glans* group. The shells on each key present differences sufficient to enable one to distinguish them. For example, in size alone, 500 of those collected about Bastion Point filled a 3-pint measure, while the same number from the neighborhood of our temporary laboratory, the "White House," near Sharp Rock Point, required a 5-pint measure to contain them. There are also other characteristics besides differences in size.

On account of the many puzzling phenomena regarding their distribution, it was thought desirable to gather large series of specimens of *Cerion* and associated mollusks for careful study and experimentation.

Of *Cerion* alone about 40,000 specimens were collected from as many localities as possible. This was done with the idea of intro-

FIG. 66.—Two races of Bahama shells (*Cerion*) planted by Dr. Bartsch on keys between Miami and Tortugas, Florida. Photograph by National Museum.

ducing some of them into other islands, so that the effect of a change of environment could be studied later.

The party returned to Nassau on May 26, and then set sail for Miami, where it remained until the end of the month. During this time a fine series of that most beautiful of all North American land shells, *Liguus*, was secured, as well as a goodly number of other species. A number of dredge hauls were made north of Cape Florida, in shallow water, by the *Anton Dohrn* and a fine series of marine invertebrates secured.

On May 31 the expedition sailed south for Key West. On this cruise, and during the stay at Miami, the two races of Bahama Cerions were introduced at different points.

During the cruise from Miami to Key West, a special effort was made to examine as many of the keys as could be reached conven-

FIG. 67.—One of the commonest shells on the Bahama eroded rock beaches, *Tectarius muricatus L.* Photograph by Bartsch.

iently for *Cerion incanum* Binney, and, wherever found, to gather as large a series as possible. It was observed that most of the keys which had been flooded during the hurricanes of 1906 and 1910, contained practically no live Cerions, though dead ones were observed in a number of places, and this caused one to wonder whether sea-water might serve as a decided barrier to these forms.

Little is known about the life history of Cerions. They are remarkably variable, usually very restricted in their distribution, and very abundant where they occur. They are very tenacious of life, specimens having been kept in the U. S. National Museum for more than eight years; these occasionally leave the tray in which they are placed and seek a new resting-place. Cerions are also not particular about specific food, in fact they might be looked upon as "the goats" among the mollusca. They are furthermore not readily affected by changes in temperature. All these features indicate a remarkably desirable subject for investigation, and the hope is entertained that the various experiments to which they might be subjected will yield information enabling one to understand what is meant by the protean nature of this group.

During this cruise careful color notes on about 160 marine animals were made, which were found very desirable in retinting the specimens which are now being installed in the faunal marine invertebrate exhibit of the National Museum.

COMPLETION OF THE SMITHSONIAN BIOLOGICAL SURVEY OF THE PANAMA CANAL ZONE

In carrying on the biological survey of the Panama Canal Zone, inaugurated in 1910, the Smithsonian had the coöperation of several government bureaus, including the Bureau of Fisheries of the Department of Commerce and Labor; the Bureau of Entomology and the Biological Survey of the Department of Agriculture; the Isthmian Canal Commission, and the Panama Railroad Company, under the War Department, etc. The Field Museum of Natural History of Chicago also took part in the investigation of the fish faunas.

The field-party for 1912 included Mr. E. A. Goldman, of the Biological Survey, Mr. August Busck, of the Bureau of Entomology, and Dr. Charles D. Marsh, of the Bureau of Plant Industry, all of the Department of Agriculture; also Professor H. Pittier, of the same Department, who remained in the field during nearly the whole period of the survey. Dr. Seth E. Meek represented the Field Museum, and Mr. S. F. Hildebrand, the Bureau of Fisheries.

The first party sailed from New York on the *Panama* on January 9, 1912, and arrived at the Canal Zone January 15, whence the different members departed for their respective collecting grounds.

Arriving at Empire in the middle of January, Mr. E. A. Goldman immediately began collecting mammals, and on February 21 went to Real de Santa Maria in Eastern Panama, where he endeavored to determine the faunal relations of this region with the Canal Zone

FIG. 68.—Cana, eastern Panama, headquarters of the Darien Gold Mining Co. Used as the base of field operations in the Pirri mountains. Photograph by Goldman.

and the areas lying to the westward and northward. His efforts were centered around the Pirri Mountains, one of the highest ranges in eastern Panama, rising to a height of over 5,000 feet, and located near the Colombian boundary, southeast of San Miguel Bay. In this work he was most successful. The region is covered with a dense unbroken forest and has a heavy annual rainfall, although at the lower levels it is usually dry from January to April, except for the almost constant fog. The collections secured by Mr. Goldman, which are deposited in the National Museum, include some 800 birds

FIG. 69.—Forest at 5,200 feet elevation, Pirri Mountains, eastern Panama; composed largely of palms and including many tree ferns. Photograph by Goldman.

and about 600 mammals. From the studies thus far made upon them, they appear to strengthen the view that the fauna of eastern Panama is South American in its general characteristics. Among them are many new forms, some of which have been described by Messrs. Goldman and Nelson in the Smithsonian Miscellaneous Collections.

Mr. Goldman returned to his headquarters at Empire, from Darien, in order to ship specimens, but again entered this region to complete his work in the lower elevations and remained there until early in July. During the time spent at Darien, Mr. Goldman states that his efforts were greatly facilitated and his expenses much reduced, through the aid rendered him by the Darien Gold Mining Company.

FIG. 70.—A part of the Pirri Mountains, eastern Panama, as seen from 1,800 feet altitude, in Cana Valley. Photograph by Goldman.

Dr. Seth E. Meek, of the Field Museum of Natural History, and Mr. S. F. Hildebrand, of the Bureau of Fisheries, who again participated in the work of collecting and studying the fishes of the Zone, arrived at Cristobal on January 15, 1912, and commenced work almost immediately. During the previous expedition, the collecting was confined mainly to the fresh and brackish waters of the Canal Zone and the immediate vicinity, but on this trip most attention was devoted to the salt-water fauna. On the Pacific Coast this was carried on from three points—Panama, Balboa, and Chamé Point, and on the Atlantic coast from four different points—Cristobal, Colon, Toro Point, and Porto Bello. Large collections were secured from both coasts.

Besides the salt-water collecting, the work was extended to the fresh waters on the Pacific slope a short distance to the east and west of the Canal Zone, in order to obtain a better understanding of the distribution of the fresh-water fishes of the Pacific coast streams than was obtainable from the small streams opposite the

Fig. 71.—Steamer *Cana* of the Darien Gold Mining Co., on which a trip was made from Panama City to Marraganti on the Rio Tuyra, eastern Panama. Photograph by Goldman.

Rio Chagres, and especially from the Rio Grande, because of the changes in this stream due to the work on the Canal.

The party continued operations for about three months, and much help was given by the Isthmian Canal Commission, the Panama Railroad and Steamship Company, and the Darien Gold Mining Company, to all of which organizations many thanks are due.

Upon his arrival in Panama on February 9, 1912, Mr. August Busck, of the Bureau of Entomology, was at once enabled to establish headquarters in the convenient comfortable dispensary in

Paraiso, through the courtesy of the Canal Commission. Here he made arrangements for visiting the islands of Taboga and Taboguilla

FIG. 72.—Waterfall from a small side-stream on the Rio Grande, near Cana, Darien, Panama. Photograph by Hildebrand.

FIG. 73.—Hydrographic Gauging Station, above Alhajuela, Panama. Photograph by Busck.

where certain conditions regarding mosquitoes, observed in 1911, suggested closer investigation.

Mr. Busck first spent a week on Taboguilla Island, which was at that time uninhabited, and was supplied with provisions by a daily boat from Taboga. It being in the height of the dry season, he established his camp with a mosquito-netted cot, acetylene lamps, and collecting sheets, halfway up the hillside, with no cover other

Fig. 74.—Cocoanut Palms, Paraiso, Panama; one normal, the other denuded by caterpillars. Photograph by Busck.

than a large mango tree. He then spent a week on Taboga Island, and early in March went up the Chagres River, making his headquarters in the gauging station at Alhajuela, and from that point explored the surrounding country, mainly along the tributaries of the Chagres and Chilibri Rivers, and especially the extensive limestone-cave region, which he had visited in 1911. On this trip he camped on the banks of the Chilibrillo River under the open sky, and investigated the caves more thoroughly than had been possible previously. It was found that there is an upper series of dry caves and a lower series containing water. In the rainy season these latter become inaccessible subterranean rivers, and it was in them that the interesting bat-fauna was found, which Mr. G. S. Miller, Jr. has described in the Proceedings of the U. S. National Museum.

The last part of March was spent on the upper Trinidad River where exceedingly rich entomological results were obtained, partly through the night work with the acetylene lamps. Early in April Mr. Busck went to Porto Bello on the Atlantic side. From that

FIG. 75.—Porto Bello Bay, showing excavation in the mountain, where the rock used for the Gatun Dam was secured. Photograph by Busck.

place he made several trips with good results, but on one of these, up the coast to the Santa Rosa River, he unfortunately became ill and was forced to go to a hospital. Having recovered, he proceeded a week later to La Chorrera where the rainy season was at its height and the collecting proved excellent. He established himself there for two weeks, collecting beyond the savannah area in the foothills near the origin of the Trinidad River. The acetylene lamps and the white trap-sheets proved valuable adjuncts to the outfit, and much material was secured by collecting at night.

The last part of May was occupied with minor excursions in or near the Canal Zone; among these a short trip up the Chagres River. On June 1, he undertook a second trip up the Trinidad River, and found conditions quite different from what they were before, owing

FIG. 76.—Dry-season camp on Taboguilla Island, showing white sheets and acetylene lamp for night-collecting. Photograph by Busck.

FIG. 77.—Palms "up to their knees" in water; Trinidad River valley, Panama, now part of Gatun Lake. Photograph by Busck.

to the damming of the Gatun Lake. The old trails through the swamp and forest were flooded knee-deep, and the water rose half a foot a day during his stay. This handicapped the collector's work considerably, as all the operations had to be carried on from a dugout canoe. The remaining hilltops, however, proved all the richer in insect life, as well as in other animal life. The augmentation of the

FIG. 78.—Tied up for the night, on the upper Chagres River. Photograph by Hildebrand.

mosquito fauna proved as interesting as it did annoying to the collector.

About the middle of June, Mr. Busck returned from this locality, which in another few months would become totally submerged, departed for New York, and arrived in Washington June 24.

Dr. C. D. Marsh, of the Bureau of Plant Industry, accompanied the survey party to the Canal Zone to make typical collections of the plankton organisms in the fresh waters of the Atlantic and Pacific slopes of the Isthmus. He arrived at Cristobal on January 15, 1912, established his headquarters at Empire, and remained in the field until February 16.

The topography of the Zone is such that it is not a particularly good collecting ground for plankton. The region visited is practically destitute of lakes, there are but few permanent pools, and although the lowlands of the Atlantic slopes form a huge swamp, the waters in this locality are so connected that no great variety of forms is found. The south slope is abrupt, with no permanent bodies of water, and the streams are small and more or less temporary.

FIG. 79.—Rio Grande Reservoir, Canal Zone, showing workmen clearing the shores to prevent decaying vegetation from falling into the water. This is an old reservoir dating from the time of the French occupation. Photograph by Marsh.

Especial attention was paid to the old reservoirs which form little lakes, and ordinarily would contain some of the typical flora and fauna of the immediate region, but these bodies of water are "plankton poor," as compared with similar bodies in a temperate climate; for, inasmuch as the temperature of the air is practically uniform throughout the year, there is no vertical circulation of the water, except where it is shallow enough to be affected by the winds. The conditions at the bottom of the deeper waters of the reservoirs are such as to make life impossible. Careful collections were made from all these reservoirs and the streams supplying them, from the embryonic Gatun Lake, its adjacent swamps, and from the waters

FIG. 80.—Rocky Island in Panama Bay, showing Frigate birds. Plankton collections were made near this spot. Photograph by Marsh.

FIG. 81.—Collecting Entomostraca in Black Swamp, Canal Zone. This locality will be covered by Gatun Lake. Photograph by Marsh.

of the Chagres and Trinidad Rivers, as well as from the streams and pools of the southern slope, and in the harbors of Colon and

Panama. Owing to the short time available for this work, very little collecting was done outside the Zone. While these collections have been examined only in a preliminary way, enough has been done to make it evident that there are some distinct differences in the faunas of the two sides of the Isthmus.

Professor Henry Pittier, of the Department of Agriculture, who has had charge of the general botanical collecting for the survey since its inception in 1910, remained in the field to continue his work, especially the collecting of ferns and lower cryptogams, from May, 1912, throughout that year. An anticipated trip to the Darien country was postponed on account of an accident to the only steamer plying between Panama and the ports of Darien, which forced Professor Pittier to remain in Culebra until January 23, 1912. A little later he secured passage to Darien where he explored the Cugra River and the Sambu Valley near Garachine Point.

Following the completion of his trips in south Darien and to Chiriqui, he went to Venezuela, whence he will return to the United States about April, 1913.

BOTANICAL OBSERVATIONS BY DR. J. N. ROSE IN EUROPE AND IN KANSAS

Dr. J. N. Rose, Associate in Botany, U. S. National Museum, at present detailed to the Carnegie Institution for the purpose of making an exhaustive study of the Cactaceæ of America, spent several months visiting the botanical gardens and institutions of Europe, and making preliminary arrangements for various exchanges. Among the places visited were the Kew Gardens, the Jardin des Plantes at Paris, the Conservatory and Botanical Garden at Geneva, the Royal Botanical Gardens at Munich and Berlin, and the Hanbury Botanic Garden in northern Italy. This last is a private garden belonging to Lady Katherine Hanbury and known as the *Hortus Mortolensis.* It lies on the shore of the Mediterranean in the little Italian village of La Mortola, about half way between the towns of Ventimiglia, Italy, and Mentone, France, in the most beautiful part of the Riviera, and during the winter and spring is the main feature of interest in all that region. Its area comprises 112 acres. The most broken and rugged parts are allowed to grow wild; some of the hills being covered by groves of native pines which suggest the hemlocks in the New York Botanical Garden. The other parts of the grounds have been beautifully terraced with convenient walks and stone steps, from which can be seen, through vistas here and

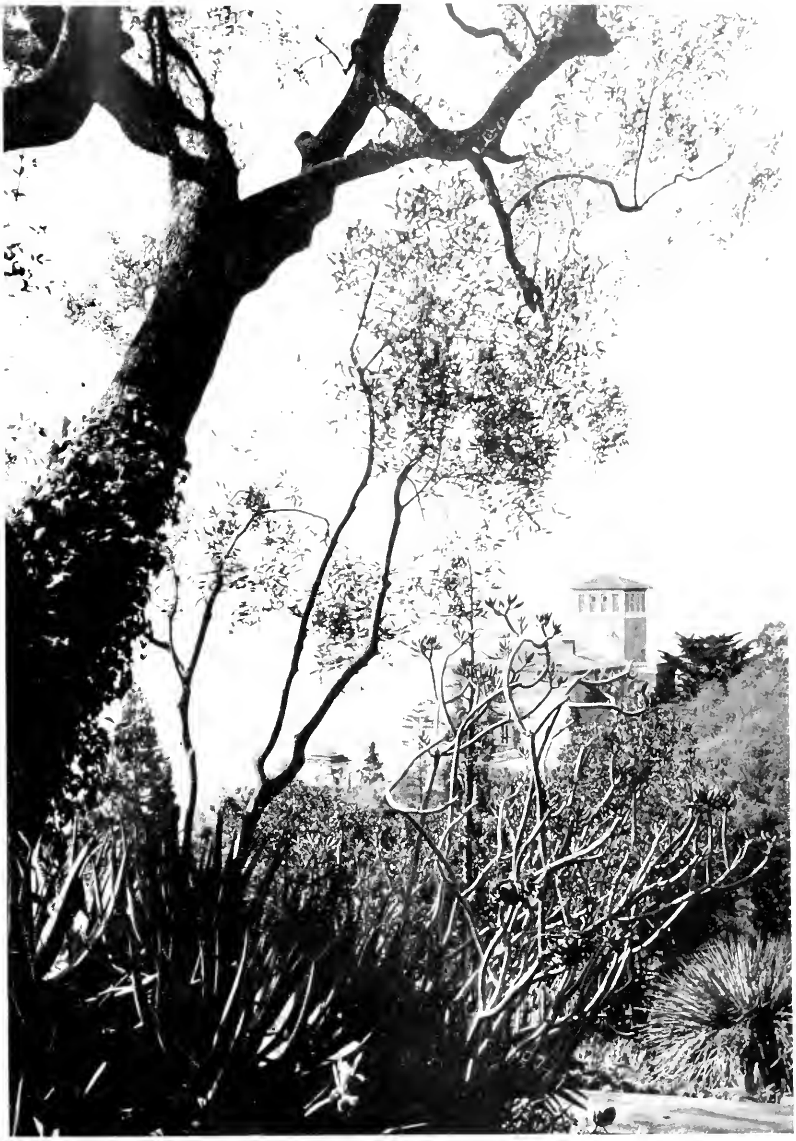

FIG. 82.—View of the Hanbury Botanic Garden from the northeast, showing olive tree and aloe plant on the left. Photograph by Nenke and Ostermaier, Dresden.

there, the Mediterranean and the nearby hills and mountains. The garden is more than simply a pleasure ground. It has been developed by Mr. Alwin Berger so as to be of great scientific value. The amount of material sent out for exchange purposes, both in the way of seeds and living plants, is enormous. A collection of succulent plants which has no counterpart in the world, and is well suited to the dry, hot summers of this region, has been assembled, and this place is fast becoming the Mecca for the study of such plants. No student of desert plants of America or South Africa can afford to omit this garden from his itinerary when visiting Europe. In connection with the garden there is a small museum building, a library, and an herbarium.

In September, Dr. Rose in company with William R. Fitch, made a botanical excursion through the western part of Kansas, collecting cactaceæ and other flowering plants. Although the region is extremely arid, a very fair collection was made. A full set of this material, as also from the collection made by Dr. Rose in Europe, has been deposited in the U. S. National Herbarium.