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CONTENTS

No. 1, May, 1937

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No. 2, June, 1937

[Issued August 28, 1937.]

No. 3, July, 1937

[Issued September 14, 1937.]

THE PHILIPPINE JOURNAL OF SCIENCE

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ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA), IV[1]

By RYOICHI TAKAHASHI

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THREE TEXT FIGURES

LACHNUS TATAKÆNSIS sp. nov.

Wingless viviparous female.—Brownish black, not darker around the bases of dorsal setæ, with many rather large black circular spots in transverse rows on the dorsum of abdomen (about six spots in a row on each segment). Antennæ black, paler on the basal part of third segment. Cornicles, cauda, and dorsal setæ black. Femora reddish brown except on the distal black part; tibiæ black, with a reddish brown part near the base. In specimens treated with caustic potash, head, thorax, and median area of basal abdominal segment dark brown on the dorsum, many small irregular brown patches present near the hind end.

Body wide, convex, covered with numerous simple setæ, which are a little or not curved and much shorter than the second antennal segment. Head divided, with many curved setæ on the front, which is nearly straight. Eyes with distinct ocular tubercles. Antennæ not imbricated, with many simple setæ, which are stiff or a little curved, pointed, and as long as, or shorter than, the diameter of the third segment; the third segment constricted at the base, as long as the distal three

[1] This work was made possible by financial aid from the Japan Society for Promoting Scientific Research. Part III was published in the Philippine Journal of Science 56 (1935) 499–507.

8049

segments taken together, with none to eight small circular sensoria in a row or scattered on the distal part; the fourth with five to eight similar sensoria not in a single row; the fifth with none to four similar sensoria besides a large circular primary one; distal part of the sixth about twice as long as wide; the relative lengths of segments about as follows: III—66, IV—22, V—23, VI—13+7. Rostrum reaching a little beyond the hind coxæ, pointed. Dorsum faintly reticulate, lacking tubercles, with numerous very small granules in rows on the black parts. Cornicles large, on hairy cones; the cones black in specimens treated with caustic potash, with very small granules in transverse rows; hairs on cones slightly longer than those on the abdomen. Cauda short, very broadly rounded. Legs with many simple long setæ, which are stiff or slightly curved; tibiæ much stouter than the third antennal segment, with setæ which are much shorter than the diameter of tibiæ. Body, about 5.5–5.7 millimeters; antenna, 2.2; width of third antennal segment at middle, 0.74–0.78; seta on antenna, 0.07; diameter of apex of cornicle, 0.16–0.18, at base of cone, 0.55–0.59; length of hind tibia, 4.5; width, 0.125; length of hind tarsus, 0.47; dorsal seta on abdomen, 0.09; diameter of larger dorsal spot on abdomen, 0.23–0.27; width of cauda, 0.46.

Host.—*Salix* sp., attacking the stem and branch.

Habitat.—Tataka (altitude 9,000 feet) near Mount Niitaka, (Mount Morrison).

Many specimens were collected by me July 25, 1936. Allied to *Lachnus saligna* Gmelin, from which it differs in the absence of dorsal tubercles, in the larger body with larger dorsal spots, and in other characters.

In Formosa *Lachnus saligna* Gmelin is found in the lowlands and the lower mountainous regions (below 3,500 feet); it does not occur at very high altitudes.

CINARA JUNIPERI De Geer.

Panimerus juniperi THEOBALD, Plant Lice Gr. Britain 3 (1929) 149.

Wingless viviparous female.—Brown, darker on the head and pronotum, with a pair of large dark spots on the meso- and metanotum and also on the basal abdominal segment; and a few small dark spots on the abdomen, especially on the posterior part, most of them at the bases of setæ. Antennæ pale, dark at the apices of the third and fourth segments and on the distal halves of the fifth and sixth. Legs paler at the bases of femora, brown or yellowish brown in specimens treated with caustic potash.

Body with many very long setæ, which are curved and nearly as long as the basal two antennal segments taken together. Head divided. Ocular tubercles very short. Antennæ not imbricated, with many setæ as long as those on the body; the third segment a little constricted basally, without sensoria; the fourth with one or two circular sensoria on the distal part; the fifth with a similar sensorium near a large primary one; the sixth with about six small sensoria in a loose group below a primary sensorium, the distal part slender, about thrice as long as wide, a little tapering, with some short stiff setæ; the relative lengths of segments about as follows: III—80, IV—40, V—48, VI—41+14. Rostrum acutely pointed apically, reaching beyond the hind coxæ, the penultimate segment widest. Cones of the cornicles with many fine setæ and much fewer, but much longer and stouter, setæ mixed; the longer setæ a little smaller than those on the body. Cauda with six very long bristles and some much smaller bristles. Legs covered with many setæ, which are as long as those on the body; tibiæ much stouter than the third antennal segment; tarsi not striate, hind tarsi slightly shorter than the third antennal segment, the distal segment about 3.8 times as long as the basal. Length of body, 2.9 millimeters; antenna, 1.2; width of third antennal segment at middle, 0.046; diameter of cornicle at apex, 0.1; at base of cone 0.3–0.4; width of cauda, 0.277; length of hind tibia, 1.7; width at middle 0.08; length of hind tarsus, 0.34; dorsal seta, 0.185.

Host—*Juniperus squamata* Lambert.

Habitat.—Kanko (altitude 8,300 feet) near Mount Niitaka (Mount Morrison).

Some specimens were taken by me August 23, 1936. New to the fauna of Formosa. The specimens are identical with the European and American specimens sent to me by Dr. D. Hille Ris Lambers and Prof. E. O. Essig.

GREENIDEA NIGRA Maki var. KANZANENSIS var. nov.

Wingless viviparous female.—Blackish brown, cornicles blackish. Body sclerotized, with numerous long fine setæ, which are a little curved, not branched apically, and as long as, or a little shorter than, the basal two antennal segments taken together. Head fused with the pronotum, with about thirty-two dorsal setæ. Antennæ with many long fine setæ, which are as long as the basal two antennal segments taken together; the third segment not curved, striate on the distal half, lacking sensoria; the relative lengths of segments about as follows: III—44, IV—15, V—15, VI—11 + 24. Cornicles reticulate near the base, slightly constricted at the base, broadest about the middle, longer than the third antennal segment, with many minute spinules in transverse rows on the distal part, and many long simple setæ. Caudal segment with a very small process. Trochanters defined from the femora; tibiæ not striate, with three or four slender spines at the tip. Length of body, 3.0 millimeters; width across abdomen, 1.9; width of head across eyes, 0.623; antenna, 1.85; width of third antennal segment at middle, 0.046; longest seta on third antennal segment, 0.185; length of cornicle, 0.97; width at base, 0.11; width at middle, 0.17; width at apex excluding flange, 0.083; seta on cornicle, 0.21; hind tibia, length, 0.12; width at middle, 0.051; longest seta on hind tibia, 0.162; hind tarsus, 0.175; dorsal seta, 0.14–0.18.

Winged viviparous female.—In specimens treated with caustic potash, abdomen pale brownish over the dorsum. Cornicles black. Head with about thirty-two dorsal setæ. Third antennal segment slightly striate on the distal part, with twenty-five to twenty-seven transversely narrowed or oval sensoria nearly in a row along the whole length except on the basal and distal small parts; fourth without sensoria; relative lengths of segments about as follows: III—48, IV—16, V—16, VI—12 + 26. Wing veins and stigma normal. Cornicles very long, cylindrical, very slightly narrowed and curved at the apical part, somewhat shorter than the antenna, with pale transverse striæ except at the base and on the distal part, many minute spinules in rows on the distal part, and many very long simple setæ. Caudal segment with a small, but distinct, process. Length of body, 2.7 millimeters; length of head, 0.26; width of head, 0.6; seta on head, 0.15; antenna, 2.1; width of third antennal segment at middle, 0.051; longest seta on antenna, 0.018; length of cornicle, 1.85; width of cornicle at middle, 0.12; width of cornicle at apex, 0.074; seta on cornicle, 0.25–0.32; length of hind tibia, 1.38; width of hind tibia at middle, 0.046; hind tarsus, 0.162; seta on abdomen, 0.046–0.069.

Host.—A species of Fagaceæ?

Habitat.—Reikwan (altitude 6,220 feet), Kizan-gun, Takao Prefecture.

Some specimens were taken by me in July, 1936. *Greenidea nigra* var. *kanzanensis* differs from the typical form of *Greenidea nigra* Maki in the fine setæ on the body, antennæ, legs, and cornicles of the wingless form, and on the head and antennæ of the winged form.

PARATRICHOSIPHUM NIITAKAENSE sp. nov.

Wingless viviparous female.—Yellow, without dark markings. Antennæ pale, darker on the distal part. Cornicles and legs pale yellow. Body elongate, rounded on the side of abdomen, with many very long fine setæ, which are not branched at the tip. Head shallowly and widely convex on the front, fused with the pronotum, with about twelve or thirteen long dorsal setæ, which are a little longer than the basal two antennal segments taken together, and with a pair of similar setæ on the frontal convex part. Eyes with prominent ocular tubercles. Frontal tubercles very short, indistinct. Antennæ imbricated, with long simple setæ; the first segment concave at the middle of lateral side; the third lacking sensoria, with about twenty to twenty-five setæ, the longer ones of which are as long as those on the dorsum of head; the fourth with four setæ; relative lengths of segments about as follows: III—39, IV—12, V—15, VI—11 + 17. Rostrum slender, pointed, reaching a little beyond the hind coxæ. Abdomen a little corrugated on the dorsum. Cornicles long, slightly curved, narrowed on the basal and distal parts, stouter than the femora, a little longer than the third, fourth, and fifth antennal segments taken together, not striate, not reticulate, with many long simple setæ, numerous spinules in rows on the distal part, and spinules scattered on the remaining part. Caudal segment rounded, with about ten long setæ, with no process. Legs slender; trochanters defined from the femora; femora imbricated; hind tibiæ somewhat curved, striate, with four slender spines at the end, and a few simple fine setæ, which are nearly as long as, or shorter than, the width of tibiæ; tarsi striate, with some long simple setæ on the basal segment. Venter with numerous granules on the thorax and over the whole surface of abdomen, granules pointed apically. Length of body, 2.2–2.5 millimeters; width of body, about 1.0; width of head across eyes, 0.44; length of antenna, 1.4; width of third antennal segment at middle, 0.032; length of cornicle, 0.95; width of cornicle at base, 0.069; width of cornicle at middle, 0.129; width of cornicle at apex excluding flange, 0.05; length of hind tibia, 0.8; width of hind tibia at middle, 0.037; length of hind tarsus, 0.12; dorsal seta on head and abdomen, 0.16; longest seta on cornicle, 0.18 to 0.21.

Winged viviparous female.—In a specimen treated with caustic potash, head, thorax, legs, antennæ, and cornicles dark brown, abdomen brownish. Head with about twelve long fine setæ on the dorsum, setæ curved and as long as, or shorter than, the basal two antennal segments taken together; front with a pair of small rounded protuberances and some long setæ at the middle. The third antennal segment with many transversely narrowed sensoria in a row, and setæ which are as long as the dorsal setæ of head. Cornicles very long, cylindrical, a little narrowed on the apical part, a little longer than the hind tibia, not striate, not reticulate, with many spinules in rows on the distal part, and very long simple fine setæ. Caudal segment with no process. Wing veins and stigma normal. Legs slender, with many long fine setæ; middle and hind femora a little imbricated; hind tibiæ striate, the setæ much longer than the width of tibiæ. Length of body, 2.25 millimeters; length of head, 0.2; width of head across eyes, 0.41; width of third antennal segment, 0.037; longest seta on third antennal segment, 0.16; length of cornicle, 1.25; width of cornicle at base, 0.07; width of cornicle at apex excluding flange, 0.046; longest seta on cornicle, 0.23; distance between cornicles, 0.41; length of hind tibia, 1.1; width of hind tibia at middle, 0.032; hind tarsus, 0.125; longer seta on tibia, 0.115; forewing, about 2.8.

Host.—A species of Fagaceæ.

Habitat.—Taikan (altitude about 6,500 feet), near Mount Niitaka (Mount Morrison).

A winged and some wingless forms were collected by me August 23, 1936. This species is closely related to *Paratrichosiphum montanum* van der Goot (syn. *Trichosiphum montanum* van der Goot) briefly described from Darjiling, India, and may be identical with it. I here designate it as new, since comparison cannot be made in detail.

AMPHOROPHORA LESPEDEZÆ Essig and Kuwana.

Rhopalosiphium lespedezæ ESSIG and KUWANA, Proc. Calif. Acad. Sci. IV 3 (1918) 57.

Host.—*Lespedeza* sp.

Habitat.—Musha (altitude 3,790 feet).

Many specimens, both alate and apterous, were taken by me July 11, 1936. Previously recorded from Japan, Korea, and China.

MACROSIPHUM SMILACETI Takahashi.

Macrosiphum smilaceti TAKAHASHI, Aphididae of Formosa III, Dept. Agr., Govt. Res. Inst. Formosa Rept. 10 (1924) 101.

Wingless viviparous female.—Red, black on the dorsum, shining; cornicles black; cauda pale. Dorsum sclerotized; basal seven abdominal segments fused together. Head somewhat convex at the middle of front, with four pairs of dorsal simple setæ, which are rather long, but much shorter than the second antennal segment. The third antennal segment not imbricated, with one to three small sensoria on the basal part. Cornicles very stout, imbricated, not distinctly reticulate, longer than the width of head including the eyes, as long as the fourth antennal segment. Cauda large, stout, with a median and six or eight lateral bristles. Femora long.

Host.—*Smilax* sp.

Habitat.—Hinokidani (altitude 8,000 feet), Kizan-gun, Takao Prefecture.

Four apterous forms were taken by me in July, 1936. Previously known from Japan and Korea.

MACROSIPHUM EURYÆ sp. nov.

Wingless viviparous female.—Yellow; head and pro- and mesonotum black; abdomen with a large black patch on the median area of dorsum, and a broad black band behind the cornicles; the black patch reaching the base of abdomen and confluent with the band. Cornicles black; cauda yellow. Legs pale. Antennæ pale, blackish on the basal segment, somewhat dusky on the apices of the fourth, fifth, and sixth segments and on the distal area of basal part of the sixth. Body oval. Head transversely corrugated on the posterior part of dorsum, lacking granules and spinules, with four pairs of dorsal stiff setæ, which are rather long, as long as the second antennal segment, and each arising from a small tubercle; a pair of these setæ nearly on the front; front prominently protruding and rounded at the middle. Venter of head with two pairs of setæ between the eyes. Frontal tubercles developed, diverging, the mesal side convex, with some striæ and two setæ; space between the frontal tubercles much wider than the tubercles. Antennæ slender, imbricated, with a few small stiff setæ; the basal segment nearly as long as wide; the second somewhat longer than wide, much smaller than the basal; the third lacking sensoria, with about nine setæ, which are much shorter than the diameter of the segment; the relative lengths of segments about as follows: III—48, IV—38, V—38, VI—28 + 70. Rostrum reaching the middle coxæ, the distal segment longer than the penultimate, nearly twice as long as wide, blunt apically; the penultimate as long as wide. Thorax corrugated on the dorsum, with some dorsal setæ, which are similar to those on the head; abdomen less corrugated on the dorsum, with transverse rows of spinules on the last two segments and behind the cornicles. Cornicles stout, broadened towards the base, a little or much curved, directed posteriorly, roughly imbricated, not reticulate, much longer than the third antennal segment, nearly as long as the width of head, stouter than, and about 2.5 times as long as, the cauda, stouter than the femora, with an apical flange. Cauda a little tapering, not much narrowed distally, long, rounded at the apex, with a median and four lateral curved setæ. Anal plate normal. Legs slender, with some short stiff setæ; middle and hind femora slightly imbricated on the apical part; tibiæ stouter than the third antennal segment, slightly imbricated on the apical part, a little widened on the distal part; tarsi striate, shorter than the basal part of the sixth antennal segment, with three short setæ on the basal segment, of which the median one is stout.

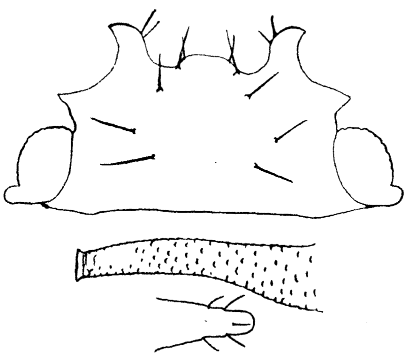

FIG. 1. *Macrosiphum euryæ* sp. nov., wingless viviparous female; head, cornicle, and cauda.

Length of body, 1.25 millimeters; length of head, 0.162; width of head including eyes, 0.35; antenna, 1.29; width of third antennal segment at middle, 0.019; length of cornicle, 0.35; width of cornicle at base, about 0.092; width of cornicle at apex excluding flange, 0.042; length of cauda, 0.148; width of cauda at base, 0.07; length of hind tibia, 0.69; width of hind tibia at middle, 0.028; hind tarsus, 0.088; dorsal seta, 0.046.

Host.—Eurya **sp.**

Habitat.—Hinokidani (altitude 8,000 feet), Kizan-gun, Takao Prefecture.

Some apterous forms were taken by me in July, 1936. This species is not a typical form of the genus, and resembles *Macrosiphum holsti* Takahashi in lacking sensoria on the third antennal segment and in the dorsum not being smooth; it differs from the latter in the color, the structure of the cornicles, and in other characters.

ACYRTHOSIPHON RHODODENDRI sp. nov.

Wingless viviparous female.—Green. Antennæ and legs pale; cornicles pale, darker on the distal part; cauda black. In specimens treated with caustic potash, pro- and mesonotum pale brown, the eighth abdominal tergite with a small pale brown band. Head smooth except on the mesal sides of frontal tubercles, with four very small blunt dorsal setæ in a row between the eyes, and two pairs of longer similar setæ between the frontal tubercles, the anterior pair of which is longer, but much shorter than the second antennal segment; front with two pairs of similar setæ. Frontal tubercles developed, diverging, moderately convex and with two short setæ and numerous granules on the mesal side; space between the frontal tubercles nearly as wide as the tubercles. Antennæ long, slender, with some very small blunt setæ; the third segment not imbricated, expanded at the apex, with one or two (usually one) small circular sensoria near the base and about twenty setæ; the fourth expanded at the apex, without sensoria; relative lengths of segments about as follows: III—30, IV—23, V—24, VI—10 + 34. Rostrum reaching a little beyond the hind coxæ, the distal segment somewhat longer than the penultimate, somewhat tapering. Thorax and abdomen with a few minute blunt dorsal setæ; pronotum corrugated; meso- and metanotum and dorsum of abdomen reticulate; posterior abdominal segments and mesosternum with spinules in rows. Cornicles cylindrical, stout, widened towards the base, not curved, directed posteriorly, smooth, lacking reticulations and imbrications, nearly as long as the cauda, shorter than the width of head across the eyes, slightly shorter than the fourth antennal segment, with one or two striæ at the apex, and a distinct apical flange. Cauda narrow, tapering, blunt apically, with three pairs of lateral setæ and a median seta. Anal plate normal, with three pairs of setæ on the hind margin. Legs long, slender; coxæ with spinules in rows; femora slightly imbricated apically; tibiæ as stout as the middle part of the third antennal segment, a little imbricated at the apical part, with many short setæ, which are shorter than the diameter of tibiæ; tarsi striate, shorter than the basal part of the last antennal segment, with three short stiff setæ on the

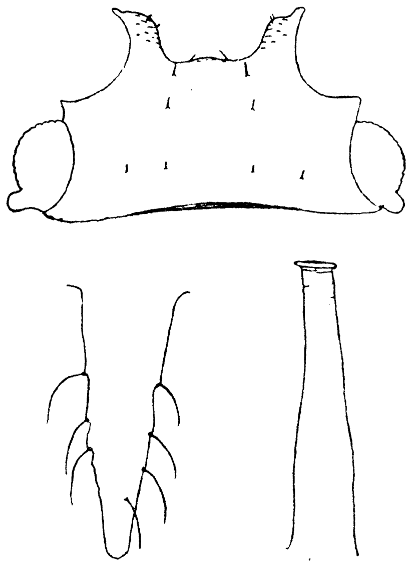

FIG. 2. *Acyrthosiphon rhododendri* sp. nov., wingless viviparous female; head, cauda, and cornicle.

basal segment, the median seta stout. Length of body, 1.4 millimeters; length of head, 0.16; width of head across eyes, 0.42; antenna, 2.0; width of third antennal segment at middle, 0.028; length of cornicle, 0.32; width of cornicle at base, 0.069; width of cornicle at apex excluding flange, 0.037; length of cauda, 0.277; width of cauda at base, 0.095; length of hind femur, 0.55; width of hind femur about middle, 0.065; length of hind tibia, 1.0; width of hind tibia at middle, 0.028; length of hind tarsus, 0.11.

Host.—*Rhododendron oldhami* Maxim.

Habitats.—Hariposon (altitude 6,699 feet), Koyo (8,349 feet), Taito Prefecture.

Some specimens were taken by me June 30, 1936. *Acyrthosiphon rhododendri* differs from other species in the short cornicles, which are as long as the cauda. It resembles *Macrosiphoniella,* from which it differs in the convex frontal tubercles, the presence of many granules on the mesal sides of the frontal tubercles, and the cornicles not being reticulate.

CAVARIELLA JAPONICA Essig and Kuwana var. NIGRA var. nov.

Differs from the typical form in that the body, antennæ, cornicles, cauda, and legs are entirely black in the apterous form, and the legs are black in the alate form.

Host.—*Salix fulvo-pubescens* Hayata.

Habitats.—Hinokidani (altitude 8,000 feet), Kizan-gun, Takao Prefecture; Sekigahara (8,600 feet), Gokwan (9,600 feet), Karenko Prefecture; Sankakuho (7,000 feet), Sakuragamine (9,100 feet), Taichu Prefecture.

Very common at high altitudes, but not found in the lowlands. Formerly recorded by me from Formosa as *Cavariella japonica* Essig and Kuwana. Many specimens were collected by me in July and August, 1936. In the wingless viviparous female, dorsum sclerotized except on the anterior part of mesothorax, with a few small irregular pale areas arranged in a longitudinal line on the thorax and basal part of abdomen; metathorax and basal seven abdominal segments fused together.

CAVARIELLA CAPREÆ Fabricius.

Cavariella capreæ THEOBALD, Plant Lice Gr. Britain 2 (1927) 5.

Wingless viviparous female.—Pale yellowish white. Antennæ pale, dusky on the distal two segments. Legs pale, dusky on the tarsi. Cornicles, cauda, and dorsal horn concolorous with the body. Body normal in shape, prominently reticulate on the dorsum. Head convex and with a pair of short stiff blunt setæ on the front; a similar, but shorter, seta on the mesal side of each frontal tubercle. Eyes rather small, protruding. Antennæ slender, short, reaching posterior part of mesothorax, 6-segmented, with a few small setæ; the third segment slightly imbricated, without sensoria; the fifth narrowed towards the base; relative lengths of segments about as follows; III—44, IV—20, V—15, VI—15+20. Rostrum reaching the middle coxæ, the distal segment slightly longer than the penultimate. Pro- and mesonotum equal in length, slightly shorter than the head; metathorax and basal seven abdominal segments fused together; dorsal horn on the eighth abdominal segment about 2.5 times as long as wide, very slightly tapering, rounded at the apex, not constricted, corrugated, as long as the cauda, but narrower than the cauda and cornicles, reaching slightly beyond the apex of cauda, with a pair of short stout capitate setæ on the apex. Cornicles long, prominently expanded gradually on the middle part, broadest beyond the middle; faintly imbricated throughout, sometimes with about two striæ at the apex, about thrice as long as the cauda, longer than the third and fourth antennal segments taken together, slightly longer than the width of head across the eyes, reaching a little beyond the tip of horn. Cauda stout, about 1.5 times as long as wide, rounded at the apex, with five setæ. Trochanters defined from the femora; tibiæ widened on the distal part, stouter than the third antennal segment, not striate, with some stiff setæ, which are shorter than the diameter of tibiæ; tarsi striate, with three short setæ on the basal segment. Length of body, 1.5 millimeters; length of head, 0.185; width of head across eyes, 0.365; antenna, 0.6; width of third antennal segment at middle, 0.019; length of cornicle, 0.38; width of cornicle at base, 0.046; width of cornicle at widest part, 0.064; width of cornicle at apex excluding flange, 0.029; length of cauda, 0.125; width of cauda at base, 0.083; length of horn, about 0.127; width of horn at middle, 0.037; length of hind tibia, 0.6; width of hind tibia about middle, 0.03.

Host.—*Salix fulvo-pubescens* Hayata.

Habitats.—Gokwan (altitude 9,600 feet), Karenko Prefecture; Tataka (9,000 feet) near Mount Niitaka (Mount Morrison).

A few specimens were taken by me in August, 1936. New to the fauna of Formosa. Differs from *Cavariella neocapreæ* Takahashi, which is found on *Salix* in the lowlands of Formosa, in the cornicles distinctly expanded beyond the middle and in the shorter dorsal horn. According to D. Hille Ris Lambers[2] *Cavariella capreæ* Fabricius is a synonym of *C. pastinacæ* Linné.

APHIS ARUNDINARIÆ sp. nov.

Wingless viviparous female.—Purplish brown. In specimens treated with caustic potash, antennæ pale, colorless on the third segment, pale brownish on the apical part of the penultimate segment and on the last; fore and middle femora pale brownish except on the distal part; tibiæ brownish on the apex; tarsi brownish or dusky; cornicles and cauda also brownish or dusky; abdomen with five small brownish patches on the side and many small pale brown spots at the bases of setæ. Body like *Aphis bambusæ* Fullaway in shape, with many very long rather fine simple setæ. Head smooth, shallowly and widely convex on the middle of front, with about four pairs of dorsal setæ, which are longer than the basal two antennal segments taken together; a pair of similar setæ present on the front, and about four pairs also on the venter of head. Frontal tubercles very short, not convex, with a long seta on the mesal side. Eyes normal. Antennæ short, 5-segmented, with many long fine setæ, setæ a little shorter than those on the head and longer than the basal part of the last antennal segment, each arising from a small tubercle; the first segment wider than long, with three setæ; the second with four setæ; the third not imbricated, lacking sensoria, with about fifteen setæ; the fourth not striate, with nine setæ, the primary sensorium small, apart from the tip of the segment; the fifth imbricated, a little narrowed basally, the distal part long, slender, longer than the third; relative lengths of segments about as follows: III—44, IV—26, V—16+60. Rostrum very short, reaching a little beyond the front coxæ. Thorax and abdomen not reticulate, some of the dorsal setæ a little longer than those on head; abdomen with a small lateral tubercle on the basal and

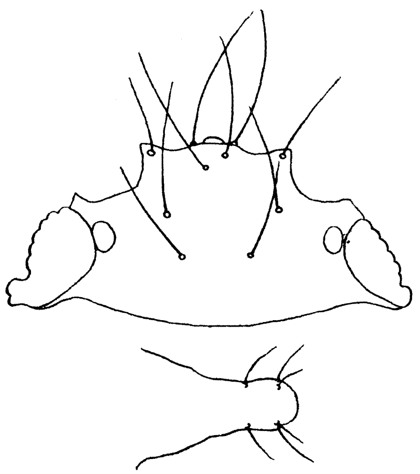

FIG. 3. *Aphis arundinariae* sp. nov., winged viviparous female; head and cauda.

[2] Stylops 3 (1934) 25.

seventh segments, tubercle distinctly longer than wide; dorsal setæ of abdomen mostly in an irregular row on each segment. Cornicles short, twice as long as wide, a little widened toward the base, as long as the cauda, somewhat faintly imbricated, shorter than the dorsal setæ of abdomen, as stout as the basal part of tibia, a little shorter than the penultimate antennal segment, with a distinct apical flange. Cauda normal, rounded apically, moderately constricted about the middle, with two pairs of lateral curved setæ and a median seta. Legs with many long fine setæ; femora with a small circular sensorium near the base; tibiæ stouter than the third antennal segment, hind tibiæ slightly narrowed towards the apex, not striate, stiff setæ lacking; tarsi striate, shorter than the penultimate antennal segment, with three short setæ on the basal segment in the fore and middle pairs, but only two setæ in the hind pair. Length of body, 1.2 millimeters; length of head, 0.162; width of head across eyes, 0.354; antenna, 0.83; width of third antennal segment, 0.028; longest seta on antenna, 0.115; length of cornicle, 0.101; width of cornicle at apex excluding flange, 0.037; hind femur, 0.37; length of hind tibia, 0.623; width of hind tibia at middle, 0.037; hind tarsus, 0.083; longest seta on abdomen, 0.15.

Winged viviparous female.—In specimens treated with caustic potash, head and thorax brownish; antennæ dusky; femora pale brownish; abdomen with some large pale brown lateral patches, median pale brown bands, and some small spots between the lateral patches and dorsal bands; wings hyaline, with pale veins and stigma; other parts like the wingless form in color. Head shallowly and widely convex on the front, with three pairs of long fine simple setæ on the dorsum, and a pair of similar setæ on the front; these setæ slightly shorter than the basal two antennal segments taken together; venter of head with five pairs of similar setæ. Frontal tubercles as in the wingless form. Antennæ 6-segmented; the third segment somewhat striate, with eleven to eighteen protruding sensoria scattered over the whole length, and about fourteen long fine setæ, setæ longer than the diameter of the segment and nearly as long as the basal antennal segment; the fourth with two to six sensoria and about thirteen similar setæ; the fifth with two to five sensoria and about ten setæ; relative lengths of segments about as follows: III—47, IV—30, V—34, VI—19+55. Front ocellus visible from above. Cornicles nearly as long as the longer setæ of abdomen, stouter than the tibiæ, shorter than the penultimate antennal segment. Cauda somewhat constricted about middle, with three pairs of setæ.

Wing veins normal, hind wings with parallel oblique veins, hooklets 2. Other characters like the wingless form. Length of body, 1.18 millimeters; length of head, about 0.13; width of head across eyes, 0.33; antenna, 0.9; length of cornicle, 0.092; width of cornicle at base, 0.05; width of cornicle at apex excluding flange, 0.032; hind femur, 0.37; length of hind tibia, 0.69; width of tibia at middle, about 0.027; hind tarsus, 0.092; longest seta on tibia, 0.095; longest seta on abdomen, 0.095.

Host.—*Arundinaria niitakayamensis* Hayata.

Habitat.—Arisan (altitude 7,500 feet).

A few specimens were collected by me August 25, 1936. Closely allied to *Aphis bambusæ* Fullaway, but differing in possessing many long fine setæ on the body, antennæ, and legs, in the frontal tubercles not protruding mesad, in having more sensoria on the antennæ of the winged form, in the wings not being clouded along the veins, and in other characters.

APHIS STRANVÆSIÆ sp. nov.

Wingless viviparous female.—Green. Antennæ, cornicles, and cauda black. Legs almost entirely black. Head about twice as wide as long (including the eyes), somewhat convex on the front, with four fine dorsal setæ in a row between the eyes and a pair of similar setæ between the antennæ, which are somewhat shorter than the second antennal segment; two pairs of curved setæ on front. Antennæ imbricated, with a few fine simple setæ, setæ nearly as long as the diameter of the third segment; the third segment narrower than the tibiæ, shorter than the width of head across the eyes, usually without sensoria, but sometimes with two to four small circular sensoria in a row mostly on the distal half, with about ten setæ; relative lengths of segments about as follows: III—20, IV—15, V—12, VI—8+14. Rostrum reaching beyond the middle coxæ, widest on the penultimate segment; distal segment nearly as long as the penultimate, a little longer than twice the width at base. Dorsum reticulate on thorax and abdomen, with a few short fine setæ. Prothorax, and the first, second, fourth, and seventh abdominal segments each with a lateral tubercle, the tubercle on the prothorax prominent, conical or slender, about twice as long as, or a little longer than, wide, larger than those on the abdomen; those on the first and seventh abdominal segments larger than those on the second and fourth. Cornicles cylindrical, a little broadened towards the base, sometimes very slightly constricted near the apical part, 1.5 times as long as the cauda, shorter than width of head, nearly as long as third antennal segment, imbricated, the distal part as stout as the tibiæ. Cauda stout, rounded at the tip, constricted about the middle, about 1.5 times as long as the basal part of the last antennal segment, slightly longer than the head, with about ten to fifteen setæ. Legs long, with many curved fine setæ; tibiæ stout, hind tibiæ slightly curved, with many setæ, which are as long as, or somewhat longer than, the diameter of tibiæ; tarsi imbricated, with three short stiff setæ on the basal segment. Length of body, 2.0 millimeters; length of antenna, 1.1; width of third antennal segment, 0.028; length of prothoracic tubercle, 0.04; length of cornicle, 0.3; width of cornicle at base, 0.07; width of cornicle at apex, 0.046; length of cauda, 0.21; width of cauda on distal half, 0.069; length of hind tibia, 0.9; width of hind tibia at middle, 0.046; hind tarsus, 0.12; dorsal seta on head, 0.041.

Winged viviparous female.—Head, antennæ, thorax, cornicles, and cauda black. Legs nearly black. Abdomen with four large black patches on the side, a large black patch behind each cornicle, and three black bands on the posterior part of dorsum. Third antennal segment with seven to nine circular sensoria in a row; fourth with none to two sensoria; relative lengths of segments about as follows: III—19, IV—14, V—14, VI—9+20. Wings normal, second branch of media rather short. Length of body, 1.75 millimeters; antenna, 1.25; length of third antennal segment, 0.31; width of third antennal segment, 0.032; length of cornicle, 0.25; width of cornicle at apex excluding flange, 0.045; length of cauda, 0.17; width of cauda on distal part, 0.055; length of hind tibia, 1.0; width of hind tibia at middle, 0.037; hind tarsus, 0.125.

Host.—*Stranvæsia niitakayamensis* Hayata.

Habitats.—Sakuragamine (altitude 9,300 feet), Gokwanzan (about 9,800 feet), Taichu Prefecture.

Numerous specimens were collected by me August 12 and 13, 1936. Many species of *Aphis* have been very incompletely described from Japan and other countries, and they cannot be compared with the present species in detail. *Aphis stranvæsiæ* differs from Theobald's description of *Aphis plantaginis* Schrank in the black legs, the cornicles about 1.5 times as long as the cauda, and the more constricted cauda. The present new species is similar to *Aphis odinæ* van der Goot in the shape of the cauda, but the cauda is less hairy in the former.

THORACAPHIS TAROKOENSIS sp. nov.

Wingless viviparous female.—Black, strongly sclerotized, with much white wax at center of dorsum, and slight white wax on margin. Legs, cauda, and antennæ black. Body wide, broadest at the middle, prominently indented at the middle of front, about 1.3 times as long as wide, with no evident setæ. Dorsum reticulate except on a large longitudinal median area, area paler, somewhat corrugated, and reaching hind end of cephalothorax. Head and thorax fused, occupying most of body; thoracic segments faintly discernible. Abdomen much reduced, broadly rounded on basal margin, separated from thorax, a little protruding posteriorly; basal seven abdominal segments fused, eighth defined, much wider than long, nearly triangular, bluntly pointed posteriorly, not distinctly reticulate, much shorter than remaining part of abdomen. Eyes of three facets, submarginal, dorsal. Antennæ very short, longer than wide, not segmented, rounded apically, separated from body margin, on mesal part of ventral marginal area of body. Apices of hind femora, and hind tibiæ and tarsi exposed, other legs concealed under body; hind tibiæ a little longer than femora, slightly narrowed toward apex, without setæ, reaching hind end of body; hind tarsi not segmented, short, a little longer than wide, without claws, but with two long fine apical setæ, setæ as long as tarsi. Cornicles wanting. Cauda and anal plate concealed under body. Venter of body with the marginal part well separated from the median area. Length of body, 0.9–0.946 millimeters; width of body, 0.72; length of basal seven abdominal segments together, 0.129; length of hind tibia, about 0.111; width of hind tibia, 0.035; hind tarsus, 0.023.

Host.—*Quercus spinosa* David., attacking lower side of leaf.

Habitat.—Seraoka (altitude 4,420 feet), Taroko, Karenko Prefecture.

Some specimens were taken by me August 14, 1936. Related to *Thoracaphis quercicola* Takahashi and *T. distyllifoliæ* Takahashi, but differing from the former in the median area of dorsum being paler and wanting reticulations, and in the presence of wax on the body; and from the latter in the larger body, the front prominently indented at the middle, and the dorsum reticulate except on the median area.

TETRANEURA RADICICOLA Strand.

Tetraneura sp., TAKAHASHI, Aphididae of Formosa IV, Dept. Agr., Govt. Res. Inst. Formosa Rept. **16** (1925) 54; ibid. V, Rept. **22** (1927) 14.

Tetraneura radicicola STRAND, Acta Univ. Latv. **20** (1929) 22; TAKAHASHI, Aphididae of Formosa VI, Dept. Agr., Govt. Res. Inst. Formosa Rept. **53** (1931) 101.

Winged viviparous female.—Head with some long, rather fine, simple setæ on dorsum and front, setæ a little curved and much longer than basal antennal segment. Antennæ with some long setæ, setæ much longer than diameter of third segment; third segment constricted basally, with thirteen sensoria in a row, sensoria very narrow, a little wavy and occupying half the circumference of segment or less; fourth narrowed on the basal part, about twice as long as wide, with four sensoria and about seven long setæ; fifth narrowed basally, with twelve sensoria, about eighteen long setæ, and many microtrichiæ in rows on the distal part, the primary sensorium small, at the apex of the segment, surrounded with setæ; sixth about twice as long as wide, wanting secondary sensoria, with two long bristles and many rows of microtrichiæ; relative lengths of segments about as follows: III—16, IV—6, V—16, VI—5. Rostrum nearly reaching middle coxæ, with long bristles. Abdomen with many fine long bristles, bristles approximately as long as, or shorter than, those on head, bristles on the posterior segments much larger. Cornicles surrounded with seven long setæ; dorsum somewhat sclerotized around the bases of cornicles. Cauda wider than cornicles. Legs with many long setæ; trochanters defined from femora; tibiæ stout, a little stouter than the third antennal segment, with many microtrichiæ in rows on distal part; tibial setæ a little curved, as long as, or a little longer than, diameter of tibiæ; tarsi with numerous microtrichiæ in rows, fore tarsi with two long setæ and a much shorter stiff median seta on basal segment, but middle and hind tarsi with only two long setæ on basal segment. Hind wings with two oblique veins and three hooklets. Length of body, 2.5 millimeters; antenna, 0.854; length of third antennal segment, 0.254; width of third antennal segment, 0.05; seta on antenna, 0.095; diameter of cornicle, 0.046; length of hind tibia, 1.18; width of hind tibia about middle, about 0.075; dorsal seta on head, 0.102.

Host.—*Miscanthus* sp.?

Habitat.—Sankakuho (altitude about 7,000 feet), Taichu Prefecture.

The single specimen found by me on the leaf of *Miscanthus*, August 11, 1936, is probably the winged form of *Tetraneura radicicola* Strand, hitherto unknown, and is described under that name. This species is characterized by many long setæ on the antennæ and legs, and by the large body.

MYZOCALLIS KURICOLA Matsumura.

Nippocallis kuricola MATSUMURA, Journ. Coll. Agr. Saporo 7 (1917) 365.

Host.—*Quercus serrata* Thunb.

Habitat.—Taihoku.

A few winged viviparous females, many apterous oviparous females, and a few alate males were found by me on a single host tree late in November, 1936. Known from Japan, Korea, and China.

The type specimens of the new species described in this paper are in the collection of the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATIONS

TEXT FIGURES

THE ODONATA OF THE PHILIPPINES

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TEN PLATES AND TWO TEXT FIGURES

This is an illustrated account of the known dragon-fly fauna of the Philippine Islands. Dragon flies are interesting insects, and none anywhere are more interesting or more beautiful than those of these Islands. They are still very insufficiently known, as little collecting has been done except in a few places. We have described a few new species and have illustrated the immature stages of many others. We hope that by bringing together in a single paper diagnostic descriptions of all the known species we are preparing the way for further work in the Islands, where alone their biology can be effectively studied.

It is mostly pioneer descriptive work that has been done on Philippine Odonata hitherto, and among the workers two names stand preëminent—Friedrich Brauer and Edmond de Sélys Longchamps. In 1868 Brauer made the largest single contribution to the knowledge of the odonate fauna.[1] In this and in several earlier papers appearing in the publications of the same society he described some twenty-nine Philippine species; also, such characteristic genera as *Brachythemis, Diplacina, Lyriothemis, Onychothemis, Trithemis, Tetrathemis,* and *Urothemis.* Some widely ranging Philippine species were described by earlier authors from other lands, in widely scattered publications: Five species by Fabricius, two each by Drury and Burmeister, seven by Rambur, a few by Dr. H. Hagen, and some by Baron de Sélys.

In 1882 de Sélys published a list [2] in which he recorded seventy-seven species (nine of them new), and in the same journal in 1891 he published a supplement to the list, adding seven species, extended notes on local distribution, and a few redescriptions. De Sélys described in all twenty-three Philippine species.

[1] Neue und wenig bekannte von Herrn Doct. Semper gesammelte Odonaten, Abhandl. der k.k. zool.-bot. Ges. Wien 18 (1868) 167–188.

[2] Odonates des Philippines, An. Soc. Esp. Hist. Nat. 11 (1882) 1–32, 1 pl.

There are few other papers dealing with the Philippine odonate fauna. Besides those by Brauer and de Sélys cited above, there are a few more recent ones.[3]

The materials for this monograph have come from but few localities, principally the region about Manila, Luzon, and about Zamboanga, Mindanao. They came in the largest measure from Los Baños, and from nearby Molawin Creek and the slopes of Mount Maquiling. Dean C. F. Baker in his time gathered a great many adult dragon flies. He occasionally sent us interesting material for naming, and since his death much more collected by him has been loaned us for study. Dr. L. B. Uichanco has continued the good work of collecting Odonata, and he and his entomological students have sent us much valuable alcoholic material, including the immature stages of many species and genera. This is a good illustration of what the mere saving and sending to specialists of the specimens gathered by field classes of students in the course of their routine collecting may do to increase zoölogical knowledge in regions where little has been done on a local fauna.

From Mr. Fred C. Hadden, formerly of the Hawaiian Sugar Planters' Association Experiment Station and living at the College of Agriculture, also came much valuable material, both adults and nymphs. Molawin Creek and its environs furnished much of this. We are indebted to Mr. Hadden also for contact with Mr. H. C. Muzzall, who gathered for us a goodly lot of material, both nymphs and adults, about Kabasalan, Zamboanga, Mindanao.

We are indebted deeply to the late Mr. R. C. McGregor, formerly of the Bureau of Science, Manila, and for many years editor of the Philippine Journal of Science, both for specimens and for encouragement in the preparation of this monograph. His collections of adult dragon flies were made mainly in the lowlands about Manila (in part with the help of Andres Celestino, Francisco Rivera, and Anacleto Duyag), but he sent some material collected earlier in Samar—a wet island "that will stand a lot more field work."

[3] Ris, H., Sauter's Formosa-Ausbeute: Odonata, Suppl. Ent. 5 (1916) 1–80, figs. Laidlaw, Notes on Oriental dragonflies, with descriptions of new species, Proc. Zool. Soc. Lond. (1928) 129–138, figs. Ris, Vier neue Calopterygiden (Odonata) von den Philippinen und Palawan, Mitth. Münchener Ent. Ges. 20 (1930) 70–92, figs. Cowley, Descriptions of three new species of Drepanosticta (Odonata) from the Philippine Islands, Trans. Ent. Soc. Lond. 85 (1936) 157–67, figs.

The first few specimens of dragon-fly nymphs known to have come from the Philippine Islands were sent the senior author by his former pupil, Mr. C. F. Carstens, who was among the shipload of teachers sent to the Islands by the United States Government in 1898 on the army transport *Thomas*.

There appear to be but few Philippine Odonata in American museums. Through the kindness of Dr. Harold Morrison we have been loaned those of the United States National Museum, collected by Prof. C. F. Baker in Luzon, and a few that were collected by Dr. W. Dwight Pierce in Negros. We have also seen a few specimens from Mindanao in the Carnegie Museum at Pittsburg. A few additional specimens in the Ledyard collection at Stanford University were loaned us for study by Prof. G. F. Ferris. These also came from the vicinity of Los Baños. Doctor Pongrácz loaned us a few specimens from the collections of the Hungarian National Museum, among which was one of the two Philippine specimens of *Camacinia* that we have seen.

On the basis of this material we have prepared the following account of the odonate fauna of the Islands, fully realizing that the resources in this order are still largely unexplored. As a first contribution to the knowledge of the immature stages it is significant material, for the nymphs of such remarkable genera as *Mesogomphus, Tetracanthagyna, Idionyx, Tetrathemis,* and *Diplacina,* here described for the first time, add facts that must be taken into account in the final classification of the order. The extraordinary nymph of *Heteronaias heterodoxa* Sélys shows at a glance how mistakenly this species has hitherto been placed in such genera as *Epitheca, Somatochlora,* and *Procordulia.*

The nymphs of most Philippine species are still unknown. Here is an open field awaiting the local student. In order to facilitate his work we have provided keys and tables, as well as descriptions and figures. The keys will help to find names quickly, and the verification tables that follow them will enable him to know whether the keys with their unfamiliar terminology have led him aright. This combination of keys and tables has proved elsewhere a great aid to identification.

In order that the reader may be able to interpret the special terms used in descriptions, keys, and tables, certain figures in the plates show detailed parts explained in the list of illustrations. The armature of the nymphal labium is shown in Plate 9, figs. 110 and 112; that of the nymphal abdomen in Plate 9, fig. 107. The grasping organs of the adult male abdomen are named in Plate 1, figs. 6 and 8; the genital armature of the adult female, in Plate 1, fig. 14. Arabic numerals indicate the respective abdominal segments. There are always ten of these segments; counting them is easiest from the tip backward.

Wing venation presents so many characters useful in the study of the Odonata that we figure it in text figure 1. Venational characters offer certain advantages of definiteness, clearness, and ease of observation. A few minutes' study of this figure, followed by half an hour's use of the keys and tables with wings of several types in hand, should enable anyone to master these terms sufficiently for generic determination.

Suborder ANISOPTERA

Dragon flies proper. Adults with wings held horizontally in repose, the hind wings broader than the fore.

Nymphs stout-bodied with a wide abdomen containing an internal rectal gill chamber, within which are the tracheal gills.

Below is a list of the Philippine anisopterous Odonata now known to us, with indications of known nymphs. Those marked with an asterisk are newly described in the following pages; those previously described from other lands are marked with a dagger.

CORDULEGASTERIDÆ

Orogomphus splendidus Sélys.

GOMPHIDÆ

Ictinogomphus tenax Sélys.
* *Gomphidia kirschii* Sélys.
* *Mesogomphus balneorum* sp. nov.
Leptogomphus semperi Sélys.
* *Heliogomphus bakeri* Laidlaw.

ÆSCHNIDÆ

Oligoæschna pœciloptera Karsch.
Oligoæschna zambo sp. nov.
Anaciæschna jaspidea Burmeister.
Anax julius Brauer.
† *Anax guttatus* Burmeister.
Anax gibbosulus Rambur.
Indæschna baluga sp. nov.
Gynacantha basiguttata Sélys.
Gynacantha subinterrupta Rambur.
† *Gynacantha hyalina* Sélys.
Gynacantha bayadera Sélys.
* *Tetracanthagyna bakeri* Campion.

LIBELLULIDÆ

MACROMIINÆ

† *Epophthalmia elegans* Brauer.
Macromia negrito sp. nov.
Macromia gerstaeckeri Krüger?
Macromidia samal sp. nov.

CORDULIINÆ

Idiophya salva sp. nov.
* *Idionyx philippa* Ris.
* *Heteronaias heterodoxa* Sélys.
† *Hemicordulia mindana* sp. nov.

LIBELLULINÆ

Orchithemis pulcherrima Brauer.
Agrionoptera quatuornotata Brauer.
Agrionoptera bartola sp. nov.
Nannophya pygmæa Rambur.
* *Tetrathemis irregularis* Brauer.
Diplacodes nebulosa Fabricius.
† *Diplacodes trivialis* Fabricius.
Raphismia bispina Hagen.
Zygonyx ida Karsch.

† *Acisoma panorpoides* Rambur.
Diplacina nana Brauer.
* *Diplacina braueri* Sélys.
* *Diplacina bolivari* Sélys.
† *Brachydiplax chalybea* Brauer.
Brachydiplax duivenbodei Brauer.
Macrodiplax cora Brauer.
Urothemis bisignata Brauer.
Zyxomma petiolatum Rambur.
Zyxomma obtusum Sélys.
* *Tholymis tillarga* Fabricius.
Rhyothemis phyllis Sulzer.
* *Neurothemis terminata* Ris.
Neurothemis palliata Rambur.
Camacinia gigantea Brauer.
† *Tramea limbata* Desjardins.
† *Hydrobasileus croceus* Brauer.
† *Pantala flavescens* Fabricius.
Orthetrum glaucum Brauer.
Orthetrum luzonicum Brauer.
† *Orthetrum sabina* Drury.
Orthetrum clelia Sélys.
Orthetrum testaceum Burmeister.
Lathrecista asiatica Fabricius.
Potamarcha obscura Rambur.
Onychothemis abnormis Brauer.
† *Trithemis aurora* Burmeister.
Trithemis pallidinervis Kirby.
Trithemis festiva Rambur.
† *Brachythemis contaminata* Fabricius.
Cratilla metallica Brauer.
Cratilla lineata Brauer.
† *Lyriothemis cleis* Brauer.
Lyriothemis latro sp. nov.
† *Crocothemis servilia* Drury.

Key to the families of Philippine Anisoptera.

ADULTS

1. Triangles of fore and hind wings similar in form and in distance from the arculus .... 2.
   Triangles of fore and hind wings different; that of forewing pointed rearward; that of the hind wing elongated lengthwise of the wing and nearer to arculus .... LIBELLULIDÆ.
2. Eyes far apart on top of head .... GOMPHIDÆ.
   Eyes scarcely meeting on top of head .... CORDULEGASTERIDÆ.
   Eyes broadly meeting on top of head .... ÆSCHNIDÆ.

NYMPHS

1. Labium flat or nearly so .... 2.
   Labium spoon-shaped, covering face up to eyes .... 3.
2. Fore and middle tarsi 2-jointed; third joint of antennæ greatly enlarged .... GOMPHIDÆ.
   Fore and middle tarsi 3-jointed; third joint of antennæ not greatly enlarged .... ÆSCHNIDÆ.
3. Median lobe of labium bifid at apex; female nymph with an ovipositor .... CORDULEGASTERIDÆ.
   Median lobe of labium entire at apex; female nymph with no ovipositor. LIBELLULIDÆ.

CORDULEGASTERIDÆ

Genus OROGOMPHUS Sélys

This family and genus are represented in the Philippines by one fine rare species of which no specimens have been before us. The following descriptions and figures, therefore, are copied. The portion of the hind wing shown in Plate 3, fig. 49, is quite adequate for its recognition.

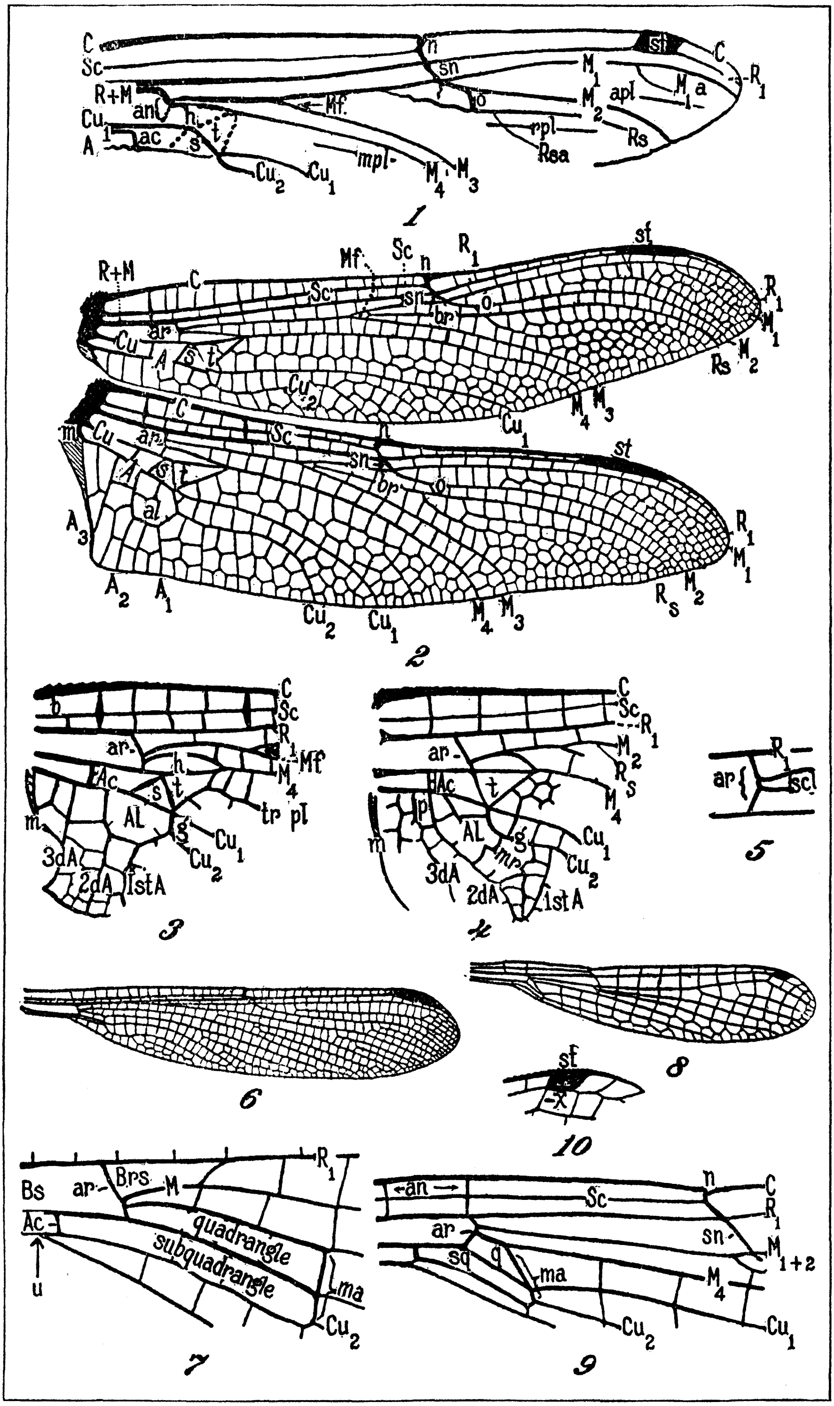

FIG. 1. Diagrams of venational characters of anisopterous wings. *1,* Diagram of the principal veins and their connections; *2, Cordulegaster savi,* wings; *3,* gomphine wing base, male; *4,* libelluline wing base; *5,* arculus and its sectors (M_{1-3} M_3); *6, Cyanocharis valga,* forewing; *7, Caliphæa consimilis,* part of wing base; *8, Telebasis salva,* forewing; *9, Telebasis salva,* part of wing base; *10, Anomalagrion hastatum,* stigma, female with brace vein *x*.

The nymphs in this family are elongate and hairy, with the body sagged in the middle and upcurved to head and tail. Superficially they resemble the nymphs of *Libellula,* having similar high-peaked eyes and squarish head, but the labium, although spoon-shaped, is very different, having a cleft in the apex of the median lobe and having the teeth on the lateral lobes deeply cut and very irregular.

OROGOMPHUS SPLENDIDUS Sélys. **Plate 1, figs. 6 and 7; Plate 3, figs. 49 and 50.**

SÉLYS, Bull. Acad. Belg. II 46 (1878) 681, female, Luzon; An. Soc. Esp. Hist. Nat. 11 (1882) 16; MARTIN, Mission Pavie Zool. (1904) 14, female, Tonkin; WILLIAMSON, Proc. U. S. Nat. Mus. 33 (1908) 277; RIS, Suppl. Ent. 1 (1912) 77–79, figs., male, Formosa; LAIDLAW, Proc. Zoöl. Soc. London 1 (1914) 60–61, pl. 1, fig. 8; Journ. Fed. Malay States Mus. 16 (1931) 235, (?) Borneo.

Male, abdomen, 55 mm; hind wing, 47.

Female, abdomen, 58 mm; hind wing, 49.

Female.—Head shining black, except for the clypeus, which forms a lemon-colored band marked with two impressed spots, and the crest of the front, which is narrowly yellowish. Eyes very slightly separate from each other; black hairs on the crest of the front, on the vertex, and on the occiput.

Thorax with an antehumeral streak, a juxtahumeral and lateral bands of yellow.

Abdomen much longer than the wings, enlarged in segments 1, 2, 8, and 9, black, without visible pattern, except a narrow terminal circle on segments 1 and 2 and yellow median lateral stripes on the same segments, that of the second rising in a narrow circle to the dorsal ridge. Anal appendages slender, cylindrical, blunt, shorter than segment 10, separated by a protuberance which ends the abdomen. Vulvar plate large, short, seemingly followed in an excavation by rudimentary lamellæ.

Legs black, the interior of the two first femora yellow at their base. Femora finely denticulate. Spines of the tibia moderately long. (From the original description.)

Male.—Labrum reddish brown. Rest of the head black, except for two yellow crossbands, one above the postclypeus with two dark impressed spots and a very small dark border on the sides, one above the top of the frons to the side margins of the flattened area.

Thorax black, marked with light yellow, as in Plate 3, fig. 50. Legs black. First pair of femora yellowish on the inside at the base.

Abdomen black, marked with yellow as follows: Two lateral spots and a cross stripe on the basal border of segment 1; a lateral border band, widened over the auricles, back to a complete ring very slightly interrupted in the middle, and two very small cross flecks on the cross margin on segment 2; on the lateral border a comparatively wider longitudinal stripe to the cross margin, fine cross streaks and a dorsal apical double spot on the cross margin on segment 3; segments 4 to 6 with only dorsal apical successive small double spots; 7 with a terminal half ring, about one-fifth the length of the segment in the middle and about one-half on the sides; 8 to 10 entirely black. Anal appendages black (Plate 1, figs. 6 and 7). (From the description in Ris. Figures from Ris.)

The nymph of this species is unknown, but Fraser has described and figured the nymphs of two Indian species, *O. atkinsoni*[4] and *O. campioni*.[5] From these sources we have drawn the characters stated in the preceding keys and tables. These will be sufficient for the recognition of the nymphs of *Orogomphus*.

GOMPHIDÆ

Key to the genera.

ADULTS

1. Triangles with crossveins; anal loop of four to six cells .... 2.
   Triangles open; anal loop of fewer cells or wanting .... 3.
2. A leaflike lateral expansion on segment 8 .... *Ictinogomphus*.
   No such expansion on segment 8 .... *Gomphidia*.
3. Median fork askew forward; median crossveins in hind wing 4 or 5 .... 4.
   Median fork symmetrical; median crossveins in hind wing 1 or 2. *Mesogomphus*.
4. Basal subcostal crossvein present; male appendages straight. *Leptogomphus*.
   Basal subcostal crossvein absent; male appendages lyrate. *Heliogomphus*.

NYMPHS

1. Tarsi 2- 2- 2-jointed .... 2.
   Tarsi 2- 2- 3-jointed .... 3.
2. Two large teeth between the bases of the antennæ; abdomen almost circular when viewed from above; body opaque .... *Gomphidia*.
   No teeth between antennæ; abdomen elongate; body in life translucent. *Ictinogomphus*.
3. Third joint of antennæ very broad and flat .... *Heliogomphus*.
   Third joint of antennæ cylindrical .... *Mesogomphus*.

[4] Mem. Dept. Agr. India Ent. Ser. 8 (1923) 29–30, fig. 1, A, B.
[5] Rec. Ind. Mus. 27 (1925) 423–429, pl. 10.

ICTINOGOMPHUS TENAX Sélys. Plate 3, fig. 51.

SÉLYS, Bull. Acad. Belg. II 21 (1854) 88, male, Manila; Monogr. Gomph. (1857) 269; Bull. Acad. Belg. II 46 (1878) 85, female; WILLIAMSON, Proc. U. S. Nat. Mus. 33 (1908) 278; SCHMIDT, Archiv f. Hydrobiol. Suppl. 13 (1934) 355–360, figs. 59–61.

Of this fine large species, known in the male sex since 1854, and recently recharacterized by Erich Schmidt, the female has been until now unknown. (The one of unknown source that was doubtfully associated by de Sélys with his male type probably does not belong with it. The likeness in arrangement of the weak crossveins within the triangle of the forewing is not significant, for these are variable, and there are differences in coloration other than those mentioned by de Sélys.) The presence of a pair in the material from Los Baños enables us to describe this sex from a Philippine specimen.

Female, allotype, length, 75 mm; abdomen, 53; hind wing, 42.

A robust black species, conspicuously striped with yellow on head and thorax and spotted with reddish yellow on the abdomen. Face black, crossbanded with yellow on the prominence of the frons, on the lower part of the postclypeus, and on the labium. On the labium divided in the middle and reduced at the ends to a pair of roundish spots. Clypeal stripe dilated at the ends. Labium and mandibles externally yellow. The black on top of the frons invades the yellow in an advancing triangle, almost dividing it in the middle. Vertex wholly black, with a sharply conical process arising behind each lateral ocellus. Occiput black, with a large oval spot of yellow occupying its central area, and with its hind margin fringed with tawny hairs and elevated in a pair of triangular processes. (These are similar to those of the female of *I. melænops* as figured by Schmidt [6] but larger.)

Prothorax blackish. Mesothoracic collar yellow, this color narrowly interrupted by the lower end of the black carina. Sulcus and hind margins of the antealar sinus yellow. Antehumeral yellow stripes divergent, isolated, narrowed and abbreviated below. All of the four additional yellow side stripes are isolated by black both above and below. The fourth is widest and semilunar, the second is wide and parallel-sided, the first and third are narrow and irregular, dilated at the uppermost end and somewhat constricted below it (Plate 3, fig. 51). Coxæ and stripes of the femora yellow; legs elsewhere black.

[6] Archiv f. Hydrobiol. Suppl. 13 (1934) 357, fig. 57*b*.

Wings subhyaline with black veins and stigma and with a distinct tinge of brown in the basal subcostal and cubital spaces. Twelve postnodal crossveins of the forewing.

Abdomen very moderately swollen at base, still less on terminal segments, and with the leaflike lateral expansion of segment 8 so narrow as to be hardly observable. Dorsum of segment 2 bears a median stripe of yellow, constricted towards the posterior end. This is followed by larger, broader, basal, double, reddish yellow spots on 3 to 7, becoming shorter and more deeply divided posteriorly, well separated and lateral on 8 and 9, small on 9. The sides of segments 1 to 3 are washed with yellow below; remainder of abdomen and appendages deep black (Plate 1, fig. 1).

LUZON, Laguna Province, Los Baños, female allotype, August 5, 1930 (*F. Bernardo*), female, August 25, 1925 (*A. de la Cruz*), male, no date or collector.

The left forewing of the second female alone has the triangle divided as described by de Sélys for the type: "Les deux veines du triangle des superieurs non confluentes."

GOMPHIDIA KIRSCHII Sélys. Plate 1, figs. 4 and 5; Plate 3, fig. 53.

SÉLYS, Bull. Acad. Belg. II 46 (1878) 81–83, male, female, Luzon, Mindanao; An. Soc. Esp. Hist. Nat. 11 (1882) 16; MARTIN, Mission Pavie Zool. (1904) 14, Philippines, Borneo, Tonkin; WILLIAMSON, Proc. U. S. Nat. Mus. 33 (1908) 281; LAIDLAW, Proc. Zoöl. Soc. London 1 (1914) 53; Part III (1920) 317 ("*karschi*"); Trans. Ent. Soc. London 78 (1930) 178.

Male, abdomen, 48 mm; hind wing, 38.

Female, abdomen, 45 mm; hind wing, 42.

Black, marked with saffron yellow.

Labrum yellow, largely bordered and traversed with black; anteclypeus yellow; clypeus black with a large yellow spot on the lateral lobes; front yellow and having above a large basal black spot prolonged in a cone in the middle and rejoining a large transverse anterior band of the same color, surmounting the clypeus. Top of the head black as well as the back of the eyes.

Thorax black, marked with yellow as follows: A mesothoracic half collar, interrupted on the back; an oblique cuneiform antehumeral band separated from the sinus and not touching the half collar (and sometimes a little superior humeral spot almost touching this band). On the sides a band under the front wing, another larger band under the hind wing, and a series of two or three spots placed in the black intermediary space (Plate 3, fig. 53).

Abdomen black, marked with yellow as follows: A large lateral inferior band on the first two segments; a dorsal spot on the second, slendered and pointed towards the tip, which it does not touch; an elongate lateral spot which occupies the basal third of segments 3 to 7, that of segment 8 prolonged towards the base in a half circle; 9 and 10 black. No leaflike expansions of segment 8.

Legs robust, very short, interior of the anterior femora yellowish, as also a touch on the posterior.

Male.—Lamina of the occiput straight. Anal appendages blackish; the superior longer than the last segment, subcylindrical, slender, almost straight; inferiors one quarter as long as the superiors, forked (Plate 1, figs. 4 and 5).

Female.—Lamina of the occiput black or with a pale spot, briefly ciliated, elevated in the middle, the superior border of this elevation truncate, straight. Anal appendages black, conical, pointed, as long as the last segment (1 and 0.5 mm). Vulvar scale as long as segment 9, divided almost halfway into two leaves by a deep cut. (From the original description.)

LUZON, Laguna Province, Los Baños, male, February 7, 1919 (*S. G. Yap*), male, July 3, 1921 (*Sueco*), male, August 25, 1926 (*S. M. Cendaña*), female, February 23, 1930 (*S. M. Cendaña*), female, June 19, 1930 (*D. Tan*), female, July 5, 1930 (*J. Calacala*).

GOMPHIDIA KIRSCHII (?) Nymph. Plate 10, figs. 129 and 130.

Length, 24 mm; abdomen, 16; hind femur, 7; width of head, 8; width of abdomen, 12.

This is a very short and stocky nymph. Head widest across the eyes where the eyes project a little beyond the roundly bulging hind angles. Before them the frontal area is flat. On the front margin of it, between the bulging bases of the antennæ, a pair of blunt spiniferous teeth project forward, overhanging the mouth, and outside the antennal bases the projecting convex margins are armed with recurved prickles intermixed with hairs. Antennæ 4-jointed, the fourth exceedingly minute, the third long, cylindric, and hairy. The broadly convex rear of the head is covered by five large scars, the median one bare, the adjacent pair divided in its anterior half by a blackish line of scurfy pubescence, the larger lateral pair traversed by marmorate lines of the same. Labium (Plate 10, fig. 129) very short, its hinge reaching backward only to the mesothorax; its lateral lobes small and set well in from the sides of the mentum. The movable hook is rather short and stout; the end hook half as long, rather blunt at the tip, and very finely denticulate along the middle portion of its inner margin. The broad mentum is hardly as long as wide, median lobe small, its slight convexity is hidden in a dense brush of hairs. The outer margin of the mentum is beset with flattened and serrately arranged spinules that suddenly increase in size at the sharp anterolateral angles.

Prothorax short and wide, the ends of its disc roundly projecting above a similar equally flat supracoxal process. Legs short and stout; femora and tibiæ twice faintly ringed with brown, and lined with bare strips separating strips of blackish prickles. The anterior face of each femur bears at its tip a flange that projects scalelike over the base of the tibia, that of the forelegs being largest—a protective device for the legs of a lotic species. The wing cases reach to the tip of abdominal segment 6.

Abdomen broadly oval, blunt at tip, triquetral in cross section, being high-ridged middorsally, and humped upward on segment 7. Stout, triangular, subequal spines terminate the lateral margins of segments 7 to 10, those of 7 a little divergent. Dorsal hooks on 4 to 9, isolated on 4, mere prolongations of the median ridge on 5 to 9, largest on 7. Segment 10 wholly recessed within 9 on the ventral side, but exposed on the dorsal for a length slightly greater than that of the stout appendages. Superior appendage triangular, a little longer than wide, a little shorter than the inferiors and like them blunt-tipped. Laterals slenderer, sharp-pointed, and a little shorter.

The reference of these nymphs to *G. kirschii* is based on the common occurrence of nymphs and adults, each of a single species, in Molawin Creek, Los Baños. That they belong to *Gomphidia* is certain since the rearing by Doctor Lew of *Ictinogomphus* (= *Ictinus*) *clavatus* (genus formerly confused with *Gomphidia*) at Peiping, China.[7]

Luzon, Laguna Province, Los Baños, 4 nymphs, April 1, 1927 (*L. B. Uichanco*); Molawin Creek, 3 nymphs, June 18, 1930 (*S. M. Cendaña*), Molawin Creek, Mount Maquiling at 200 feet, 3 nymphs (2 and a cast skin), April 9, 1932, no collector.

[7] Peking Nat. Hist. Bull. 6 (1931) 1.

MESOGOMPHUS BALNEORUM sp. nov. Plate 1, figs. 8, 11, and 12; Plate 3, figs. 46 and 55.

Male, hind wing 28 mm; abdomen, 33; appendage, 4.

Colors deep black and yellow. Face yellow, broadly cross-striped with black. Labrum yellow in the middle, a broad band along its basal suture, a little dilated downward in the middle, only slightly invading the yellow, and a narrow one around its free border. An arcuate band borders the postclypeus in front, its ends conjoined with the black below at the basal angles of the labrum. Frons black in front except close to the post-clypeal suture, shiny black above with a large transverse, oblong, yellow spot on each side. Vertex black with a faint yellow spot on the rear of the ocellar tubercle. Antennæ black, the basal segments ringed with paler. Occiput fuscous, its hind margin concave and nearly bare.

Prothorax black above with only a faint yellow spot on each side of the median lobe. Synthorax black, conspicuously marked with bright yellow. The collar cross stripe divided widely by black at the carina. Two oblong yellow antehumeral spots are divergent downward, and well isolated both above and below. A humeral stripe is represented by a triangular spot above and a narrow line below. There is a broad oblique yellow stripe under each wing, in the hinder one broader and subterminal, and in the black between these two stripes is a row of three spots, the middle one close behind the spiracle narrower (Plate 3, fig. 55).

Legs mostly black, only the sides of the femora yellow. Wings hyaline, faintly flavescent, with black veins including the costa (Plate 3, fig. 46). Stigma dark brown.

Abdomen black, marked with yellow. Dorsum of segment 1 about half covered by a broad apical triangle of yellow, followed on segment 2 by a yellow middorsal line. A double, diffuse, yellowish spot on the dorsa of segments 3 to 7, divided on the median line apically, becoming somewhat shortened and better defined rearward. Sides of segments 1 and 2 yellow inferiorly. On the sides of 8 and 9, just above the large leaf-like lateral expansion of those segments, a double, irregular yellow spot.

Appendages (Plate 1, figs. 11 and 12) black, the superior equal in length to segments 9 and 10, regularly tapered and decurved to their slender downwardly directed tips. Hamules as shown in Plate 1, fig. 8.

This species resembles *M. lindgreni* Fraser, from Darjeeling, India, in size, in the black costa, and in the male appendages, but differs in numerous details of coloration and especially in the form of the male inferior appendage.

LUZON, Laguna Province, Los Baños, 2 males, November 6, 1923, no collector.

MESOGOMPHUS sp. Nymph. Plate 10, figs. 125 and 126.

Male, length, 27 mm; abdomen, 13; hind femur, 3.5; width of head, 5.5; width of abdomen, 6.5.

Female, length, 26 mm; abdomen, 12; hind femur, 3.5; width of head, 5.5; width of abdomen, 6.5.

This is a smooth-bodied hairy-legged nymph with a lanceolate abdomen. Head widest across the middle where the large eyes cover most of the sides, scarcely narrowed behind them to the broadly rounded hind angles. Occipital margin deeply and widely concave; hairy before the eyes and across the frons. Antennæ rather long with the slender upturned fourth joint one-third as long as the cylindric third joint. Labium (Plate 10, fig. 126) short, its hinge reaching backward well upon the mesothorax. Mentum almost parallel-sided in its wider distal two-thirds with a very prominently arched middle lobe that bears a long and uniform fringe of stiff, flattened, bristles. Lateral lobes rather small with a short movable hook that is hardly as long as the outer margin of the lobe before its origin, and with a small end hook half as long as the movable one, smooth on its inner margin.

Prothorax rather large, its disc depressed with its rounded lateral margins little projecting, beneath these the straight-edged supracoxal process projects moderately. Wing cases divergent (possibly because in process of emergence), their tips reaching segment 5.

Abdomen lanceolate with something of a color pattern showing on the middle segments: A pair of submedian dashes on each segment and a patch of brownish scars farther out towards the lateral margin. Low dorsal hooks on segments 2 and 3, smaller on 8 and 9, and scarcely indicated on the intervening segments. Lateral spines on 3 to 9, sharp, similar in all but slightly increasing in size posteriorly. Appendages long, longer than 9, sharp, regularly tapering, all subequal in length.

LUZON, Laguna Province, 1 female nymph, January 27 to February 18, 1931, no collector; Molawin Creek, 1 male nymph, June 18, 1930 (*S. M. Cendaña*). These specimens may be of different species.

LEPTOGOMPHUS SEMPERI Sélys.

SÉLYS, 4. Addit. Synop. Gomph. (1878) 38, male, Mindanao; An. Soc. Esp. Hist. Nat. **11** (1882) 16; MARTIN, Mission Pavie Zoöl. (1904) 11, Philippines, Borneo, Tonkin; WILLIAMSON, Proc. U. S. Nat. Mus. **33** (1908) 292, fig. 17; RIS, Suppl. Ent. **1** (1912) 68; LAIDLAW, Proc. Zoöl. Soc. London **1** (1914) 54; (1920) 317; Rec. Ind. Mus. **24** (1922) 378; FRASER, Journ. Bomb. Nat. Hist. Soc. **31** (1927) 883; LAIDLAW, Trans. Ent. Soc. London **78** (1930) 179.

Male, abdomen, 39 mm; hind wing, 33.

Head grayish brown mixed with yellowish and blackish. Labrum and face obscure; top of front with a lemon yellow band traversed by a fine median prolongation in the excavation forming a T in joining the blackish part of the crest; vertex and occiput obscure; the latter little elevated, ciliated with brown, on the border a little divided in two festoons; the middle being excavated.

A median lemon-colored spot on the prothorax. Thorax short, probably obscure in front, the sides pale yellow. Irregular black spots, probably disposed in two bands on the sutures and not touching the base.

Abdomen long, slender, uniform, at the base a little constricted and lightly expanded on segments 8 and 9. Colors altered, probably blackish marked with yellow. The yellow seems to occupy in a dorsal band segments 1 and 2 and the auricles; on 3 to 6 a large basal half circle and a part of the dorsal ridge; on 7 and 8, the dorsal ridge in a more distinct fashion; finally the dorsal ridge of segment 9, but only at the base. Segment 10 is entirely obscure, a little shorter than 9.

Anal appendages yellowish, the superiors a little shorter than segment 10 (about 1 mm long); they are remote, slim, subcylindrical, straight, slightly thickened at the base, briefly bifid at the tip, which is obscure; the external point a little longer than the internal. The inferior border, seen in profile with a lens, shows a series of very small black teeth. The inferior appendage a little shorter, almost completely divided in two slender, conical branches a little recurved to a blunt obscure tip, slightly slanted on the outside, the branches having the same separation as the superiors.

Legs very short, yellowish, the tip of the femora obscure, the spines blackish, those on the femora on short tubercles.

(Description from the original, which was drawn from one very poorly preserved specimen.)

No specimens have been before us.

HELIOGOMPHUS BAKERI Laidlaw. Plate 1, figs. 9, 10, and 14; Plate 3, figs. 47 and 54.

LAIDLAW, Philip. Journ. Sci. 28 (1925) 560–562, male, Mount Maquiling, Luzon; Trans. Ent. Soc. Lond. 78 (1930) 182.

Male, abdomen, 33 to 39 mm; hind wing, 29 to 35.

Female, abdomen, 42 mm; hind wing, 39.

Female allotype.—Labium blackish with a diffuse yellowish U-shaped mark in the center and a large pale oval spot in each of the upper lateral corners. Genæ yellow. Anteclypeus yellow. Postclypeus blackish with a medium-sized quadrate pale spot in the center of each lateral border and a small median yellow spot on the lower border. Frons yellow with a goblet-shaped dark spot bisecting it medially. Lower part of vertex yellow except for triangles of blackish at the bases of the antennæ. Median part black. Top of vertex excavate and dull fuscous yellow. Occiput yellowish fuscous, concave on margin except for a very small median point.

Anterior lobe of prothorax yellow with anterior margin black. Median lobe black, broadly bordered laterally with pale yellow, which continues along the caudal border to a point just laterad of two medium-sized pale yellow spots, which almost join on the middorsal line. Posterior lobe black, with a heart-shaped yellow spot, which almost bisects it. Synthorax black on dorsum. Mesothoracic collar yellow, interrupted at the center and joined at the lateral extremities to the ends of the dorsal bands. Two very small conjoined yellow spots in the center of the black, which interrupts the collar. Laterad of the dorsal bands at their upper ends there is a roughly triangular yellow spot and at the lower end a very small touch of yellowish (the latter not always present). Sides pale yellow with a narrow dark stripe on each lateral suture—all joined narrowly dorsally and the first two joined more broadly ventrally. Legs blackish. Front and middle femora paler on the inside. Wings hyaline, very slightly flavescent towards the base. Veins, including costa, all black. Pterostigma yellow. Antenodals and postnodals 18 : 15 and 12 : 15 in fore and hind wing, respectively.

Abdomen black, marked with yellow as follows: A stripe of irregular width on segments 1 to 7; a small basal and a larger apical half ring on segment 1; lateral half of segment 1; a broad lateral band, broader on the basal than on the apical half on segment 2; lateral band on segment 3 broken into two, the basal half broader and better defined than the apical; a large basal, roughly triangular, lateral spot on segment 4; 5 missing; a similar but more nearly quadrate spot on 6; a ring covering the basal fourth of 7; a basal dorsal spot, a basal lateral J-shaped spot, and an apical unciform spot on 8; a narrow apical half ring on 9; a dorsal apical border and median dorsal triangular spot on segment 10. Appendages brown at base, paler apically. Subgenital plate as shown in Plate 1, fig. 14.

Male.—Labrum yellow, narrowly bordered with black. Black along the clypeolabial suture extending downward in a broad median line almost bisecting the yellow of the labium. Anteclypeus yellow, with a dark band on its lower border interrupted at the middle and a dark round spot a little above the center. Postclypeus black with a small median yellow spot contiguous with the color of the anteclypeus and a very large triangular yellow spot on each side. Frons yellow with a broad black line bisecting it vertically. Vertex black with a transverse yellow band above the antennæ and below the paired ocelli. Occiput black, concave on rear margin.

Anterior lobe of prothorax yellow, narrowly bordered anteriorly with black. Median lobe black with a small round yellow spot on each side of the middorsal line, lateral borders broadly yellow. Posterior lobe black with a small posterior median dorsal yellow spot. Dorsum of thorax black marked with yellow as follows: Mesothoracic collar yellow, interrupted in the middle, joined at sides by the ends of the dorsal bands; at outer sides of these at the upper end a triangular spot and at the lower end a small streak. Sides yellow with a dark stripe on each lateral suture, all narrowly joined dorsally and the first and second joined ventrally (Plate 3, fig. 54). Venter yellow. Legs black, posterior femora touched basally with yellow on the inside. Wings hyaline, very slightly flavescent at extreme base (Plate 3, fig. 47). Veins, including costa, black. Stigma yellow-brown. Antenodals and postnodals 13: 13 and 10: 10 in fore and hind wings, respectively.

Abdomen black, marked with yellow as follows: A narrow line on dorsum of segments 1 to 7, widened to form a half ring on the apical half of segment 1 and somewhat widened on the apical half of 2; a spindle-shaped dorsal spot on the base of segment 8; a small lateral basal triangular spot on 5 and 6; a somewhat quadrate spot on the base of 7 and a more broadly triangular one on the base of 8; an apical lateral triangular spot on segment 7 and an L-shaped one on 8. Segments 9 and 10 entirely black. Superior anal appendages lyrate (Plate 1, figs. 9 and 10), with an ectolateral projection shortly before the point where they begin to curve inward, the tips curved upward, yellow at the tips, shading gradually to black at the base. Inferior appendage black, with widely divaricate branches, slightly curved upward at tip.

LUZON, Laguna Province, Los Baños, 1 male, May, 1915 (*F. Otanes*), 1 female, February 29, 1932 (*C. Antenor*). NEGROS, Saravia, 1 male, December 4, 1929 (*W. D. Pierce 7*).

HELIOGOMPHUS BAKERI (?) Nymph. Plate 10, figs. 121 and 122.

Length, 25 mm; abdomen, 16; hind femur, 7; width of head, 6; width of abdomen, 13.

This is an elongate flattish nymph with broadly linear abdomen. Head widest behind the middle across the large and somewhat prominent eyes, regularly narrowed behind to the low hind angles. A forward projection of the frons forms a raised semicircular area between the bases of the antennæ. Third joint of antennæ a very broad thin pentagonal plate nearly as wide as long and as broad as the space between the compound eyes. Labium (Plate 10, fig. 121) rather short, its hinge reaching the mesothorax. Lateral lobes rather narrow, with short and blunt end hook and with irregularly and minutely dentate inner margin. Movable hook long and sharp, slightly longer than the lateral lobe. Median lobe rather prominent, regularly convex, with a lower row of peglike chitinous denticles, and along their upper side a line of stiff flattened hairs that are inclined upward. Mentum a little longer than wide at apex, widened from base to apex, its side margins smooth. At the sides of the labium on the undersurface of the head is a longitudinal ridge that rises in two projections, the anterior of which is visible from above in front of the eye.

Prothorax short, its dorsal disc somewhat crescentic with blunt scurfy-pubescent anterolateral angles. Below these angles a supracoxal process projects laterally as a squarish plate. Legs brown, concolorous, scurfy-pubescent except for the usual curved longitudinal bare lines on them. Femoral apical flanges well-developed on all legs. Wing cases reach the base of the sixth abdominal segment.

Abdomen rather flat, parallel-sided for most of its length. brown with a row of irregular pale spots each side of the middle segments. Lateral spines on segments 7 to 9, triangular, subequal, becoming spinulose-serrate to rearward on outer margin. Dorsal hooks on segments 2 to 9 low, ridgelike, increasing in length to rearward, on 9 reaching the apex of 10. Segment 10 annular, almost included in the apex of 9. Appendages short, half as long as 9; laterals and superior equal but a little shorter than the inferiors.

Determined generically by nymphal wing venation.

LUZON, Laguna Province, 2 nymphs, January 27 to February 18, 1930, no collector; Los Baños, 1 nymph, June 18, 1930 (*S. M. Cendaña*); Molawin Creek, at 200 feet, 8 nymphs, June 9, 1932, no collector.

ÆSCHNIDÆ

Key to the regional genera.

ADULTS

1. Vein Rs simple .... 2.
   Vein Rs forked .... 3.
2. Two cell rows between veins M_1 and M_2 behind the stigma. *Oligoæschna.*
   Three cell rows between veins M_1 and M_2 behind the stigma. [*Linaæschna*].
3. Sectors of the arculus arising from its upper end, the base of the upper sector nearer to vein R than to the middle of the arculus. 4.
   Sectors lower on the arculus, the base of the upper nearer to the middle than to vein R_1 .... 6.
4. Anal loop of two vertical cell rows; three cell rows in the terminal fork of Rs .... *Anaciæschna.*
   Anal loop of three vertical cell rows; two cell rows in the terminal fork of Rs .... 5.
5. With an extra lateral longitudinal carina on the middle abdominal segments, and with several bridge crossveins .... *Anax.*
   With no extra lateral longitudinal carina on the middle abdominal segments, and with but a single bridge crossvein .... [*Hemianax*].
6. With crossveins in the midbasal space .... 7.
   With no crossveins in the midbasal space .... 9.
7. Two cell rows between Cu_1 and Cu_2 where widest apart. [*Amphiæschna*].
   One cell row between Cu_1 and Cu_2 where widest apart .... 8.
8. The median planate subtends four rows of cells .... *Indæschna.*
   The median planate subtends one row of cells .... [*Cephalæschna*].
9. Radial planate straight, subtending a single row of cells. [*Æschnophlebia*].
   Radial planate strongly sagged, subtending four or five cell rows .... 10.
10. One cell row between veins Cu_1 and Cu_2 .... *Gynacantha.*
    Two or three cell rows between veins Cu_1 and Cu_2 .... *Tetracanthagyna.*

NYMPHS

1. With dorsal hooks on apical abdominal segments .... *Tetracanthagyna.*
   No such dorsal hooks .... 2.
2. With lateral spines on segments 7 to 9 .... *Anax.*
   With lateral spines on segments 6 to 9 .... *Gynacantha.*
   With lateral spines on segments 5 to 9 .... *Amphiæschna?*

Names in the foregoing key that are inclosed in square brackets are of genera not yet recorded from the Philippines, but their species are strong-flying and the genera are of regional (mostly southward) distribution and likely to be represented in the Islands.

Verification table.

Genus.	Forewing.					Hind wing.	
	Cross-veins in midbasal space.	Brace vein to stigma.	M_4 turns—	Fork of Rs.	Cell rows subtended by radial planate.	Cubito-anal cross-veins.	Length.
							mm.
Æschnophlebia	No	No	Out [a]	Straight	1–2	3	44
Amphiæschna	Yes	No	Out	Variable	6	6–9	55–62
Anaciæschna	No	Yes	Up [b]	Sagged	4–5	3–4	42–46
Anax	No	Yes	Up	do	4–5	4–5	48–55
Cephalæschna	Yes	Yes	Out	Straight	1	4–5	41–44
Gynacantha	No	Yes	Out	Sagged	4–5	6–8	39–52
Hemianax	No	Yes	Up	do	4–5	4	45–46
Indæschna	Yes	No	Out	do	4–5	7–9	60
Linæschna	No	Yes	Out	None	1–2	2	53
Oligoæschna	No	Yes	Out	do	1	2	35–42
Tetracanthagyna	No	No	Out	Sagged	4	8	60–66

[a] That is M_4 is in its normal position. [b] M_4 apparently conjoined with M_3.

Genus OLIGOÆSCHNA Sélys

(=*Jagoria* Karsch)

In this primitive genus two species are represented in the collections before us, one of which has long been known and the other is new. The nymphs are unknown.

OLIGOÆSCHNA PŒCILOPTERA Karsch.

KARSCH, Ent. Nachr. 15 (1889) 238 (in *Jagoria*), Luzon; SÉLYS, An. Soc. Hist. Nat. Esp. 20 (1891) 212; MARTIN, Cat. Coll. Sélys 18 (1908) 130–132 (in *Jagoria*), Sumatra, Borneo.

A single female from Mati, Davao, Mindanao. Its wings are stained with brown deeply at the base, especially before the arculus, the color fading before the level of the nodus in the forewing and just beyond in the hind wing. Length of hind wing 42 mm.

OLIGOÆSCHNA ZAMBO sp. nov. Plate 2, figs. 33 and 34; Plate 3, fig. 48.

Length, 53 mm; abdomen, 49; hind wing, 38.

Entire face brownish olivaceous with a tinge of reddish. Top of frons and antennæ brown. Vertex and occiput black.

Synthorax brown, thinly clothed with blackish hairs, and with carina and crest somewhat paler. On the front a pair of ill-defined, antehumeral, pale streaks, divergent downward, and just above each of them an equally obscure, transverse, pale streak below the crest. On the sides are two broad and very diffuse yellowish streaks, one under each wing, overlaid on their opposed margins by some wavy lines of fuscous. Legs brownish at base, becoming black distally. Wings (Plate 3, fig. 48) subhyaline, tinged with yellow almost out to the triangles; veins and stigma brown. Ante- and postnodals 18 : 9 and 13 : 11 in fore and hind wings, respectively. First and sixth antenodals thickened.

Abdomen slender, inflated on the two basal segments, constricted on segment 3 then parallel-sided to 10, which is bulged upward and dome-shaped on the dorsal side. The color is brown with pale markings that cover the base of segment 1, most of the sides of 2, a transverse dorsal subapical band on 2 to 7, a lateral subbasal spot on 3 to 7, and an oblique streak beside the curving impressed line near the middle of each side on 3 to 6. Segments 1 and 2 hairy above.

Appendages (Plate 2, figs. 33 and 34) blackish, twice as long as segment 10, inferior nearly as long as the superiors, the latter flattened and dilated towards their obliquely truncate tips and armed on their interno-inferior margin with a row of denticles.

MINDANAO, Zamboanga Province, Kabasalan, 1 male, type, July, 1932 (*H. C. Muzzall;* Cornell University collection). Another male lacking the last four segments of the abdomen, same data.

This species is nearest *O. buhri*, from North Borneo, but differs markedly in the form of the male appendages, lacking the large basal inferior tooth of that species and having instead a row of several interno-inferior denticles on the superior appendage.

Genus ANACIÆSCHNA Sélys

This well-known, widely distributed Oriental genus appears not to have been reported hitherto from the Philippines. It is represented in our collections by the following species.

ANACIÆSCHNA JASPIDEA Burmeister.

BURMEISTER, Handb. Ent. 2 (1839) 840 (in *Æschna*); BRAUER, Reise d. Novara (1866) 63 (in *Anax*); SÉLYS, Mitth. Mus. Dresden 3 (1878) 317; MARTIN, Cat. Coll. Sélys 18 (1909) 30 (figs.); NEEDHAM, Bishop Mus. Bull. 113 (1932) 22 (fig.).

Hind wing, 42 to 46 mm.

This yellowish æschnine is easily recognized by the oblique brown stripe laid on the middle of the side of its yellow synthorax. Four specimens only are before us.

LUZON, Laguna Province, Mount Maquiling, 1 female (*Baker*); Los Baños, 1 female, February 28, 1934 (*Ramon Quilapio*), 1 male, November 21, 1934 (*B. Hollero*), altitude 50 meters, 1 female, November 22, 1934 (*Mateo R. Tibay*).

Genus ANAX Leach

This cosmopolitan genus is represented in the Philippines by three recorded species, two of which have been before us. They may be distinguished as follows:

1. Smaller; hind wing 50 mm or less .... *julius*.
   Larger; hind wing 51 mm or more .... 2.
2. Middle abdominal segments with three rather large pale spots. *guttatus*.
   Middle abdominal segments with but two smaller spots.... *gibbosulus*.

Anax julius is further distinguished by a blackish bar across the prominence of the frons, followed by one of blue; also, in the male, by the form of the abdominal appendages as shown in the figure. The dorsum of the abdomen is covered by a broad brown band, below which is a much interrupted band of paler on each side (often obscure in dried specimens).

Anax guttatus and *A. gibbosulus* are distinguished with difficulty, being of about equally large stature and similar and equally variable coloration. In both the brown color of the abdomen is extensive, the pale color of the sides being broken into smaller and well-segregated spots. *Anax guttatus* has the prominence of the frons pale, while *gibbosulus* has a brown stripe across it that is generally connected more or less broadly with the brown before the ocelli, forming a T-spot above.

The appendages of the male are typically a little heavier with a stouter apical tooth in *A. gibbosulus* (Plate 2, figs 21 and 22), and the undersurface is more nearly straight; but they appear differently according to the position in which they are viewed, and we are inclined to think that they alone will hardly serve to distinguish the two species. The same may be said concerning the form of the abdominal appendages of the female, which are typically more obtuse at the apex in *A. gibbosulus*. There is greater elongation and narrowing of abdominal segment 3, especially in the male, that is, enough for recognition in well-preserved specimens.

ANAX JULIUS Brauer. Plate 2, figs. 23 and 24.

BRAUER, Verh. zool.-bot. Ges. Wien 17 (1865) 508, Hongkong; Reise d. Novara, Neur. (1866) 61, 63; SÉLYS, C. R. Ent. Soc. Belg. 27 (1883) 116; MARTIN, Cat. Coll. Sélys 18 (1909) 21.

Japan, China, Formosa, Bengal.

Hind wing, 48 to 50 mm.

ANAX GUTTATUS Burmeister. Plate 2, figs. 25 and 26.

BURMEISTER, Handb. Neur. 2 (1839) 840 (in *Æschna*), male, female, Java; BRAUER, Reise d. Novara, Neur. (1866) 62; HAGEN, Verh. zool.-bot. Ges. Wien 17 (1867) 39; MARTIN, Cat. Coll. Sélys 18 (1909) 23; LIEFTINCK, Treubia 8 (1930) 328, Supplement.

East Indies, Seychelles Islands, Queensland.

Hind wing, 51 to 54 mm.

A nymph referred to this species by supposition was described and figured by the senior author. [8]

LUZON, Manila, 1 female, July 26 (*W. Schultze*), 1 male, November 3, 1933 (*Fortunato Guzman*), 1 male (*McGregor*): Laguna Province, Laguna, 1 male, May, 1932 (*Muzzall*); Los Baños, 1 female, February 21, 1925 (*F. Leus*), 1 female, February 23, 1930 (*Pangramuyen*), 1 female, August 2, 1930 (*F. Isidoro*), 1 female, September 6, 1930 (*C. Reyno*), 1 male, July 8, 1931 (*L. T. Viado*), 2 males (*Baker*). MINDANAO, Zamboanga Province, Kabasalan, 1 male (*Muzzall*).

ANAX GIBBOSULUS Rambur. Plate 2, figs. 21 and 22.

RAMBUR, Hist. Nat. Neuropt. (1842) 187, male, Australia; BRAUER, Reise d. Novara, Neur. (1866) 62; RIS, Libell. Bism. Arch. (1900); MARTIN, Cat. Coll. Sélys 18 (1909) 24.

Australia, Kei, New Guinea, Philippines.

Hind wing, 54 to 55 mm.

LUZON, Mountain Province, Benguet, 1 male and 1 female: Laguna Province, Los Baños (?), 1 male, no collector.

Genus INDÆSCHNA Fraser

Neither this genus nor *Amphiæschna*, from which it was separated by Fraser, [9] has been reported from the Philippines hitherto. We have the adult of a new species, closely allied to the type, *I. grubauri*, that is known from Malacca, Borneo, and Java. We describe it herewith and follow it with the description of a nymph that appears to belong in the allied genus *Amphiæschna* in so far as its developing venation can be seen.

[8] Proc. U. S. Nat. Mus. 27 (1904) 695, pl. 40, fig. 2.

[9] Treubia 8 (1926) 474.

INDÆSCHNA BALUGA sp. nov. Plate 2, figs. 31 and 32.

Length, 90 mm; abdomen, 65 (width, approximately 7); hind wing, 60.

This is a long-winged blackish species. Head wide, with eyes meeting in a seam that comprises half the length of the head. Face green, becoming blackish on the front of the frons, and hairy around the sides; labrum pale brown on its emarginate free border. Top of head all blackish. Antennæ reddish. Occiput deeply concave in the rear, bare, shining.

Synthorax blackish, clothed with brown pubescence, with obscure pale markings as follows: A pair of isolated cuneate antehumeral spots on the front, tapering and divergent downward; an oblique lateral band under each wing, ill-defined, the rear one more than twice as wide as the other and covering most of the metepimeron. Legs black beyond the knees, dark rufescent basally, long and nearly bare. Wings subhyaline, faintly tinged with amber, the latter color forming a number of faint clouds towards the rear margin. Veins and stigma dark brown. Ante- and postnodals 42: 29 and 27: 35, respectively, with the first and thirteenth or fourteenth thickened.

Abdomen blackish, paler on the sides of the two basal segments and with subapical paler rings on segments 3 to 7, widest on 3, very narrow on 7. Segments 8 to 10 black. The two basal segments hairy, especially on the dorsum, and a median carina on segment 1 is raised on the posterior half in a semicircular ridge that is densely hairy. Segment 10 bears a low middorsal ridge that is elevated in a tooth at one-third of its length that, viewed from the side, is a nearly equilateral triangle. Appendages as shown in Plate 2, figs. 31 and 32.

LUZON, Tayabas Province, Mount Banahao, elevation 975 meters, 1 male, type, May 20, 1933 (*A. Y. Coronel*).

This species is closely allied to *I. grubaueri* Förster, but seems to differ in lacking the brownish color along vein M_1 in having the metepimeron more extensively pale, in having a semicircular middorsal prominence on segment 1 of the abdomen (not mentioned, at least by Förster), in having the dorsal tooth on segment 10 smaller and more remote from the base, and in having the principal dilation of the superior appendages of the male narrower.

? AMPHIÆSCHNA sp. ? Nymph (supposition). Plate 10, figs. 119 and 120.

Length, 54 mm; abdomen, 39; hind femur, 12; width of head, 11; width of abdomen, 11.

This is an elongate smooth nymph with wide flat head and brown-ringed femora. Head widest across the broadly rounded eyes, and narrowed rather regularly behind them to the broadly truncate hind angles, between which the hind margin is roundly notched. Antennæ 6-jointed, the last joint very long, comprising nearly half the flagellum. Labium (Plate 10, fig. 120) rather broad and flat. Lateral lobes about as long as the regularly curved and tapering movable hook, truncate on the end which terminates the inner angle in a large prominent tooth, proximal to which on the inner margin a row of about fifteen minute denticles. Median lobe a little produced, with a narrow median cleft. At each side of the cleft a minute tooth almost hidden in a marginal fringe of hairs. The mentum is suddenly widened at two-fifths of its length and then again parallel-sided to the base of the lateral lobes, with margins spinulose-serrate.

Disc of prothorax almost semilunar, with the anterolateral ends of the crescent projecting. The supracoxal process bears a long middle tooth, a shorter and wider posterior one, and a low and inconspicuous anterior one. The synthorax is smooth, pale in color, streaked with darker brown. Legs smooth, of moderate length, with a brown ring on each femur.

Abdomen rather elongate, widest on segment 6, slowly tapering both ways. Lateral spines on 5 to 9 increasing in size posteriorly. No dorsal hooks, but a low middorsal ridge on the terminal segments terminating in a near-hook on 9. The relative lengths of segments 8, 9, and 10 as 10 : 8 : 6, and the appendages a trifle longer than 9. Superior appendage about equal to inferiors in length, both truncate on tip; laterals one-fourth shorter, incurved, and sharply pointed.

A single male nymph from Hamilton Lakes, March 25, 1930.

The following venational data derived from examination of the wings may aid in the determination of the species when corresponding adults are at hand. Ante- and postnodal crossveins 24: 15 and 17: 16 in fore and hind wings, respectively, with the first and ninth or tenth thickened. The fork of Rs appears to include four rows of cells. The radial planate is straight, not strongly sagged. The triangle of the hind wing is 4-celled, two of the cells on its proximal side, and the supratriangular space seems to be traversed by an unusually large number of crossveins, apparently seven or eight. The median planate of the hind wing subtends two or three cell rows. Between the branches of Cu there is but a single row of cells. The anal loop appears elongate transversely to the axis of the wing, with but two vertical cell rows, and with another looped-up single row on its proximal side. In most of these characters this specimen seems to resemble *Amphiæschna* more closely than any other regional known genus. Unfortunately the basal part of the wings is not well preserved.

Genus GYNACANTHA Rambur

It is very difficult to distinguish some of the species of this genus. One who is familiar with them can recognize them fairly easily, but it is almost impossible to list any character or group of characters by which a single specimen may be determined with certainty. There is so much overlapping among some groups of species that they probably should be considered as mere varieties.

Gynacantha basiguttata should be easily separated from the other species in the Philippines by the red-brown spots in the wing bases and the tooth on the inner margin of the superior appendages of the male. *Gynacantha bayadera* is smaller than the others; dried specimens are more definitely green on face and thorax; the auricles are smaller; the anterior laminæ much smaller, paler in color, and with more curved spines; the superior appendages are more even in width, more nearly undulant in side view. *Gynacantha subinterrupta* is best differentiated from *hyalina* by the difference in proportion of the male appendages and the number of ante- and postnodal crossveins (see the descriptions). The wings of *subinterrupta* appear to be more closely and darkly veined than those of *hyalina,* which is scarcely borne out by the actual numbers of crossveins and cells. In *hyalina* the anal loop looks broader than in *subinterrupta,* and frequently consists of three rows of cells for its entire length; while the latter tapers to two rows at the lower end in all the specimens we have seen. The inter-alar sclerites and the ventral surface of the auricles in *hyalina* are very often the color of verdigris. The females of all these species resemble the males in general appearance; they have only vestiges of the auricles and are best identified by the number of nodal crossveins.

GYNACANTHA BASIGUTTATA Sélys. Plate 2, figs. 42 and 43.

SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 18, Luzon, Borneo; MARTIN, Cat. Coll. Sélys 20 (1909) 192, Philippines, Burma, Sunda Archipelago; FRASER, Treubia 8 (1926) 179 (*javica*), Java; LIEFTINCK, Treubia 12 (1930) 165.

Hind wing, male, 45 mm; female, 52.

Male.—Face olive-yellow, top of frons yellow with a thick black T. Thorax maroon or greenish brown. Legs black. Wings more or less yellowish with a red-brown mark at the base under the subcosta (sometimes extending above it) reaching to the first antenodal. Ante- and postnodals 26–30 : 22–23 in the front wings. Abdomen yellowish brown, extremely enlarged at the base and very much constricted in the third segment. Auricles very large. Superior appendages black, longer than the last two segments, very slender at the base and for about three-fourths of their length, somewhat widened and spatulate at the tip, with a tooth on the inner margins at the base. The inferior appendage about one-fifth the length of the superiors (Plate 2, figs. 42 and 43). (Description from Martin.)

GYNACANTHA SUBINTERRUPTA Rambur. Plate 2, figs. 35, 40, and 41.

RAMBUR, Hist. Nat. des Ins. Néuroptères (1842) 212, Java; MARTIN, Cat. Coll. Sélys 20 (1909) 193, Philippines, Burma, Sunda Archipelago.

Hind wing, male, 45 to 49 mm; female, 51.

Male.—Face yellowish; top of frons with a (usually) distinct, thick black T. Thorax dark olivaceous brown on the dorsum, shading to yellowish on sides. Legs reddish. Wings hyaline or slightly suffused with saffron, sometimes with small basal brown spots between Sc and R+M and Cu and A. Ante- and postnodals 26–31 : 22–27 and 19–23 : 24–27 in fore and hind wings, respectively. First segment of abdomen yellowish, bordered posteriorly with black. Auricles on segment 2 very large, narrowly bordered with black, with about six small, inwardly inclined teeth on the caudal border. Spine on the anterior lamina stout, nearly straight, scarcely tipped with brown (Plate 2, fig. 35). First two segments much enlarged; segment 3 much constricted, especially laterally; 4 to 7 moderately wide and about equal; 8 to 10 somewhat narrower. Superior appendages blackish, about equal in length to segments 8 and 9 together, relatively straight in lateral view; inferior appendage about one-fourth the length of the superiors, yellow, blackish at base and tipped with dark brown (Plate 2, figs. 40 and 41).

LUZON, Laguna Province, Los Baños, 1 male, May 25, 1923 (*D. Villadolid*); Mount Maquiling, 1 male (*Baker*). MINDANAO, Davao Province, Mati, 1 male and 1 female, April, 1927, no collector.

GYNACANTHA HYALINA Sélys. Plate 2, figs. 36, 38, and 39.

SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 17, male and female, Luzon; MARTIN, Cat. Coll. Sélys 20 (1909) 198, Philippines, Borneo, Tonkin, China, Japan, Burma.

Male, length of abdomen, 50 to 52 mm; hind wing, 40 to 47.

Female, length of abdomen, 52 to 56 mm; hind wing, 46 to 51.

Male.—Face yellowish, top of frons with a thick black T. Thorax brown with an olivaceous shade on the dorsum and yellowish brown on the sides. Legs reddish yellow. First segment of abdomen brown on dorsum. Segments 1 and 2 much swollen, 3 much constricted in the middle, 4 to 10 moderate and nearly equal in width. Auricles on segment 2 large, bordered with black and with about six small inward-pointing teeth on the posterior margin. Spine on the anterior lamina moderate, nearly straight, tipped with brown (Plate 2, fig 36). Superior appendages blackish, longer than segments 9 and 10 together, quite straight in lateral view. Inferior appendage yellow, brown at base and tip, about one-third the length of the superiors (Plate 2, figs. 38 and 39).

Wings hyaline or slightly saffron tinted, sometimes with a small brown spot between Sc and R+M and Cu and A. Forewing antenodals 22–28, postnodals 16–20. Hind wing antenodals 16–20, postnodals 18–23.

LUZON, Manila, 1 male, August 24, 1930 (*McGregor*): Rizal Province, Novaliches, 1 female, April 26, 1930: Nueva Ecija Province, Gapan, 1 male, June 26, 1932 (*J. Ramos*): Laguna Province, Mount Maquiling, 1 male (*Baker*); Los Baños, 1 male, August 2, 1932 (*M. Cortez*), 1 male, August 6, 1932 (*Felix Bauaug*), 1 female, October, 1930 (*Entomology 1 students*), 1 female, October 19, 1930 (*N. Bartolome*). PALAWAN, Taytay, 1 male, April 24, 1913 (*W. Schultze*).

GYNACANTHA BAYADERA Sélys. Plate 2, figs. 37, 44, and 45.

SÉLYS, Ann. Mus. Genov. II 10 (1891) 483, Bhamo, Sikkim; MARTIN, Cat. Coll. Sélys 20 (1909) 195, Burma, India, Sunda Archipelago, New Guinea.

Male, hind wing, 39 to 40 mm.

Female, hind wing, 39.5 mm.

Male.—Face olivaceous green, a faintly darker bar along the ridge of the frons but no T. Thorax dull, sometimes brownish, green. Abdomen brownish, somewhat enlarged in segments 1 and 2, constricted in the middle of 3, tapering slightly from 4 to 10. Auricles on segment 2 moderate with about five rather strong inward-curving teeth on the posterior margin. Superior appendages longer than segments 9 and 10 together, almost equal in width from base to tip, slightly undulant in side view. Inferior appendage yellow, darkening to brown at the tip, about two-fifths as long as the superiors (Plate 2, figs. 44 and 45). Anterior laminæ pale yellow, rather short and broad at the base, the spines directed outward at first and then curving inward at the tips which are brown (Plate 2, fig. 37). Wings hyaline or shaded with saffron, sometimes with basal spots of brown between Sc and R+M and Cu and A. Ante- and postnodals 17–21 : 12–17 and 13–17 : 13–17 in fore and hind wings, respectively.

LUZON, Laguna Province, Los Baños, 1 female, October, 1930 (*G. Malabayabas*), 1 male, January 8, 1931 (*P. C. Gabertan*), 1 male, January 15, 1931 (*Melencio Agustin*) : Tayabas Province, Quezon Park, 1 male, May 8, 1931 (*F. Juan*). MINDANAO, Zamboanga Province, Kabasalan, 1 male, July, 1932 (*Muzzall*).

GYNACANTHA sp? Nymph. Plate 10, figs. 123 and 124.

The single nymph of this genus in the collection is apparently about half grown (length 22 mm). It is a broken specimen, hardly adequate for description. It will suffice here to point out the principal characters in which the nymphs of this genus differ from those of other known Philippine æschnine genera.

The eyes are broadly rounded and very large, covering more than half the length of the sides of the head. The labium (Plate 10, fig. 124) is armed with raptorial setæ in mixed array; two long strong ones on the lateral lobe near the base of the movable hook and about five weak and indistinct ones in a row more proximal; also three long ones on the movable hook intermixed with a number of weak shorter ones. The median lobe is produced and unarmed, but densely fringed with soft hairs, and its median cleft is tightly closed. The lateral lobe is very broad at its squarely truncate apex. The disc of the prothorax is unarmed. On the sides of the prothorax there are two subequal supracoxal processes. There are no dorsal hooks, and the short lateral spines on segments 6 to 9 increase in length posteriorly.

TETRACANTHAGYNA BAKERI Campion. Plate 2, figs. 27 to 30.

CAMPION, Proc. Zoöl. Soc. London No. 9 (1928) 129, male, Luzon.

Male, abdomen, 67.5 mm; hind wing, 60.
Female, abdomen, 60 mm; hind wing, 66.

Female.—Face pale yellowish brown. Ridge of frons black, this color shading back over the top of the frons. Vertex red-brown. Occipital triangle pale brownish yellow.

Pro- and synthorax light brown and entirely unmarked. Legs light reddish brown, tarsal claws blackish. Wings hyaline with small basal touches of brown in the costal and subcostal spaces. Costa yellowish, the rest of the venation dark brown and the lesser details extremely variable.

Abdomen reddish brown, shading to blackish at the tip. Appendages blackish brown, of the shape shown in Plate 2, figs. 27 and 28. This is the first description of the female.

Male.—Similar in coloration to the female. The additional length of the abdomen is due to the appendages (Plate 2, figs. 29 and 30).

LUZON, Laguna Province, Los Baños, 1 female, August 18, 1927 (*Pascual Matulac*), 1 male (locality ?); Mount Maquiling, 1 male and 2 females (*Baker*).

TETRACANTHAGYNA BAKERI Campion. Nymph. Plate 10, figs. 127 and 128.

Length, 55 mm; abdomen, 38; hind femur, 9; width of head, 10; width of abdomen, 10. (Measurements from a female nymph, apparently in the penultimate instar.)

This is an elongate short-legged nymph with tuberculate thorax and triquetral abdomen. Head widest across the rather narrowly projecting eyes, narrowed behind them, at first suddenly, then slowly to the backwardly projecting hind angles, sloping forward moderately to the front of the wide and narrow frons, then declivitous to the mouth. Antennæ pale, 7-jointed. Two pairs of prominent tubercles project from the sides of the head behind the eyes, one on the upper and one on each lower margin, two pairs of low wartlike submedian elevations on the dorsum. Rear of head deeply concave, sides irregularly rugose. Labium (Plate 10, fig. 128) very long, its hinge reaching the base of the middle legs. Lateral lobe short but with a long narrow end hook as long as its body, and with a very long and strong movable hook. The latter is twice as long as the end hook and of equal width at base. Median lobe bifid in two well-rounded hair-fringed curves that meet in an acute median notch. Mentum parallel-sided in its basal two-fifths, then greatly widened almost to the base of the lateral lobes, with the thin outer curving margins spinulose-serrate.

Prothoracic dorsum divided transversely into an anterior annular belt with raised front margin, and a wider, more or less shield-shaped disc whose outer anterior angles project in a conspicuous nipple-shaped tubercle. At the sides the supracoxal plate bears a pair of similar tubercles projecting laterally, and a third one projecting forward beneath the lower lateral tubercle on the head. Spiracles black-lipped, bordered with paler. Sides of synthorax undulate with a number of low tubercles. Legs nearly bare, brown, obscurely ringed with blackish.

Abdomen long and narrow, widest on segment 7. Color pale brown, paler beneath, washed with darker brown towards the end and mottled indistinctly with the same color on the dorsum. Segments 5 to 10, with short thick lateral spines, increasing in length and stoutness posteriorly. Segments 7 or 8 to 10 with low short blunt dorsal hooks, largest on 9. Terminal segments diminishing slowly in length to rearward, 10 longer than the appendages. The superior appendage almost as long as the inferior and bearing on its basal half (male) or third (female) a middorsal projection similar to the dorsal hook on 10, beyond which the margin is serrate, as are all the margins of the superiors. The sides of these appendages beset with minute blackish prickles. The lateral appendages one-third as long as the others. Cerci short, stout, projecting conspicuously at the sides of the appendages.

This very unique nymph may be referred to *Tetracanthagyna* with assurance, and to the one known Philippine species, *T. bakeri*, with little doubt, because the developing wings of one male specimen show the following venational characters: ante- and postnodal crossveins 42:27 and 28:32 in fore and hind wings, respectively; no brace vein to the stigma; no crossveins in the midbasal space; six to eight cubito-anal crossveins, with some irregularity near the triangles; in the triangles two cells bordering the proximal side, followed by a row of four or five parallel crossveins; four rows of cells in the fork of Rs; the radial planate is nearly straight; it subtends four rows at widest separation from Rs, diminishing to two rows towards the wing margin; the median planate subtends four rows of cells; between the branches of Cu there is in the forewing a single row of cells, and in the hind wing, first two rows, then diminishing to one; the rather ill-defined anal loop of the hind wing seems to inclose four vertical rows of cells.

LUZON, Laguna Province, Los Baños, Molawin Creek, 2 female nymphs and 1 smaller male, April 1, 1927 (*Uichanco*).

LIBELLULIDÆ

Key to the subfamilies.

ADULTS

1. Triangle of hind wing much nearer arculus than in forewing; anal loop elongated, becoming foot-shaped, with a distinct midrib .... 2.
   Triangle of hind wing but little nearer arculus in forewing; anal loop hardly longer than wide and with no midrib .... MACROMIINÆ.
2. Anal loop scarcely foot-shaped, there being little development of the toe; hind wing of male strongly angulated and with an anal triangle (except in *Hemicordulia*) .... CORDULIINÆ.
   Anal loop generally foot-shaped, with well-developed toe: hind wing of male with anal angle rounded .... LIBELLULINÆ.

NYMPHS

1. Abdomen less than twice as long as wide; long-legged ...... MACROMIINÆ.
   Abdomen more than twice as long as wide .... 2.
2. Hind femora distinctly longer than the head is wide; when lateral spines are long, there is a series of large cultriform dorsal hooks on the abdomen .... CORDULIINÆ.
   Hind femora about as long as the head is wide; when lateral spines are long the dorsal hooks are minute or wanting .... LIBELLULINÆ.

MACROMIINÆ

Key to the genera.

ADULTS

1. Triangle with crossveins .... *Epophthalmia.*
   Triangle without crossveins .... 2.
2. Triangle of hind wing distant from the arculus by more than its own length; veins M_3 and M_4 sagged and undulate .... *Macromia.*
   Triangle of the hind wing distant from the arculus by less than its own length; veins M_3 and M_4 smoothly curved .... *Macromidia.*

NYMPHS

1. Head with a transverse frontal shelf; lateral lobe of labium very deeply and irregularly cleft .... *Epophthalmia.*
   Head with a pyramidal frontal horn arising between bases of the antennæ; lateral lobe of labium rather regularly toothed along its distal margin .... *Macromia.*

EPOPHTHALMIA ELEGANS Brauer.

BRAUER, Verh. zool.-bot. Ges. Wien 15 (1865) 905, Malaysia; SÉLYS, An. Soc. Esp. Hist. Nat. 20 (1891) 211, Dolores.

This species has been recorded but once from the Philippines, and is not represented in the material before us. It is common in China and Japan. It is strong-flying and difficult to capture. It is readily recognizable by the characters given in our key;

by the presence of crossveins in the triangles, by having three or four cubito-anal crossveins in both wings, and by its size (hind wing 48 to 54 mm).

The nymph was described and figured by Cabot[10] and by the senior author[11] as *Azuma elegans*.

MACROMIA GERSTAECKERI Krüger. Plate 3, fig. 56.

KRÜGER, Stett. Ent. Zeit. **60** (1899) 335, Java; LAIDLOW, Journ. Str. Br. Roy. Asiat. Soc. **85** (1902) 225; MARTIN, Cat. Coll. Sélys **16** (1906) 70, Borneo, Malay Peninsula, Tonkin; LIEFTINCK, Tijd. v. Ent. **72** (1929) 106.

There is a single incomplete female specimen in the collections sent us. It lacks segments 4 to 10 of the abdomen. It agrees in rather close detail with the original description of *M. gerstaeckeri* in size (hind wing 37 mm) and in coloration, except that it is a little more extensively yellow (perhaps less mature). For example, there is a small spot of yellow just beneath each outer end of the antealar crest, the yellow crossband covering the anterior half of abdominal segment 2 is hardly divided by black on the middorsal line, although clearly divided on the middle of the sides of that segment, and the mesothoracic carina is wholly yellow. There is also a curving transverse line of long tawny hairs standing erect like a ruff a little distance behind the mesothoracic collar. This is not mentioned in the descriptions. Wings as in Plate 3, fig. 56.

One female pinned specimen, lacking the last six segments of the abdomen and bearing the label "13 VII 1915, C. S. Banks."

MACROMIA NEGRITO sp. nov. Plate 1, figs. 2, 3, and 15.

Length, 55 mm; abdomen, 41; hind wing, 38.

This is a rather slender blackish species with slightly fumose wings. Head black with a yellow band across the rear of the postclypeus, this band bordering an elevated hairy transverse ridge, and encircling that ridge at its dilated ends. Labrum black. Anteclypeus brown. Frons shining metallic greenish blue, without transverse carina, but deeply divided into two almost mammiform portions that are very hairy on the outer side. Vertex low, transverse grooved behind and hairy within the groove. Occiput black, clothed with long hairs in the rear. Rear of head black. Labium blackish, yellowish in its basal half.

Prothorax blackish above, paler across front and rear margins, the hinder one pilose. Synthorax metallic greenish black with

[10] Mem. Mus. Comp. Zool. **17** (1890) 9, pl. 1, fig. 1.

[11] Zool. Sinica (A) **11** fasc. 1 (1930) 109, pl. 11, figs. 5 and 5*a*.

lateral stripes of yellow, thickly clothed with long tawny hairs in front. Carina and crest black; antealar sinus yellow. Side stripes three; a short antehumeral one that runs upward from the middle of the mesinfraepisternum halfway to the crest; a midlateral one covering the spiracle running from the same level up to the alar crest; the rear stripe covers the postlateral ridge of the synthorax and is elongate triangular, pointed at the front end, widened rearward to the base of the abdomen. Underneath the rear of the synthorax a yellow Y mark divides the black into three distinct areas. Legs black beyond the pale coxæ, clothed with long thin spines. Claws cleft at tip with the lower division twice as heavy as the upper. Wings subhyaline, with black veins and stigma and flavescent membrane. Stigma hardly twice as long as wide. Membranule pale brown. Ante- and postnodal crossveins 14: 6 and 10: 6 in fore and hind wing, respectively.

Abdomen rather slender and elongate between the strongly swollen terminal segments, black with scanty yellow markings; five yellow spots on segment 2, one middorsal, and two lateral on each side, the anterior of these larger and situated in front of the black-edged auricle. Two obscure yellowish crossbars on segment 3 are interrupted on the middorsal line. Remainder of the abdomen black except for a small middorsal basal spot on segment 7 and small midlateral spots on 8 and 9. Segment 10 nearly smooth above, finely transversely rugose, produced a little in the rear and truncate above the base of the appendages. The appendages equal in length and about twice as long as segment 10 (Plate 1, figs. 2 and 3). Superiors stout and strongly carinate above in their basal half, at which level arises a very stout triangular lateral tooth, and beyond which they slightly converge to blunt tips. Form of tips obscured by a terminal cluster of unusually short stout bristles or fine spines. Under the more convex portion of their slightly upcurved tips a row of minute denticles. Inferior appendage is slightly carinate beneath at base, and its tip sharply recurved upward to a fine-pointed tip.

The female differs very slightly: The antehumeral yellow stripe reaches a little farther upward, the yellow markings of the abdomen are a little more extensive, and the swollen segments 8 and 9 of the abdomen tend to be a little more sharply keeled on the middorsal line and to end in a minute apical spine. Subgenital plate as shown in Plate 1, fig. 15.

LUZON, Laguna, Mount Maquiling, 1 male (type) and 1 female, June 9, 1932, in the same envelope and presumably taken together.

This species resembles *Macromia thalia* Fraser (described by Laidlaw as *M. frænata*) from Assam in the form of the male superior appendages as figured by Fraser.[12]

MACROMIA sp. ? Nymph. Plate 9, figs. 110 to 112.

Length, 22 mm; abdomen, 12; hind femur, 10; width of head, 6; width of abdomen, 8.

A flat, widely sprawling long-legged nymph with upturned horn on front of head. Coloration pale with blackish paired spots on thorax and on middle abdominal segments, and with blackish rings on femora. Head widest behind eyes, then narrowed to a slightly concave occipital border. A blackish cross-band between the eyes broken by pale spots of the three ocelli. In front of it the predominantly yellow area about the low pyramidal horn bearing a black median stripe and paired triangular spots. Black rings on the two basal antennal segments, a row of spots on upper margin of the lateral labial lobes. Eyes produced upward in a low, conic, blunt-tipped, shining black prominence. Labium (Plate 9, figs. 110 to 112) wide, its hinge reaching the metathorax. Lateral setæ five; mentals seven on each side, in the innermost smaller. On the distal end of the lateral lobe six large obliquely rounded teeth, each of the middle ones armed at tip with about six spinules. Median lobe low, its undulant margin armed with a line of small spinules, produced in a prominent median tooth bearing a pair of spinules.

Prothorax wide and flat, its disc outlined in black. Outside its anterior angle a conspicuous triangular supracoxal process ending in a tuft of long yellowish hairs. Legs very long and thin. Feet spinulose-serrate beneath and ending in extremely long smooth tapering claws. Femora ringed with black near the bases and besprinkled with the same color more proximally. Wing cases reach backward well upon the sixth abdominal segment.

Abdomen broadly oval, strongly depressed, widest on segments 5 and 6. Dorsal hooks on 3 to 9, slender and erect on 3, laterally flattened on 4 to 9, highest on 4 and slowly declining to rearward. Segment 10 exserted, cylindric, two thirds as long as 9 middorsally. Appendages short and thick, about as long as 9 middorsally, subequal to each other.

[12] Tijd. v. Ent. 72 (1929) 104, fig. 21.

LUZON, Laguna Province, Los Baños, 3 nymphs, April 1, 1927 (*Uichanco*), Molawin Creek, 1 young specimen, June 18, 1930 (*S. M. Cendaña*); 6 badly preserved specimens, Laguna, lot A.

MACROMIDIA SAMAL sp. nov. Plate 1, fig. 18; Plate 3, figs. 52 and 57.

Length, 40 mm; abdomen, 38; hind wing, 31.

Female.—A rather broad-winged blackish species. Face all blackish, only the anteclypeus paler, very hairy with bluish reflections on the labrum and coppery on the frons. Frons low and divided by a shallow median grove. Vertex high, transverse, and bulging, with a dense covering of blackish hairs. Occiput narrow, bare, and brown.

Prothorax small and wholly pale, with only a pair of tufts of brownish hairs tipping the upper edge of its posterior lobe. Synthorax blackish with metallic greenish reflections from its more convex surfaces and with a covering of long tawny hairs in front. A narrow irregular numeral pale stripe deep in the suture, running down at an angle upon coxa and trochanter of the middle leg. Midlateral pale stripe much wider but not very sharply defined and not connected with the yellow of the hind coxa. An isolated broad streak covering part of third lateral suture, an area behind it, another area extending to the base of abdomen. Legs dark brown beyond their pale basal segments, with deeply forked claws of lighter brown (Plate 3, fig. 52). Wings (Plate 3, fig. 57) hyaline with blackish veins and a fuscous stigma, and with a brown spot covering base of both out to first crossveins. Brown less distinct in the forewing. The nodal crossveins 16:10 and 10:14 in fore and hind wing, respectively. Bridge crossveins five or six, four of them before level of subnodus. Two crossveins behind stigma, no distinct brace vein. Radial planate beginning at oblique vein coming down from the subnodus and extending directly to wing margin. Near its middle portion two of the included crossveins are oblique, marking the place where two accessory tracheal branches cross the planate. In the space beyond the triangle in the forewing a single row of cells for a distance of six crossveins, two rows for five more crossveins, and three rows to wing margin.

Abdomen slender, little enlarged even on basal segments, tending to be ridged middorsally, where traversed by a narrow pale median line on segments 2 to 9. A pale transverse area across base of 1, and a tuft of long tawny hairs on elevated hinder end of that segment. A pale spot on sides of 1 and 2 below and a narrow line of the same color extending along the inferior margins of all the segments to rearward to the base of 10, widening a little on 7 and 8. Relative length of last four segments as 10: 6: 4: 2, black appendages twice as long as segment 9. Subgenital plate (Plate 1, fig. 18) but slightly produced backward and divided full depth by a median notch. A pale midventral spot with a pair of rather large palps at its hind edge, the remainder of sternum of 9 smooth.

This very distinct species is most like *M. shanensis*, of India, in thoracic color pattern. It has a single row of crossveins beyond the forewing triangle—the character on which Fraser[13] mainly based a new genus, *Indomacromia*, that he later abandoned. Two species having this character are known from India.

MINDANAO, Zamboanga Province, Kabasalan, 1 female, July, 1932 (*H. C. Muzzall*).

CORDULIINÆ

Key to the genera.

ADULTS

1. Triangle in hind wing far beyond arculus .... 2.
   Triangle in hind wing retracted to arculus .... 3.
2. Triangle of forewing 4-sided .... *Idiophya.*
   Triangle of forewing 3-sided .... *Idionyx.*
3. Triangle divided into three cells; base of A_2 out from the anal crossing (*Ac*); radial planate subtends eight or more cells .... *Heteronaias.*
   Triangle divided into two cells; A_2 opposite the anal crossing; radial planate subtends five cells .... *Hemicordulia.*

NYMPHS

1. Synthorax wider than the head; teeth of lateral lobes of labium large. *Heteronaias.*
   Synthorax not wider than head; teeth of lateral lobes moderate .... 2.
2. Teeth five; lateral spines minute, on eight vestigial .... *Idionyx.*
   Teeth eight: lateral spines moderate; on eight distinct.. *Hemicordulia.*[14]

Genus IDIOPHYA Fraser

We are following Fraser in the use of this name for a new *Idionyx*-like species with a 4-sided triangle in the forewing, but with some doubt as to the validity of the genus.

ODIOPHYA SALVA sp. nov. Plate 3, fig. 58.

Length, 38 mm; abdomen, 32(?); hind wing, 31.

A dainty little corduline with a 4-sided triangle in the forewing. Head with very large eyes meeting in a long seam, and

[13] Indian Mus. Rec. 26 (1924) 514.

[14] Characters taken from a nymph of *Hemicordulia assimilis* (supposition) Needham, Bishop Mus. Bull. 98 (1932) 113–114.

a very hairy face. Frons shining metallic green above where deeply grooved in the median line and minutely punctate on the bulging sides, front brown. Vertical vesicle dark metallic blue. Labrum and anteclypeus pale. Occiput a brown triangle, yellow at the sides.

Prothorax mostly pale. Synthorax metallic green on brown in front, and paler on the sides without full stripes but with yellowish streaks low down on the sides as follows: One on each of the two hinder coxæ, reaching down to the femora and up across the infraepisterna but not invading the episterna; one between these two and covering the spiracles; and a larger one in the form of a long triangle pointing downward covering a good part of the metepimeron. The short soft pile of the front of the thorax is golden brown. The legs are pale; femora thrice faintly ringed with brown. Leg spines very long, especially on the tibiæ, and numerous, claws bifid at the tip. Wings (Plate 3, fig. 58) hyaline, with only a faint tinge of yellowish at the base, along the costa, and within the veins of the stigma. Venation as shown in figure.

The abdomen (crushed and perhaps with the colors not fully developed) slender, a little dilated before the tip; yellowish brown in color, darker at the sides and across apical margin of the segments; cerci brown, hardly as long as segment 10. Subgenital plate as shown in fig. 16.

LUZON, Laguna Province, Los Baños, 1 female, April 25, 1931 (*F. Juan*).

In coloration of the thorax this species seems to resemble closely *Idionyx philippa* Ris, but it differs in venation from Ris's figure of the wings of that species [15] as follows: (*a*) In the space beyond the 4-sided triangle of the forewing a single row of cells continues beyond the level of the nodus, while in *I. philippa* beyond a 3-sided triangle the row is doubled well before the level of the nodus. (*b*) In our species veins Cu and Cu_2 of the same wing diverge to the wing margin while in *I. philippa* they converge.

IDIONYX PHILIPPA Ris.

RIS, Suppl. Ent. 1 (1912) 81–82, fig. of wing of female, Naujan, Mindoro.

Abdomen, 30 to 35 mm; hind wing, 30 to 35.

Female.—A handsome little corduline with a yellow-spotted metallic green thorax and a bright golden spot in each wing

[15] Suppl. Ent. 1 (1912) 81, fig. 16.

base reaching out to the triangle. Labrum yellow with a broad black front border. Frons and vertex shining metallic green, the former with a deep, median, longitudinal furrow, the latter broadly rounded.

Prothorax yellow, including the front lobe of the dorsum, behind which the dorsum is black. Synthorax shining metallic green, clothed in front with long tawny hairs, and with a row of four yellow spots low on the sides, the first above the middle coxa, the second on the spiracle, the other two on the metepimeron. Coxæ yellow behind; femora and tarsi black, tibiæ a little paler. Wings beyond the golden basal spot (which may cover the triangles) subhyaline, more deeply tinged towards the stigma. Ante- and postnodals 13: 6–7 and 9: 9 in fore and hind wings, respectively. Stigma fuscous, slightly narrowed and pointed apically, covering two cells. In the anal loop four or five cells in the distal and six or seven in the proximal rows.

Abdomen black with a marginal yellow streak on the ventral margins of segments 2 and 3. Subgenital plate a little produced backward, its end upturned and raised in a low longitudinal carina. Sternum of 9 also a little produced. Appendages conic, about as long as the middorsal length of 10; these and the subanal plates tufted with brownish hairs.

LUZON, Laguna Province, Los Baños, 3 females, no date.

One venational character given by Ris in his key to the species,[16] "but one cell bordering the distal side of the triangle," does not hold for any of our specimens. The position of the first crossvein in the space beyond the triangle of the hind wing is variable, its upper end descends along the triangle for a little way in our specimens.

IDIONYX sp. ? Nymph. Plate 8, figs. 93 to 95.

Length, 19 to 20 mm; abdomen, 12; hind femur, 5; width of head, 5; width of abdomen, 6.5.

A smooth, slender-legged nymph with blunt-tipped abdomen. Head compact, with eyes at middle of sides and contracted at their rear margin, between which and the low hind angles is a slightly bulging scurfy pubescent area. Occipital margin straight. Frons a little prominent between the bases of the antennæ with the mouth parts projecting and the large teeth of the labium showing plainly from above. Antennæ 7-jointed, slender, pale, and hairless. Labium (Plate 8, figs. 94 and 95) rather short, its hinge reaching the mesothorax. Lateral lobes

[16] Op. cit. 80.

subtriangular, with five lateral setæ and a long straightish movable hook, and about six coarse teeth on the terminal border. The three large middle teeth wider than high, obliquely rounded, each armed with about a dozen spinules in double array longer and shorter. Median lobe low triangular, evenly contoured, spinulose margined, and bearing on each side eleven raptorial setæ.

Prothorax rather small, its disc with obtuse laterally projecting angles inclined slightly to rearward, far behind the blunt, vertically inclined, hairy supracoxal process. Legs concolorous, slender, with tibiæ thinly hairy. Hind femora reaching middle of abdominal segment 6. Wings streaked and shaded with brown.

Abdomen strongly depressed, oblong, of about equal width on segments 6 to 8, narrowed mostly on 9, with strong lateral spines on 8 and 9, and with a fringe of long hairs across the apex of 9 beneath. No dorsal hooks. Appendages short, sharply pointed, superior an equilateral triangle, its tip on a level with that of the spines of 9; laterals slenderer, slightly shorter and with outcurving tips.

LUZON, Laguna Province, Mount Maquiling, Molawin Creek, altitude 200 feet, 3 nymphs; and 2 nymphs labeled "Laguna, P. I."

Venation well preserved in the nymphal wings and generic determination positive.

Genus HETERONAIAS novum

Genotype, *Epitheca heterodoxa* Sélys.

In describing the male of this peculiar species in 1878, de Sélys first placed it in *Epitheca,* remarking that it differs from the other species of that genus in having the triangle of the forewings divided into three cells, and in having the stigma notably short. But in his summary list at the end of this same paper the name appears as a species of *Somatochlora.*

Martin in 1906 stated that the male and female types are in the de Sélys collection, but he makes no mention of the very peculiar characters of the female nor does he describe it. He does say,[17] however, "Espece remarquable por ses fémurs roux très gros, longs de 8 mm."

E. M. Walker (1925), discussing the affinities of the genus *Somatochlora* in his monograph of the North American species of that genus, thus refers to *H. heterodoxa:*

[17] Coll. Zool. Sélys 17 (1906) 21.

I have not seen this species, but it shows * * * with Procordulia an instability in the development of the second cubito-anal crossvein of the hind wings, which feature together with its geographical range throw considerable doubt on the probability of its being a genuine Somatochlora.

F. F. Laidlaw in 1928 referred this species to *Procordulia,* saying that it could be so referred without much difficulty, and that it is not a true *Somatochlora.* He adds, however:

It is possible that *heterodoxa* may ultimately require the creation of a distinct genus to hold it. This genus would be characterized by the absence of an internal triangle in the hind wings, the presence of an accessory bridge-nerve, and the brilliant metallic coloring of the body, with the thorax unmarked. The upper anal appendages of the male long, straight, and bluntly pointed, and the second tibia without keel.[18]

Thus it will be seen that a number of the peculiarities of this species have been noticed hitherto: Long femora, very short stigma, 3-celled triangle in the forewing, absence of a second cubito-anal crossvein in the hind wing, presence of extra bridge crossveins, and the form of the abdominal appendages in the male. Singularly enough the form of the abdomen in the female has not been noticed. But it is the extraordinary nymph that sets it farthest apart from all known genera of Corduliinæ.

The genus may now be further characterized as follows: Head with a rather large occiput that is about as long as the eye seam in front of it. Frons deeply bilobed by a wide longitudinal furrow, in front rounded and having no transverse carina or angulation. Legs long, tibiæ armed with numerous long spines, femora with a single subterminal spine and before it a long series of very minute denticulations. Claws bifid, with the lower division slightly shorter than the upper. Front wing triangle and subtriangle both 3-celled, followed by two rows of cells. In both wings there is a very long space without crossveins on each side of the subnodus. The narrow stigma is diamond-shaped, its sides hardly twice as long as its ends, and behind it stands a single crossvein. There are three bridge crossveins and a sagging radial planate subtends about ten rather large cells. In the hind wing vein A_2 arises beyond the anal crossing (*Ac*), and the base of the two-celled triangle is retracted to slightly before the arculus. The anal loop is elongate, sagging, almost foot-shaped, with slight development of a toe; a well-developed midrib, arising near vein A_2, divides the two rows very unequally, the cells on the distal sides being much larger.

[18] Proc. Zoöl. Soc. London (1928) 133.

The anal triangle in the male is generally 2-celled with the dividing crossvein near its pointed rear end. The abdomen is moderately swollen on the three basal segments, narrow and depressed on the middle segments, then slowly enlarged to segment 9. Appendages of the male about as long as 9 and 10 together. In the female the enlarged end segments are compressed, the subgenital plate is divided in a pair of triangular flaps with a U-shaped notch between. The sternum of segment 9 is prolonged beyond the apex of 10, inclined downward to a blunt extremity and keeled. The appendages of the female are elongate-conic and much longer than segment 10.

HETERONAIAS HETERODOXA Sélys. Text fig. 2.

SÉLYS, Bull. Acad. Belg. II 45 (1878) 192, male, Luzon (in list on p. 217 placed in *Somatochlora*); An. Soc. Esp. Hist. Nat. 11 (1882) 16; MARTIN, Coll. Zool. Sélys 17 (1906) 20; WALKER, Univ. of Toronto Biol. Stud. 26 (1925) 16; LAIDLAW, Proc. Zoöl. Soc. London for 1928 (1928) 132 (referred to *Procordulia*).

Male, length, 63 mm; abdomen, including appendages, 46; appendages, 7; hind wing, 40 to 44.

Female, length, 59 mm; abdomen, 44; hind wing, 42 to 44.

This is a brownish clear-winged species with shining metallic green on the convexities of the frons and the thorax, and on the dorsum of the abdomen of the fully developed male. It will be easily recognized by the generic characters stated above and by the figures.

LUZON, Laguna Province, Los Baños, 7 males and 3 females, no date, 1 male, February 23, 1930 (*Pangramuyen*), 1 male, February 7, 1932 (*M. Macasaet*); Mount Maquiling, 2 males and 1 female, no date; Mount Banahao, 2 males, May 22, 1933 (*A. Y. Coronel*): Tayabas Province, Quezon Park, 1 female, May, 1931 (*F. Juan*).

HETERONAIAS sp. Nymph (determined by venation).

Length, 24 mm; abdomen, 13; hind femur, 10; width of head, 7.5; width of abdomen, 8.

A sprawling, long-legged, flat-bodied nymph, with a bulky synthorax wider than either head or abdomen. Head wider than long, with rather small, well-rounded, laterally prominent eyes behind which it is narrowed to the occiput. A suborbital longitudinal carina appearing from above as a projecting angle just behind the eye. Top of head sloping forward to the mouth, the huge teeth of the labium showing plainly from above. Antennæ 7-jointed. Labium short and wide, its hinge not reaching back to the mesothorax. Lateral lobe more or less hand-shaped, the teeth on the end long, almost like fingers, the edges incurved. Lateral setæ eight; mentals nine or ten, the two series set in a straight line across the mentum parallel to its front border. Teeth seven, each bearing long spines at the tip, the spines numbering 0, 1, 2, 3, 3, 3, respectively, and a toothlike ending of the inner margin bearing a dense cluster of more than a dozen

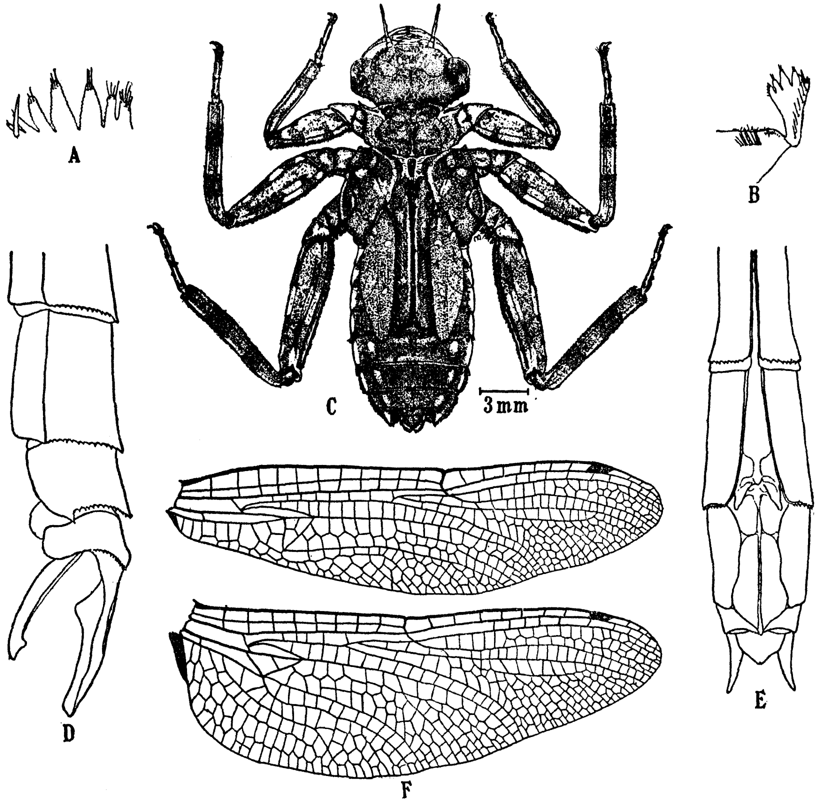

FIG. 2. *Heteronaias heterodoxa* Sélys; A, Tip of lateral lobe of labium of nymph; B, labium of nymph; C, nymph; D, lateral view of tip of abdomen of male; E, ventral view of tip of abdomen of female; F, wings.

spines. The edges of the tenth bear close set, microscopic crenulations. The moveable hook is straight, about as long as the lateral setæ, and regularly tapering. The median lobe is truncate, scarcely at all produced, and bordered with about a dozen major crenulations with spines set between them, and each of these is margined with minor crenulations with a row of spinules at their proximal edges.

Thus this "mask" is not floored by a median lobe, but by the lower inrolled edges of the two scooplike lateral lobes.

Prothorax with a rather small obscurely margined disc, beyond the anterolateral angle of which a long spinelike supracoxal process projects forward, parallel to the sloping hind angle of the head. In corresponding position on the wide metathorax there is an angulate process projecting forward towards the front coxa. Spiracles conspicuous. Sides of synthorax depressed. Legs long and strong, doubly carinate above and below, femora flat on the sides. Hind femora reach the middle of abdominal segment 8. Wing cases reach 7.

Abdomen oval in outline, rather short, flat, and wide, with blunt lateral spines on segments 8 and 9, those of 8 short, those of 9 long, reaching almost to the level of the tips of the appendages. Dorsal hooks represented by long blunt tubercles on segments 8 to 10, highest on 9. Appendages short and wide; inferiors longest, externally rounded to the blunt apex, superiors a little shorter, triangular, sharp-pointed, laterals still shorter, blunt-tipped.

Coloration mottled with a darker middorsal line and paler markings in the "scars" near the margin from the edges of which arise tufts of long whitish hairs.

A number of specimens, one only fully grown, from Molawin Creek, Mount Maquiling, Laguna, Luzon, at 200 feet altitude. This one had the wings crumpled within their sheaths, but when expanded they showed the adult venation, rendering the determination positive.

HEMICORDULIA MINDANA sp. nov. Plate 1, figs. 19 and 20.

Length, 57 mm; abdomen, 43; hind wing, 31.

A handsome metallic green species, paler on the sides and beneath, and becoming blackish towards the end of the abdomen; face amber brown, including the whole of the labrum; sparsely hairy on the frons; top of frons and vertex brilliant metallic green, both sparsely hairy; antennæ black; occiput brown, beset in the middle in front with long tawny hairs behind which it is bare. In the female the occiput is produced backward, declined, and bilobed, with a brush of short stiff bristles arming each lobe externally (Plate 1, fig. 19).

Thorax brown with a pair of very broad, shining, metallic green bands that almost cover its front. On the sides similar diffuse metallic bands overspreading the deep lateral sutures (obsolete above the spiracle on the middle suture), conjoining with them below, and extending rearward on the lower part of the metepimeron. Four streaks of paler yellowish brown occupying the middle portion of the pleural sclerites between the metallic stripes, the foremost one running down on the middle coxa, the others circumscribed below by darker color. Wings subhyaline, tinged with brownish around the crossveins, especially in the females; veins and stigma brown. The thin, sharp-edged basal dilation of the costa on the forewing yellowish. Ante- and postnodal crossveins in the forewing 7: 5, in the hind wing 5: 7, respectively; veins M_3 and M_4 twice convergent towards the end, once at the bend, and again at the hind margin with a single cell row between them all the way; median planate well developed. Legs black; first femora paler externally.

Abdomen metallic green above except for a pale basal segment, with diffuse brown areas on the side of segments 2 and 3; 1 and 2 clothed above with tawny hairs; superior appendages longer than segments 9 and 10 together; the inferior one-sixth shorter than the superiors. Hamules as shown in Plate 1, fig. 20.

MINDANAO, Kabasalan, 1 female (type), July, 1932 (*H. C. Muzzall*): Cotabato Province, Kidapauan, a damaged male (allotype), United States National Museum (*B. P. Clark*).

LIBELLULINÆ

Key to the genera.

ADULTS

1.	Anal loop present	2.
	Anal loop absent	*Orchithemis.*
2.	Anal loop foot-shaped	5.
	Anal loop not foot-shaped	3.
3.	Hind wing 25 mm or less	4.
	Hind wing 30 mm or more	*Agrionoptera.*
4.	Anal loop open	[*Nannophya*].
	Anal loop closed	*Tetrathemis.*
5.	Midrib of anal loop much nearer A_2	7.
	Midrib of anal loop halfway between A_1 and A_2	6.
6.	Last antenodal crossvein continuous	[*Nannodiplax*].
	Last antenodal crossvein discontinuous	*Diplacodes.*
7.	Forewing triangle crossed	14.
	Forewing triangle not crossed	8.
8.	Anal loop with toe closed	9.
	Anal loop with toe open	*Raphismia.*
9.	Last antenodal crossvein continuous	10.
	Last antenodal crossvein discontinuous	*Zygonyx.*
10.	Cu_1 arising from hind angle of triangle	12.
	Cu_1 arising from distal side of triangle	11.

11. Hind wing less than 23 mm; cells in hind angle greatly elongated. *Acisoma.*
Hind wing more than 23 mm; cells in hind angle not greatly elongated. *Diplacina.*
12. A_2 opposite the anal crossing (*Ac*) .... 13.
A_2 beyond the anal crossing .... *Brachydiplax.*
13. Five postnodal crossveins .... *Macrodiplax.*
Seven postnodal crossveins .... *Urothemis.*
14. Toe of anal loop closed .... 16.
Toe of anal loop open .... 15.
15. One row of cells above the radial planate .... *Zyxomma.*
Two rows of cells above the radial planate .... *Tholymis.*
16. Less than five rows of cells in discoidal field .... 19.
Five or more rows of cells in discoidal field .... 17.
17. Forewing triangle reticulately crossed; a large number of antenodal crossveins .... 18.
Forewing triangle simply crossed .... *Rhyothemis.*
18. M_2 smoothly curved .... *Neurothemis.*
M_2 undulate .... *Camacinia.*
19. Less than four rows in the discoidal field .... 21.
Four rows in the discoidal field .... 20.
20. Base of hind wing greatly widened .... *Tramea.*
Base of hind wing normal .... *Neurothemis.*
21. Three rows of cells in the discoidal field .... 22.
Two rows in the discoidal field .... *Diplacina.*
22. M_2 smoothly curved .... 27.
M_2 undulant .... 23.
23. Anal loop normal foot-shaped .... 24.
Anal loop with a very long heel .... *Hydrobasileus.*
24. One cubito-anal crossvein .... 25.
Two cubito-anal crossveins; stigma shorter in hind wing .... *Pantala.*
25. Last antenodal crossvein discontinuous; A_2 out from anal crossvein. 26.
Last antenodal crossvein continuous; A_2 opposite anal crossvein. *Orthetrum.*
26. Hind wing less than 35 mm .... *Potamarcha.*
Hind wing more than 37 mm .... *Onychothemis.*
27. More than nine and one-half antenodal crossveins .... 29.
Less than nine and one-half antenodal crossveins .... 28.
28. Abdomen much constricted after third segment .... *Trithemis.*
Abdomen not so constricted .... *Brachythemis.*
29. Last antenodal crossvein discontinuous .... 31.
Last antenodal crossvein continuous .... 30.
30. Extra bridge crossveins: one cubito-anal .... *Cratilla.*
No extra bridge crossveins: three cubito-anals .... *Lyriothemis.*
31. A_2 smooth: two crossveins under stigma .... 32.
A_2 zigzag: four crossveins under stigma .... *Lathrecista.*
32. Usually one row of cells above radial planate; stigma long; discoidal field widening at edge of wing .... *Crocothemis.*
Two rows of cells above radial planate; stigma short; discoidal field narrowing at edge of wing .... *Trithemis.*

For convenience the genera are discussed, not in any phylogenetic orders, but in the order of their names in the key. The phylogeny of the group has not been well worked out. To that end nothing would contribute more than further knowledge of the immature stages. Nymphs are still unknown for a majority of the Philippine genera. Two regional genera not yet recorded from the Islands are indicated in the key by square brackets.

Verification table.

Genus.	Forewing.						
	Cross-veins in triangle.	Cells in subtriangle.	Last antenodal cross-vein.	Extra bridge cross-veins.	Cell rows subtended by the radial planate.	Cell rows within the discoidal field.	M_2.
Acisoma	0	1	C [a]	0	1	2	s [b]
Agrionoptera	1	3	C	0	1–2	2	s
Brachydiplax	0	2–3	C	0	1	2	s
Brachythemis	1	3	D	0	1–2	3	s
Camacinia	10	20	v	3–4	3	5	u
Cratilla	1	3	C	1–3	2	3	s
Crocothemis	1	3	D	0	1–2	3	s
Diplacina	0–1	1–3	C	0	1	2	s
Diplacodes	v–1	1–3	D	0	1	2	s
Hydrobasileus	2	6–8	D	0	2	3	u
Lathrecista	1	3	D	0	1–3	3	s
Lyriothemis	1	3	C	0	1	3–2–3	s
Macrodiplax	0	3	C	0	1	2	s
Nannophya	0	1	C	0	1	2	s
Neurothemis	1-9	1–14	v–D	v	1–2	4–7	s
Onychothemis	1	3	D	0	2	3	u
Orchithemis	0	1–2	C	0	1	2	s
Orthetrum	1	3	C	0	1–2	3	u
Pantala	1	3–5	D	0	2	3	u
Potamarcha	1	3	v–D	0	2	3	u
Raphismia	0	1–3	D	0	1	2	s
Rhyothemis	2–3	7–10	D	0	2	5	s
Tetrathemis	0	1	C	0	1	1	s
Tholymis	1	3–4	D	0	2	3	s
Tramea	1–2	3–7	D	0	2	4	s
Trithemis	1	3	D	0	1–2	3	s
Urothemis	0	3	C	0	1	2	s
Zygonyx	1	1–2	D	0	1	2	s
Zyxomma	1	3	D	0	1	3	s

[a] C, continuous; D, discontinuous. [b] s, smoothly curved; u, undulate.

Verification table—Continued.

Genus.	Hind wing.						
	Cross-veins in triangle.	Vein Cu 1.	Vein A 2.	Cubito-anal cross-veins.	Base of triangle.	Anal loop.	Length.
							mm
Acisoma	0	U[a]	out[b]	1	a[c]	f c[d]	17–22
Agrionoptera	0	D	out	1–2	d	n c	30–39
Brachydiplax	0	D	out	1	a	f c	21–32
Brachythemis	0	D	v	1	a	f c	23–29
Camacinia	2–3	D	opp	2	a	f c	47–48
Cratilla	1	D	opp	1	a	f c	34–39
Crocothemis	0	v–D	v-opp	1	a	f c	27–35
Diplacina	v	U	v	1–2	a	f c	34–36
Diplacodes	0	U	v	1	a	f c	19–22
Hydrobasileus	0	D	opp	1	a	f c	40–48
Lathrecista	0	D	out	1	a	f c	31–35
Lyriothemis	1	D	out	3	a	f c	24–37
Macrodiplax	0	D	opp	1	p	f c	30–35
Nannophya	0	U	out	1	a	n o	13–15
Neurothemis	1–3	D	v	1–2	a	f c	19–31
Onychothemis	0	D	opp	1	p	f c	37–46
Orchithemis	1	v	out	2	d	n o	23–24
Orthetrum	v	v	opp	1	a	f c	26–44
Pantala	0	D	v	2	a	f c	39–41
Potamarcha	1	D	out	1	a	f c	31–34
Raphismia	0	v	out	1	d	f o	25–27
Rhyothemis	0	D	opp	1	a	f c	30–40
Tetrathemis	0	U	out	3	d	n c	17–24
Tholymis	0	D	opp	1	a	f o	31–37
Tramea	0	D	opp	1	a	f c	45–50
Trithemis	0	D	opp	1	a	f c	23–34
Urothemis	0	U	opp	1	a	f c	37–40
Zygonyx	0	U	opp	1	p	f c	40–45
Zyxomma	0	v–U	opp	1	a	f o	33–40

[a] U, Arising from the outer side of the triangle; D, arising from the hindmost angle of the triangle.

[b] out, Arising beyond anal crossing; opp, arising opposite anal crossing.

[c] a, At arculus; p, proximad; d, distad.

[d] f, Foot-shaped; n, not foot-shaped; c, complete; o, open at toe.

Key to the genera.

NYMPHS

1. With middorsal hooks on some abdominal segments .... 2.
   With no middorsal hooks on any abdominal segment .... 8.
2. With a middorsal hook on segment 9 .... 3.
   With no middorsal hook on segment 9 .... 6.
3. Teeth on lateral lobe of labium large .... 4.
   Teeth on lateral lobe of labium obsolete .... 5.
4. Small (length 12 mm); abdomen flattened, its appendages short. *Tetrathemis.*
   Large (length 23 mm); abdomen sharply triquetral, its appendages long .... *Tholymis.*

5. Lateral setæ of labium 6 .... *Brachythemis.*
   Lateral setæ of labium 9 .... *Lyriothemis.*[19]
6. Eyes produced laterally in a recurved cone, sharply pointed. *Hydrobasileus.*
   Eyes normal .... 7.
7. Dorsal hooks laterally flattened; a minute lateral spine on segment 7. *Brachydiplax.*
   Dorsal hooks more spinelike; no minute lateral spine on segment 7. *Orthetrum.*
8. Lateral spines obsolete .... *Acisoma.*
   Lateral spines well developed .... 9.
9. Lateral spines on segments 7 to 9 .... *Diplacina.*
   Lateral spines on segments 8 and 9 only .... 10.
10. Lateral setæ of labium 4 or 5 .... *Diplacina.*
    Lateral setæ of labium 9 or more .... 11.
11. Lateral spines short, not longer than the segments that bear them. 12.
    Lateral spines about twice as long as the segments that bear them. 14.
12. Lateral setæ 11 .... 13.
    Lateral setæ 9 .... *Neurothemis.*
13. Small (length 15 mm), mental setæ 12 to 13 .... *Diplacodes.*
    Larger (length 22 mm), mental setæ 15 .... *Crocothemis.*
14. Superior abdominal appendage longer than the inferiors .... *Pantala.*
    Superior abdominal appendage shorter than the inferiors .... *Tramea.*

Verification table.

Genus.	Abdomen.				Labium.		
	Length.	Segments bearing lateral spines.	Segments bearing dorsal hooks.	Length of inferior appendages in relation to abdominal segments.	Lateral setæ.	Mental setæ.	Teeth on lateral lobe.
	mm.						
Acisoma	14	(a)	(a)	=9	7	14	Obsolete.
Brachydiplax	20	8–9	4–8	=9+10+	11	15	Do.
Brachythemis	20	8–9	4–9	=9	6	10–12	Do.
Crocothemis	22	8–9	(a)	=9+10	11	15	Do.
Diplacina	18	7 or 8–9	(a)	=9+10	4–5	4–5	Low.
Diplacodes	15	8–9	(a)	=9+10	10–11	12–13	Obsolete.
Hydrobasileus	25	8–9	4–8	=9+10	9	11	Do.
Lyriothemis	17	8–9	4–9	=9	9	12	Do.
Neurothemis	15	8–9	(a)	=9	9	12	Do.
Orthetrum	17	8–9	4–8	=9	5–8	3+	Medium.
Pantala	25	8–9	(a)	=9+10+	12–14	15	Large.
Tetrathemis	12	8–9	4–9	=9+10	9	12–13	Do.
Tholymis	23	8–9	4–10	=9+	8	11	Do.
Tramea	27	8–9	(a)	=9+10+	11	12	Low.

[a] Obsolete.

[19] These characters are taken from *L. pachygastra*, reared by the senior author in China [Zoöl. Sinica (A) 11 fasc. 1 (1930) 156, pl. 14, fig. 4] and that species differs so markedly from the Philippine *L. cleis* (type of the genus) that its nymph may hardly be expected to conform.

ORCHITHEMIS PULCHERRIMA Brauer. Plate 4, fig. 61.

BRAUER, Sitz. Akad. Wien 77 (1878) 6, male, female, Malacca, Johore, Pengullon Patie; RIS, Cat. Coll. Sélys 9 (1909) 85, figs. 54, 55.

This species appears not to have been reported hitherto from the Philippines, and it is represented in the material sent us by only a single male, which is labeled "Los Baños(?)." It is Ris's "black form" of this species—black above on the whole body, metallic on the frons above the yellow face. It is further characterized by very slender legs and narrow wings. The most unique character in its venation is the absence of an anal loop in the hind wing (Plate 4, fig. 61).

Length of hind wing, 25 mm.

Genus AGRIONOPTERA Brauer

We are able to report two species of this rather primitive genus, one of which has long been known and the other of which is new. Both are characterized in venation by a short anal loop, with a distinct midrib, but not foot-shaped, lacking the toe entirely; by having the triangle of the hind wing situated well beyond the arculus; by having the arculus in both wings situated beyond the second antenodal crossvein; and by having fairly well-developed planates, both radial and median.

There are differences in venation that may be used to distinguish the two species, as follows:

1. With only a single bridge crossvein; radial planate subtends a single row of cells; the anal loop is widened at the base and rounded at the apex; and in the hind wing the triangle is distant from the arculus nearly its own length .... *quatuornotata*.

   With two or three bridge crossveins; the radial planate subtends two rows of cells in its middle portion; the anal loop is parallel-sided to the base and obliquely truncate at the apex; and in the hind wing the triangle is retracted almost to the arculus............ *bartola* sp. nov.

AGRIONOPTERA QUATUORNOTATA Brauer. Plate 4, fig. 60.

BRAUER, zool.-bot. Wien 17 (1867) 289, 298, male, Menado; SÉLYS, Mitt. Mus. Dresden (1878) 294; An. Soc. Esp. Hist. Nat. 11 (1882) 10 (as *insignis*); KIRBY, Trans. Zoöl. Soc. London 12 (1889) 292, pl. 56, fig. 3; RIS, Cat. Coll. Sélys 10 (1909) 138, fig. 98.

Celebes, Philippines, Yap, Saleyer, Djampea, Kalao, Ponape.

SAMAR, Oquendo, 1 female, December 30, 1931 (*F. Reformina*).

MINDANAO, Zamboanga, Kabasalan, 1 female, July, 1932 (*Muzzall*).

The Samar specimen shows the beautiful color pattern described by Ris,[20] while the Zamboanga specimen is obfuscated with black. In both the hind wing measures 33 mm.

[20] Cat. Coll. Sélys 10 (1909) 138–139.

AGRIONOPTERA BARTOLA sp. nov. Plate 1, fig. 17; Plate 4, fig. 59.

Female, length, 45 mm; abdomen, 28; hind wing, 41.

A long-winged species with bright yellow face below a shining metallic blue frons. Labium yellow with a black median stripe that widens basally to cover the median lobe. Labrum yellow with a narrow black front margin. Mandibles black with a large external yellow spot. Frons all shining blue except a large roundish yellow spot next the eye and confluent below with the yellow of the clypeus. Vertex metallic blue, sunken in the middle and rimmed around the edge next the ocelli. Occiput brown, shining above, on its rear face a twin spot of bright yellow, covered with pale tawny hair. Another large yellow spot on the posterior face of the ridge behind each eye.

Prothorax black above, with two cross stripes of yellow, the narrower one at the front, marginal, and with a large yellow median twin spot on the hinder part. Synthorax black with greenish reflections, striped with yellow and pruinose beneath between legs and abdomen. A middorsal yellow stripe covering carina and followed by a twin spot in the antealar sinus, then a large spot, a triple spot, and another large spot between the wing bases. An irregular humeral stripe, angulated at the lower end of the humeral suture, extending down to the middle coxa, and upward halfway to the wing above it; widely separated from it two small isolated spots, one on either side of the upper end of the humeral suture. Two irregular narrow stripes following the other two lateral sutures, the rear one incomplete below. Legs black with pale basal segments and with inner face of the front femora yellow. Wings (Plate 4, fig. 59) subhyaline with a long heavy very dark brown stigma. Ante- and postnodal crossveins of the type specimen 15: 13 and 13: 13 in fore and hind wing, respectively. The triangle retracted almost to the arculus, its inner end almost in line therewith. Anal loop short, its two rows of inclined cells, from five to nine in number, having one more cell in the hind than in the front row. Anal loop not boot-shaped, but looking as if the foot were cut off at the angle, its terminal bordering vein, A_1, perpendicular to the long axis of the wing. Two bridge crossveins.

Abdomen black with segments 6 and 7 conspicuously red within black marginal carinæ. Venter similarly but less conspicuously colored. On segment 1 three roundish spots of yellow, one midlateral on each side, and one middorsal. Behind the latter a narrow interrupted median line of yellow on segments 2 to 5, near the lateral margins a similar but more widely interrupted line of yellow on 3 to 5. Segment 8 deep black including lateral expansions. Terminal segments only a little paler beneath where clothed with short tawny hairs. Subgenital plate as shown in Plate 1, fig. 17.

This species is nearly allied to *A. sexlineata* Brauer, but is distinctly larger, has a yellow, not an olivaceous face, the humeral yellow stripe abbreviated, not entire, and the fifth abdominal segment wholly black.

Nannophya pygmæa Rambur, ranging from China to Celebes and beyond, should be found in the Philippines. It is the smallest of known libellulines (hind wing 13 to 14 mm) and will be readily recognized by its 4-sided triangle, its anal loop open to rearward, a wide space without crossveins behind the stigma, and the small number of antenodal crossveins, five in the forewing and four in the hind (Plate 4, fig. 63). The nymph is unknown.

Genus TETRATHEMIS Brauer

This unique genus is markedly primitive in certain features of its venation. For example, the triangle of the forewing is 4-sided, that of the hind wing but little retracted towards the arculus, the cubital vein very moderately deflected at the triangles; it shows several cubito-anal crossveins, a weak development of the anal loop, and no planates are developed. We present a description and a figure of its nymph, which also shows primitive characters—characters that appear in the mature nymphs of the more generalized cordulines, and in the early instars of many libelluline nymphs, such as the pair of tubercles on top of the head and the middorsal row of cultriform hooks on the abdominal segments.

TETRATHEMIS IRREGULARIS Brauer. Plate 4, fig. 64.

BRAUER, Verh. zool.-bot. Wien **18** (1868) 183, 727, female, Mindanao; SÉLYS, Ann. Mus. Dresden (1878) 295; An. Soc. Esp. Hist. Nat. **11** (1882) 9; RIS, Cat. Coll. Sélys **9** (1909) 47, Luzon.

This, the only species known to occur in the Philippines, will be readily recognized by the generic characters stated above and by those of our key, table, and wing figures (Plate 4, fig. 64). Judging by the collections before us it is not uncommon in Luzon. Our adult material is as follows:

LUZON, Rizal Province, Makabud, March 19, 1930, June 16, 19, 20, 22, 30 (*A. C. Duyag*); Novaliches, July, August, 1930 (*Duyag*); Pasig, June 4 (*Duyag*); San Francisco del Monte, June 5 (*Duyag*): Tayabas Province, Lucban, June 20, 1930

(*McGregor and Rivera*), January 27, 1931 (*F. Rivera*). MINDANAO, Kabasalan, Zamboanga, July, 1932 (*H. C. Muzzall*).

We have a few nymphs from Zamboanga, and these are well enough preserved to show clearly the venation in their wings. The latter is so very distinctive that there can be no doubt about the generic determination, even though the nymphs have not been reared.

TETRATHEMIS IRREGULARIS. Nymph. Plate 9, fig. 100.

Length 12 mm; abdomen, 7; hind femur, 4; width of head, 4; width of abdomen, 5.

A small, slender-legged nymph with a broadly depressed abdomen. Head widest across the prominent eyes, narrowed behind them to a nearly straight occipital border, smoothly rounded above with a transverse row of brownish longitudinal streaks in the rear. Antennæ ringed and "mask" spotted with brown. Labium (Plate 9, figs. 98 and 99) rather slender basally, its hinge reaching the middle of the mesothorax; mentum with a Y-shaped widening to bases of the lateral lobes. Lateral setæ nine, very slender, especially the proximal ones, the end hook long and thin, with increasing curvature towards the tip. On the distal margin the six or seven teeth are about as high as wide, obtuse, slightly oblique, each armed with two or three spinules. Mental setæ twelve or thirteen, in a regular graduated series, with the fourth or fifth, counting from the side, longest.

Prothorax rather short and wide, its disc projecting forward in a prominent obtuse angle, below it a low hair-tufted supracoxal process. Legs sparsely hairy, pale, femora twice ringed with brown. The wing cases reaching backward to abdominal segment 6.

Abdomen widest on segment 7, thereafter abruptly tapering to a subtruncate tip. Lateral spines on 8 and 9 subequal, those on 9 pointing sharply inwards. Dorsal hooks on 4 to 9, on 4 small, on 5 to 9 subequal, low, stout, strongly directed to rearward. Segments 7 to 9 slightly decreasing in length, 10 annular, almost included in the apex of 9. Appendages short and thick, hardly surpassing level of tip of lateral spines on 9, superior and inferiors subequal, triangular, cuspidate-pointed; the laterals cylindric, slightly shorter.

MINDANAO, Zamboanga, 5 nymphs.

Genus DIPLACODES Kirby

Here belong two small species, one of which, *D. trivialis*, is among the commonest in the Islands. They can readily be recognized by the following combination of venational characters: a half antenodal crossvein in the forewing, a long space without crossveins before the stigma in both wings, vein Cu_2 arising from outer side of the triangle in the hind wing.

Our two species may easily be distinguished as follows:

1. Forewing triangle free from crossvein; subtriangle of one or two cells. *nebulosa.*
   Forewing triangle crossed; subtriangle of three cells .... *trivialis.*

DIPLACODES NEBULOSA Fabricius.

FABRICIUS, Entom. Syst. 2 (1793) 379, male, Oriental India; RIS, Cat. Coll. Sélys **12** (1911) 463.

The male of this species is strikingly marked by blackish wing tips, but the female is clear-winged, as are both sexes in the other species.

Hind wing, 17 to 19 mm.

LUZON, Ilocos Norte Province, Piddig, 2 males, January 7, 1931 (*Ignacio Valentin*).

DIPLACODES TRIVIALIS Fabricius. Plate 4, fig. 62.

FABRICIUS, Suppl. Ent. Syst. (1798) 284, Oriental India; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 8, Philippines; RIS, Cat. Coll. Sélys **12** (1911) 468; NEEDHAM, Proc. U. S. Nat. Mus. 27 (1904) 708.

This is the species that fairly swarms in the lowlands of the Oriental Tropics.

When recently emerged the sides of the thorax are pale greenish yellow with three narrow irregular and more or less interrupted black lines on the sutures, the front is darker with a pale median stripe. Old specimens become wholly pruinose of body and blackish with only the face and the appendages at the end of the body remaining pale.

Specimens from every collector and every lowland locality.

DIPLACODES sp. Nymph.

Length, 15 mm; abdomen, 9; hind femur, 5; width of head, 5; width of abdomen, 5.5.

In 1904 [21] the senior author described a nymph of this genus by supposition from a large lot of very poor material—nymphs of all sizes dried on pins and mostly broken. Now we have a few more nymphs from Los Baños and Zamboanga, this time in alcohol, and again very badly preserved. In one of these the venation is well enough preserved to make certain that the

[21] Proc. U. S. Nat. Mus. 27 (1904) 708.

genus was rightly determined. Now we can give a few details not well shown in the dried and shriveled specimens.

Head wide with large and laterally prominent eyes and abruptly narrowed in the rear portion (as shown in the photo reproduced).[22] Labium (Plate 9, figs. 96 and 97) rather slender with very prominent triangular middle lobe, smooth of border, and sparsely fringed with setæ. Setæ ten to eleven lateral and twelve to thirteen mental. Movable hook very slender and regularly curved. Terminal border of lateral lobe faintly serrulate with single spinules on the serrulations.

Prothoracic disc scurfy pubescent on its rounded lateral margins. No distinct supracoxal process, instead a broad sloping pubescent area. Slender, nearly bare, legs faintly ringed with brown, wing cases mottled with the same color at base and at nodus.

Abdomen oval, moderately depressed, marked with two broad bands of brown that are interrupted by cross rings of paler color on the sutures. No dorsal hooks. The lateral spines on segments 8 and 9 minute but sharp and straight and well-defined. Abdominal segment 10 annular and almost included in the apex of 9. Appendages as long as 9 and 10 together on the middorsal line, with the laterals a fifth shorter than the others.

While the venation of the nymphal wings of our specimen were adequate for determination of the genus, the distinctive area about the stigma being well preserved, the portion about the subtriangle of the forewing that would have furnished characters to distinguish the two Philippine species had disintegrated.

RAPHISMIA BISPINA Hagen. Plate 6, fig. 77.

HAGEN, Stett. Ent. Ztg. **28** (1867) 91, Morotai, Halmaheira; RIS, Cat. Coll. Sélys **11** (1910) 369.

This little blackish, clear-winged dragon fly is easily recognized when teneral by its pattern of four broad, yellow, oblique stripes on the sides of the thorax, the first and third interrupted near both ends to form isolated spots above and below (a pattern that becomes entirely obscured by pruinosity in old males) and by the presence of a pair of conspicuous spines underneath the metathorax of the male; also by these venational characters in addition to those mentioned in our table of genera; the

[22] Op. cit., pl. 41, figs. 8 and 9.

triangle in the hind wings is situated far beyond the arculus and the anal loop is open at the toe, vein A_2 not being conjoined with A_1 at the end of the midrib (Plate 6, fig. 77).

Hind wing, 24 to 25 mm.

Nymph unknown.

LUZON, Manila, Maypajo, 10 males, June, 1930 (*A. C. Duyag*): Rizal Province, Navotas, 1 male, December 24, 1930 (*T. San Pedro*); Malabon, 1 male, January 2, 1935 (*A. C. Gallardo*): Bulacan Province, 2 males and 1 female, December 27, 1930 (*P. V. Cruz*): Pangasinan Province, San Carlos, 3 females, January 2, 1931 (*Dominador Santos*).

ZYGONYX IDA Karsch. Plate 7, fig. 83.

KARSCH, Berlin Ent. Ztsch. **33** (1889) 281; RIS, Cat. Coll. Sélys **14** (1912) 819, Java, Malacca, Sumatra, Lombok, Ekas, Sapit.

This is a clear-winged species of moderate size, with metallic green frons and dorsum when fully mature. It may be distinguished by the following combination of venational characters in addition to those shown in our table of genera: two rows of cells in the space beyond the forewing triangle out to the level of the nodus; vein Cu_2 in hind wing arises from the outer side of the triangle; a very long and much angulated anal loop, the midrib of which is bent at the ankle at an angle of about 90 degrees; antenodals of fore and hind wing twelve and a half and nine to ten, respectively (Plate 7, fig. 83).

Hind wing, 40 to 47 mm.

LUZON, female.

ACISOMA PANORPOIDES Rambur. Plate 7, fig. 86.

RAMBUR, Hist. Ins. Neur. (1842) 28, male, female; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 8, Philippines; RIS, Cat. Coll. Sélys **12** (1911) 457; NEEDHAM, Zoologia Sinica (A) **11** fasc. 1 (1930) 177.

This species will be readily recognized by the unique form of the abdomen; the basal half greatly inflated, the apical half slender. Segments 7 to 10 black with white or pale appendages. Thorax and swollen base of abdomen pale bluish green with a complicated pattern of curving black lines.

Hind wing, 22 mm.

LUZON, Bulacan Province, Calumpit, 1 female, December 21, 1930 (*Fidel Reyes*): Laguna Province, Los Baños, 1 male, December 23, 1930 (*Vedasto Javier*); Bangyas Bay, 1 female, December 30, 1930 (*E. Carandang*): Batangas Province, Talisay, 1 male, December 30, 1930 (*A. P. Evangelista*), 1 female, December 30, 1931 (*Entomology I*).

The nymph was described and figured by the senior author in 1930.[23]

Genus DIPLACINA Brauer

This genus may be distinguished from its nearest allies by a simple venational character; the vein Cu_2 arises in the hind wing, not from the hind angle of the triangle but from its outer side. Also, the single bridge crossvein is situated extremely far forward, almost its own length before the subnodus. In the prothorax the posterior dorsal lobe is very high, bilobed, and fringed on its erect rounded margins with long hairs.

Three species, of moderate size, handsomely striped with black and yellow, are found in the Philippines. One of these, *D. nana,* we have not seen. Apparently it has not been collected since Semper obtained the two original specimens (Cebu, Bohol) that Brauer described in 1878.

Ris (1909) was clearly in error when he recognized but one additional Philippine species, relegating *D. braueri* to synonymy with *D. bolivari.* Karsch earlier (1889) correctly diagnosed the two species, pointing out some of their distinctive venational characters; but his very scanty material led him to cite differences that do not hold when a greater number of specimens are examined. He had but a single male of each. We have a long series of specimens of each. Both species seem to be common at Los Baños, *D. bolivari* perhaps a little more so than *D. braueri.* We have carefully compared venation and color pattern in more than fifty specimens of each, and find no difficulty in distinguishing them.

The nymph [24] also is easily recognizable by reason of its having, in *D. braueri* at least, lateral spines on segments 7, 8 and 9 of the abdomen, and not on 8 and 9 only, as in the other genera.

The three species may be distinguished as follows:

1. One row of cells in the space beyond the triangle .... *nana.*
   Two rows of cells in the space beyond the triangle .... 2.
2. One cubito-anal crossvein in the hind wing .... *braueri.*
   Two cubito-anal crossveins in the hind wing .... *bolivari.*

DIPLACINA BOLIVARI Sélys. Plate 7, fig. 85.

SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 15, male, Luzon; KARSCH, Berl. Ent. Zeitschr. **33** (1889) 379; RIS, Cat. Coll. Sélys 9 (1909) 97.

[23] Zoologia Sinica (A) **11** fasc. 1 (1930) 178, pl. 14, fig. 2.

[24] Lieftinck has doubtfully referred a Moluccan nymph to *Diplacina phœbe* Ris (Treubia 7: 323, pls. 8, 9). His good description and figures show far too many raptorial setæ on the labium, when compared with our nymphs, for close association with the nymphs we have been able to refer to *Diplacina* by characters of the developing venation.

This is a slightly larger species that in fully mature specimens becomes darker above and more pruinose on the underside of the thorax. The three black stripes of the sides of the synthorax are broader, especially the middle one which is complete below, and generally confluent at two intermediate places as well as at both ends with the one behind it (Plate 7, fig. 85). The two cell rows beyond the triangle generally begin with three cells next its outer side. There are two cubito-anal crossveins as noted in the key, and vein M_2 is distinctly undulate.

Hind wing, 33 to 39 mm.

DIPLACINA sp. Nymph (BOLIVARI supposition). Plate 9, figs. 114 and 115.

Length, 18 mm; abdomen, 10; hind femur, 5; width of head, 5; width of abdomen, 6.

This is an elongate nymph, approaching the *Orthetrum-Libellula* type, with eyes capping the anterolateral angles of the head only a little less prominently. The head only slightly wider across eyes than on the broadly rounded hind angles. Labium (Plate 9, figs. 114 and 115) large, with prominent evenly bordered median lobe very thickly beset with stout irregular spinules. Lateral setæ four or five; mentals four or five in an outer row that dwindles internally into a series of ten to fifteen smaller ones, these becoming irregular towards middle line of mentum. Teeth on terminal border of lateral lobe very low, eroded, many times wider than high and bearing each about half a dozen strong spinules. Prothoracic disc rather broad, its projecting ends densely clothed with long bristles. So also is the still broader supracoxal process beneath. Legs hairy. Wing cases reach well upon the sixth abdominal segment.

Abdomen elongate, oval, widest on segment 6, roundly tapered to rearward, with small lateral spines on 8 and 9, low, sharp, straight, subequal. No dorsal hooks. Segment 10 cylindric, half as long as 9 on the middorsal line. Appendages moderate, not as long as 9 and 10, superiors and inferiors of equal length; laterals slender, more sharply pointed, a fifth shorter.

DIPLACINA BRAUERI Sélys. Plate 7, figs. 84 and 87.

SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 15, Philippines; KARSCH, Berl. Ent. Zeitschr. **33** (1889) 379; RIS, Cat. Coll. Sélys **9** (1909) 97 (as *bolivari*).

This is the slightly smaller (hind wing 26 to 28 mm) and more brightly colored species. Of the three black stripes on the lateral sutures of the synthorax, the middle one is narrowed and discontinued below the spiracle, or conjoined with the one before it only by a decurrent hair line (Plate 7, fig. 84).

Besides the single venational distinction used in our key, the absence of a second cubito-anal crossvein (a character which appears to be quite constant) there are two other good characters that were pointed out by Karsch:[25] the two rows beyond the triangle generally begin with but two cells touching its outer side, and vein M_2 is scarcely undulate, much less so than in *D. bolivari.* The numbers of nodal crossveins and of marginal cells given by him are inconstant and therefore not significant.

Nymph: (Plate 9, fig. 113).—Very similar in form to the preceding species, but differing in being a little smaller (length 16, abdomen 9) and lighter in color, and, more strikingly, in having larger and rather conspicuous lateral spines on abdominal segments 7 to 9, as shown in our figure. Minor differences in the labial characters; teeth on terminal border of lateral lobe of labium eroded to obsolescence and their marginal spinules alternately long and short; mental setæ but three in the outer group, with a scattering line of much smaller and more numerous spinules extending inward.

DIPLACINA sp?

We have a single female specimen in which there is a single cell in this area touching the triangle, and also a one-celled interruption of the two rows three cells farther out in the wing: also there is a subtriangle in the forewing of one side divided into only two cells; but the arcuate dividing crossvein suggests something omitted. The other forewing is missing from this specimen. The black stripes of the sides are much as described above, but the humeral yellow stripe is broader and interrupted before the crest. Within the antealar sinus a pair of bright yellow spots lie opposite the two that are forward from the detached upper end of the humeral stripes. Is it another species?

Genus BRACHYDIPLAX Brauer

Two species of this genus of rather small dragon flies are recorded from the Islands, but only one of them has been before us. The genus will be recognized by the venational characters shown in our table, and perhaps by the following additional characters: There are wide spaces without crossveins behind

[25] Berl. Ent. Zeitschr. 33 (1889) 379.

the stigma and before it in the same (R_1) space, the radial planate is continuous to the wing margin, the triangle of the hind wing is retracted almost to the arculus but generally not quite touching it, and the large first anal cell next the membranule is emarginate by a reëntrant curve on its posterior side. Both species have seven antenodal crossveins in the forewing. The two species may be separated as follows:

1. Subtriangle of the forewing 3-celled .... *chalybea.*
   Subtriangle of the forewing 1- or 2-celled .... *duivenbodei.*

BRACHYDIPLAX CHALYBEA Brauer. Plate 6, fig. 80.

BRAUER, zool.-bot. Wien 18 (1868) 173, Bohol; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) (*chalybæa*); RIS, Cat. Coll. Sélys 11 (1910) 363; NEEDHAM, Zoologia Sinica (A) 11 fasc. 1 (1930) 175, nymph.

Dark species, metallic blue on top of frons, and also in the dorsum of the thorax of the males. Sides clouded rather than striped with paler on the convex areas between the dark sutures. Old specimens become blackish over whole abdomen. Base of both wings washed with brown over two or three cells outward.

Hind wing, 27 to 30 mm.

LUZON, Laguna Province, Los Baños, 1 male, August 31, 1930 (*M. E. Rosell*), 1 male, February 15, 1931 (*M. R. Viloria*), 1 female, August, 1932 (*A. Muyco*), 1 male, November 11, 1933 (*Prisco Caraig*); Raymundo Barrio, 1 female, October (*Leoncia L. Serrano*); Pila, 2 males and 1 female, January 1, 1931 (*J. K. Santiago*); Molawin Creek, 1 female, February 14, 1934 (*Z. T. Neri*); Mount Maquiling, 2 males, no date (*Baker*): Ilocos Norte Province, Laoag, 1 male, January 2, 1931 (*Manuel Asuncion*). MINDANAO, Zamboanga Province, Kabasalan, 16 males, April, 1932 (*H. C. Muzzall*), 3 males, July, 1932 (*H. C. Muzzall*).

BRACHYDIPLAX DUIVENBODEI Brauer.

BRAUER, zool.-bot. Wien 16 (1866) 569, a male, New Guinea; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 8, Bohol; RIS, Cat. Coll. Sélys 11 (1910) 365.

We have not seen this species. The single known specimen is reported by Ris [26] to have an extra half antenodal in one forewing.

Genera MACRODIPLAX Sèlys and UROTHEMIS Brauer

Here is superficial likeness between representatives of two distinct genera. Both are reddish brown, black-legged dragon flies of similar size, nonpruinose when adult, with little color

[26] Cat. Coll. Sélys 11 (1910) 365.

pattern on the villous thorax, with broad black middorsal stripe on the abdomen, and a spot in the base of the hind wing. This spot is large, blackish and gold-bordered in *Urothemis*, smaller and all golden in *Macrodiplax*. The antenodal crossveins are 7 in *Urothemis*, 6 in *Macrodiplax*. In *Macrodiplax* the reverse crossvein is extremely aslant and about twice as long as the crossvein in its proximal side, much less so in *Urothemis*. The forewing triangle is more convex on its distal side and the "toe" of the anal loop is more pointed in *Macrodiplax*.

MACRODIPLAX CORA Brauer. Plate 5, fig. 69.

BRAUER, zool.-bot. Wien **17** (1867) 20, 289, Ceram, Philippines; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 15; RIS, Cat. Coll. Sélys **16** (1913) 1036.

Hind wing, 35 mm.

Specimens from practically all localities.

UROTHEMIS BISIGNATA Brauer. Plate 5, fig. 70.

BRAUER, zool.-bot. Wien **18** (1868) 175, 737, female, Luzon; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 15; RIS, Cat. Coll. Sélys **16** (1913) 1025.

Hind wing, 35 mm.

There are 23 females and 15 males from Laguna, Rizal, Pampanga, Pangasinan, Nueva Ecija, Bulacan, Isabela, Batangas, and Tarlac Provinces, Luzon, collected by F. M. Fronda, B. G. Salinas, J. M. de Vera, V. Labayen, A. P. Varona, F. S. Manipol, Melchor Dugus, Clemente Valdez, P. M. Caguicla, W. Macapagal, Rodrigo Odes, Jacinto Lagtapon, F. C. Francisco, V. Gagolinan, A. P. Evangelista, I. Villanueva, G. Mejia, T. Oliquino, C. Magno, Domingo Fermin, J. K. Santiago, W. Figueroa, H. Angel, S. R. Roque, F. A. Caña, Mariano Magtang, A. P. Bayan, Bartolome Javier, "Entomology I."

Genus ZYXOMMA Rambur

Two species are represented in the material before us. Both are rather plain brown dragon flies of medium size with narrow black apical carinæ on the middle abdominal segments. They are distinguished from related genera by the open "toe" of the anal loop: vein A_2 does not join A_1 at the end of the midrib in the usual manner but runs out independently to the wing margin. The two may be distinguished as follows:

1. Abdomen longer than hind wing.. *petiolatum*.
   Abdomen at most as long as hind wing.. *obtusum*.

ZYXOMMA PETIOLATUM Rambur. Plate 7, fig. 81.

RAMBUR, Hist. Ins. Neur. (1842) 30, pl. 2, fig. 4*d*, male, Bombay; RIS, Cat. Coll. Sélys 15 (1913) 903.

This species has the abdomen bulbous at the base and exceedingly attenuated beyond. Two dashes of tawny yellow color in the base of each wing, and sometimes a wash of pale brownish across the wing apex, mark the otherwise generally hyaline wing membrane. Stigma pale.

Hind wing, 32 to 33 mm.

LUZON, Laguna Province, Los Baños, male, July 7, 1931 (*M. Enriquez*), male, February 10, 1932 (*J. Reyes*), female, February 20, 1932 (*P. Asuncion*).

ZYXOMMA OBTUSUM Sélys.

SÉLYS, Mitt. Mus. Dresden (1878) 293; Celebes; RIS, Cat. Coll. Sélys 15 (1913) 908.

In this species the abdomen is relatively shorter and stouter, the constriction at the end of the third segment being less close and the portion beyond less narrowed. In most specimens, but not in all, the wing tips are brown from the level of the proximal end of the stigma, but in one female from Kabasalan, Zamboanga, they are wholly tinged with brown.

Hind wing, 38 to 40 mm.

LUZON, Laguna Province, Los Baños, female, August 3, 1932 (*A. B. Barroquillo*), male, August 20, 1932 (*Gregorio A. Jaime*); Mount Maquiling, female (*Baker*); Raymundo Barrio, female (*Leoncia Serrano*). MINDANAO, Zamboanga, Kabasalan, 4 males and 1 female (*H. C. Muzzall*).

THOLYMIS TILLARGA Fabricius. Plate 8, fig. 91.

FABRICIUS, Suppl. Ent. Syst. (1798) 285, Oriental India; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 6, Manila; RIS, Cat. Coll. Sélys 15 (1913) 913.

This wide-ranging species is easily recognized by a large cloud of yellowish or brownish color occupying most of the basal half of the hind wing (there is a whitened area beyond it in old specimens) with a fainter wash of yellow in the basal third of the forewing. The body is yellowish brown, possibly olivaceous in life, almost destitute of color pattern.

Hind wing, 36 mm.

There are 33 males and 32 females from Laguna, Tarlac, Rizal, Pampanga, and Cagayan Provinces, Luzon, collected by F. O. Panis, L. Boongaling, Restituto B. Realeza, Eufemio Salera, Modesto M. Ragat, Pablo B. Agcanas, Santos S. Garcia, Felix Bauoag, Manuel A. Aaron, F. J. Madrid, I. A. Cabauatan, Isidro Dumaua, G. A. Pangga, L. S. Gonzales, Rodrigo Odes, G. O. Palis, P. Rosales, Jose David, Domingo Endrinal, Rudyardo Santiago, P. M. Caguicla, T. Faysan, I. Villafuerte, J. Amores, Rodolfo Guerrero, R. Baes, M. R. Viloria, C. Antenor, M. Enriquez, Domingo Fermin, H. Angel, Celerino Gariando, T. Catlazo, Hilario J. Santos, J. S. Versoza, Ruperto Cabahug, P. Enrile, F. Briones, Tomas Carag, Federico Deximo, I. Villanueva, McGregor, Baker, Duyag, A. Celestino, and R. Denoga, in all months of the year except April, May, June, and July. MINDANAO, Zamboanga Province, Kabasalan, 13 males (*Muzzall*).

THOLYMIS sp. Nymph. Plate 9, figs. 116 to 118.

Length, 23 mm; abdomen, 15; hind femur, 7; width of head, 6; width of abdomen, 9.

A smooth, slender-legged nymph with strongly triquetral abdomen, the flat sides sloping like a roof to the serrated dorsal ridge. Head rather small with the moderately large eyes prominent at the middle of sides. Behind the eyes the sides converging to a rather wide, slightly concave occipital border. Labium (Plate 9, figs. 116 and 117) freckled with brown, its hinge reaching backward to the middle of the mesothorax. Lateral setæ eight, mentals eleven on each side. Teeth on the distal border of the lateral lobe eight, deeply and very obliquely cut, nearly as high as wide, each of the middle ones armed with four or five stout spinules. Movable hook large, strong, and curved only towards the tip.

Prothorax moderate, its disc rather wide, and with a thickened, upturned, and hair-fringed margin. Below it and in front of it a long, stout, blunt, pyramidal, supracoxal process that is very hairy externally. Legs pale, thin, and sparsely hairy; femora and tibia each faintly and doubly ringed with brown. Wing sheaths with a brown dot at the nodus.

Abdomen beyond the tips of the wings with a middorsal band of brown divided by a paler line along the median ridge. Sides faintly washed and mottled with brown farther towards the lateral margin. Lateral spines on segments 8 and 9, sharp, straight, subequal, each about a fifth as long as its segment. Lateral margin of these segments distinctly serrulate. Dorsal hooks on 4 to 10 small and erect on 4, becoming successively wider and flatter and more strongly declined to rearward on 5 to 9, a low vestige on 10. Segment 10 nearly cylindric, a little flattened on the sides, a third as long as 9 on the middorsal line.

Appendages very long, straight, and sharply triquetral. Superior and inferiors of equal length, distinctly longer than 9 middorsally; laterals slender and about half as long as the others.

This differs from the nymph from Batangas,[27] in having eight raptorial setæ instead of five on the lateral lobe of the labium, but otherwise quite similar. Venation of nymphal wings well enough preserved for assured generic identification.

The nymph figured by Fraser [28] as belonging to this species was clearly in error, as was also the one referred to *Tramea limbata* on the same plate.

RHYOTHEMIS PHYLLIS Sulzer. Plate 5, fig. 71.

SULZER, Ab. Ges. der Ins. (1776) 169, "Indient;" SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 7, Luzon, Cebu, Bohol; RIS, Cat. Coll. Sélys 15 (1913) 939.

This elegant species is easily recognized by its yellowish-tinted wings that are handsomely marked with brown as follows: A band across the tips beyond the stigma, a small spot on the nodus of the forewing, and two large spots on the base of the hind wing separated by light yellow. The spot nearer the hind angle is very variable in extent and may be wanting. In well-colored specimens it is very prominent, being surrounded by bright yellow.

Hind wing, 31 to 37 mm.

The nymph is unknown.

LUZON, Laguna Province, Los Baños, 1 female, February 28, 1931 (*B. Orig*), 1 female, January 7, 1932 (*M. Aldama*), 1 female, February 16, 1932 (*I. Villanueva*), 1 male, February 16, 1932 (*P. Cabreros*), 2 males and 4 females, no collector: Pangasinan Province, Mangaldan, 1 male, December 25, 1930 (*A. F. Cortes*); San Carlos, 1 female, December 28, 1930 (*Mariano Magtang*). SAMAR, Oquendo, 1 male, December 30, 1931 (*F. Reformina*). MINDANAO, Zamboanga, Kabasalan, 3 males, July, 1932 (*Muzzall*).

Genus NEUROTHEMIS Brauer

This colorful genus is easily recognized by the rich red-brown of the wings of the males and by the riot of crossveins in them. The two known Philippine species have the wings of the male

[27] Described by the senior author, Proc. U. S. Nat. Mus. 27 (1904) 701, as *Rhyothemis phyllius* supposition.

[28] Rec. Ind. Mus. 26 (1924) pl. 32, fig. 2.

suffused with brown from base to stigma. They may be distinguished as follows:

1. Brown area of wings of male squarely truncated at the base of stigma in both wings: two cubito-anal crossveins in hind wing...... *terminata.*
   Brown area in hind wing abbreviated on posterior side and rounded externally: generally a single cubito-anal crossvein in hind wing. *palliata.*

The females of *N. terminata* are dimorphic. One form is colored like the male but less intensively; the other has subhyaline wings, and much more open venation. Females of *N. palliata* have the brown area of the wings terminating about midway between the nodus and the stigma.

NEUROTHEMIS TERMINATA Ris.

RAMBUR, Hist. Nat. Neur. (1842) 127 (*Polyneura apicalis*) Java; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 8; RIS, Cat. Coll. Sélys **13** (1911) 569.

Specimens from all localities.

NEUROTHEMIS PALLIATA Rambur. Plate 5, fig. 66.

RAMBUR, Hist. Nat. Neur. (1842) 129, East Indies; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 7; RIS, Cat. Coll. Sélys **13** (1911) 554.

Specimens from all localities.

NEUROTHEMIS sp. Nymph No. 1. Plate 9, figs. 101 and 102.

Length, 15 mm; abdomen, 9; hind femora, 5; width of head 5; width of abdomen, 6.

A stocky little nymph with rather large head, and prominent, roundly bulging eyes. Behind the eyes the head narrowing rapidly to a rather straight occipital border, down which run seven streaks of brown. Labrum and free border of frons and a spot behind the base of each antenna also brown. Labium ample, its hinge reaching the middle of the mesothorax; with nine lateral setæ and twelve mentals; teeth obsolete, represented by tufts of spinules.

Prothoracic disc crescentic, its low incurving end margins armed with a row of stout decurving setæ. Coxæ and low supracoxal processes bear tufted weaker setæ. Legs slender spinulose, especially the outer side of the tibiæ; femora pale, twice ringed with brown. Wing cases reach the tip of the sixth abdominal segment.

Abdomen oblong, somewhat depressed, widest on segment 6, most narrowed on 9; with a middorsal ridge that is pale, not rising into hooks with free tips. Sharp subequal spines terminate the lateral margins of 8 and 9, each as long as half the middorsal length of 9. Appendages sharply pointed, superior almost equal to inferiors in length, these very spinous beneath, the slender and pale laterals a fifth shorter.

NEUROTHEMIS sp. Nymph No. 2.

A second species of nymph of this type appears to differ by having a broad pale median facial stripe extending down in the labrum, by lacking the white line on the middorsal ridge of the abdomen, by having the raptorial setæ of the labium eleven on both lateral lobe and mentum each side, by having the lateral spines of segments 8 and 9 very unequal, those of 8 being shorter.

CAMACINIA GIGANTEA Brauer. Plate 8, fig. 92.

BRAUER, zool.-bot. Wien 17 (1867) 8, male, female, Amboina; MATIN, Mission Pavie (1904) 4, Philippines: TILLYARD, Proc. Linn. Soc. N. S. Wales 33 (1908) (as *C. othello*); RIS, Cat. Coll. Sélys 15 (1913) 925–928.

This species is easily recognized by its size, it being the largest of the libellulines, and by the black color of the basal half of both wings. Venationally it is distinguished by having three rows of cells above the radial planate, the latter with its distal end upturned and strongly conjoined with vein Rs.

Hind wing, 47 to 52 mm.

LUZON, "Tolands," 1 male. POLILLO, 1 male (*Baker*).

The specimen from Luzon fits the description of *C. othello* Tillyard, having the black area in the forewing hardly surpassing the nodus, and in the hind wing extending diffusely but one cell beyond. The Polillo specimen fills the gap between that and the *C. gigantea* figured by Ris,[29] showing the extent of the black to be variable, as are the body colors as well, and no proper basis for species recognition.

TRAMEA LIMBATA Desjardins. Plate 8, fig. 89.

DESJARDINS, Rapport Société Maurice (1) (1832), Mauritius; CABOT, Mem. Mus. Comp. Zool. 17 (1) (1890) 48; NEEDHAM, Proc. U. S. Nat. Mus. 27 (1904) 712, fig. 4; RIS, Cat. Coll. Sélys 16 (1913) 979.

This fine wide-ranging, strong-flying dragon fly appears not to have been reported from the Philippines hitherto, and but two specimens are in the collections before us. It is difficult to capture. It will be readily recognized by its large size, and by the extreme breadth at base of the hind wings, with a broad trans-

[29] Cat. Coll. Sélys 15 (1913) 924, fig. 535.

verse band of dark brown covering most of the area behind vein A_2 adjacent to a whitish membranule.

Hind wing, 45 mm.

The nymph was described by Cabot in 1890 [30] and figured by the senior author in 1904.[31]

LUZON, Laguna Province, Los Baños, male, November 10, 1932 (*I. Villanueva*) : Benguet Subprovince, Baguio, male (*Baker*).

HYDROBASILEUS CROCEUS Brauer. Plate 7, fig. 82.

> BRAUER, zool.-bot. Wien 17 (1867) 813, male, Luzon; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 7; RIS, Cat. Coll. Sélys 16 (1913) 969; FRASER, Mem. Dept. Agr. India 8 (1924) (8) 71, fig.

This fine large yellowish-brown species is easily recognized by a big brown irregular blotch that covers in part the "foot" of the anal loop (not wholly covering the remarkably bulging "heel") and extends to the hind angle of the wing. Veins M_3 and M_4 converge outward to the point where they rather sharply bend to rearward.

Hind wing, 45 mm long; greatest width, about 11 or 12 mm.

The nymph was described and figured by Fraser in 1924.[32] It may be readily distinguished by the strange, rearwards-produced cone-shaped eyes.

One male, without specific locality label, probably Los Baños.

PANTALA FLAVESCENS Fabricius. Plate 8, fig. 90.

> FABRICIUS, Suppl. Ent. Syst. (1798) 285, India; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 6, Philippines; RIS, Cat. Coll. Sélys 15 (1913) 917.

This robust strong-flying cosmopolitan dragon fly is easily recognized by a combination of characters: The stigma is trapezoidal, vein M_2 is strongly undulate, and there is a second cubito-anal crossvein in the hind wing forming there a distinct subtriangle. Also, there are extra transverse carinæ on the slightly swollen basal segments of the abdomen, and the entire basal area of the hind wings is flavescent.

Hind wing, 41 mm.

A photograph of the nymph was published by the senior author in 1904.[33]

Specimens from practically all localities.

[30] Mem. Mus. Comp. Zool. 17 (1890) (1) 48.
[31] Proc. U. S. Nat. Mus. 27 (1904) 712, pl. 40, fig. 4.
[32] Mem. Dept. Agr. India 8 (1924) (8) 71, fig.
[33] Proc. U. S. Nat. Mus. 27 (1904) pl. 40, fig. 5.

Genus ORTHETRUM Newman

The five well-known species of this genus occurring in the Philippines may be distinguished as follows:

1. Triangle of hind wing usually free from crossveins .... 2.
   Triangle of hind wing crossed .... 4.
2. Vein C_2 in hind wing arises from hind angle of triangle .... *glaucum.*
   Vein Cu_2 in hind wing arises from outer side of triangle .... 3.
3. Sides of synthorax almost concolorous; swollen basal abdominal segments but little compressed .... *luzonicum.*
   Sides of synthorax marked with four or five distinct stripes; swollen basal abdominal segments very strongly compressed .... *sabina.*
4. Basal wing spots of male blackish; top of frons blackish in male; body becoming very pruinose with age; first three segments of abdomen black, followed by lighter color .... *clelia.*
   Basal wing spots of male golden or reddish brown; top of frons reddish; entire abdomen concolorous .... *testaceum.*

ORTHETRUM GLAUCUM Brauer.

BRAUER, zool.-bot. Wien 15 (1865) 1012, Balangodde, Ceylon; RIS, Cat. Coll. Sélys 10 (1909) 233.

Hind wing, 34 to 40 mm.

LUZON, Laguna Province, Los Baños, 2 males: Tayabas Province, Candelaria, 1 female, June 25, 1930 (*McGregor and Rivera*): Mountain Province, Baguio, 1 male (*Baker*). "Planta," 1 male, July 10, 1932 (*Leon Milapiup*).

ORTHETRUM LUZONICUM Brauer.

BRAUER, zool.-bot. Wien 18 (1868) 169, 732, Luzon; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 11; RIS, Cat. Coll. Sélys 10 (1909) 210.

Hind wing, 29 to 34 mm.

LUZON, Mountain Province, Baguio, 1 male (*Baker*).

ORTHETRUM SABINA Drury. Plate 6, fig. 76.

DRURY, Ill. Exot. Ins. 1 (1770) 114 (pars), China; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 8, Philippines; RIS, Cat. Coll. Sélys 10 (1909) 223.

Hind wing, 30 to 35 mm.

Specimens from all localities and all collectors.

ORTHETRUM CLELIA Sélys.

SÉLYS, Mitth. Mus. Dresden (1878) 294, 313, male, female, Menado, Moluccas, Luzon; An. Soc. Esp. Hist. Nat. 11 (1882) 11; RIS, Cat. Coll. Sélys 10 (1909) 242.

Hind wing, 37 to 41 mm.

LUZON, Manila, 2 males, June, 1930 (*McGregor et al.*): Cavite Province, Indang, 1 female, December, 1930 (*P. Erce*): Tayabas Province, Lucban, 1 female, January, 1931 (*F. Rivera*);

Mount Banahao, 2 males and 1 female, May, 1933 (*A. Y. Coronel*) : Laguna Province, Los Baños, 1 male, February, 1930 (*B. Dalid*), 1 male, December, 1930 (*C. T. Mamon*), 1 male, January, 1931 (*D. Fermin*), 1 male, February, 1931 (*T. Oliquino*); 1 male, July, 1932 (*A. P. Evangelista*), 1 male, September, 1932 (*B. Utzurrum*), 1 male, 1930 (no collector); Planta, 5 males, August, 1932 (*Leon M. Capinpin*) ; Majayjay, Uube, 3 males (*McGregor and Celestino*). MINDANAO, Zamboanga Province, Kabasalan, 1 male and 2 females, July, 1932 (*Muzzall*).

ORTHETRUM TESTACEUM Burmeister.

BURMEISTER, Handb. Ent. **2** (1839) 859, Java; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 12, Philippines; RIS, Cat. Coll. Sélys **10** (1909) 235.

Hind wing, 31 to 37 mm.

LUZON, Laguna Province, Los Baños, 1 male, February, 1930 (*G. Pangga*), 1 male, March, 1931 (*A. Felix*), 1 male, July, 1931 (*J. Saddul*), 1 female, February, 1932 (*P. Cabreros*), 1 male, June, 1932 (*Jaime Reyes*), 2 males, no date, no collector; Uube, 1 male, April, 1930 (*McGregor and Celestino*): Cagayan Province, Pina Blanca, 1 male, no date, no collector: Rizal Province, Novaliches, 1 male, July, 1930 (*McGregor*), 1 male, November, 1930, no collector, 1 male, December, 1930, no collector; Makabud, 1 male, June, 1930, no collector; Montalban, 1 male, May, 1931, no collector. SAMAR, Samar Province, Oquendo, 1 male, December, 1931 (*F. Reformina*). MINDANAO, Davao Province, Mati, 1 male, May, 1927, no collector: Zamboanga Province, Kabasalan, 8 males and 2 females, July, 1932 (*H. C. Muzzall*).

ORTHETRUM sp. Nymphs. Plate 9, figs. 103 to 109.

The nymphs of several species that may belong to this genus are included in the materials sent us. Unfortunately in none of them is the venation of the wings well enough preserved to aid in the determination of the species.

All agree in having elongate and more or less hairy bodies, and squarish heads with the eyes set far forward and prominently elevated at their anterolateral angles. This form is shown for a nymph from Java in a photograph published by the senior author [34] under the name *Orthetrum lepturum* (= *sabinum*) (supposition). It will suffice here to indicate the principal differences between the three sent us.

[34] Proc. U. S. Nat. Mus. 27 (1904) pl. 41, figs. 4, 5.

No. 1 (Plate 9, figs. 105 and 106) has eight lateral setæ, and a broken series of mentals seven of which are in an external line and five additional internals in a line almost at right angles to the seven with two small inner ones out of line. The ten teeth on the terminal border of the lateral lobe are serrate and truncate, hardly wider than high, and the middle ones bear each three or four graduated spinules. Abdominal segment 10 is very short, less than half of 9.

This genus is the one most abundantly represented in the nymph material sent us. It resembles most closely the Javanese nymph referred to above.

LUZON, Laguna Province, Los Baños, Molawin Creek, 1 nymph, June 18, 1930.

No. 2 (Plate 9, figs. 108 and 109) has six lateral setæ, and a series of three weak mental setæ, placed well towards the lateral margin and after an interval followed by a line of short numerous setæ ending in a median patch of spinules. The eight teeth on the terminal margin of the lateral lobe are lower, twice as wide as high, and bear shorter spinules. The border of the median lobe is more deeply crenulate. Abdominal segment 10 is about half the length of 9. This nymph is more densely hairy than the others.

MINDANAO, Zamboanga Province.

No. 3 (Plate 9, figs. 103 and 104) has five lateral setæ, and three mentals set far out, as in No. 2, followed internally by a somewhat stronger series of smaller setæ, at first in line and then scattering. The eight teeth on the terminal border of the lateral lobe are nearly obsolete, especially towards the inner angle, and the spinules on them likewise. Abdominal segment 10 is longer than half of 9.

MINDANAO, Zamboanga Province, many nymphs, all sizes.

Genera LATHRECISTA Kirby and POTAMARCHA Karsch

These two genera present a singular similarity in superficial appearance coupled with excellent differential structural characters. Both have the yellow sides of the synthorax obliquely traversed by a YIY-pattern of black stripes, and the black dorsum traversed by a broad yellow middorsal stripe that is narrowly divided by a black-edged middle carina. Both have brown wing tips but the brown in *Potamarcha* is less extensive, not reaching back to the stigma. Both have metallic blue frons with the face yellow beneath it, and both are of similar slender stature.

Lathrecista is readily distinguished from *Potamarcha* by lacking a crossvein in the triangle of the hind wing, by having the vein M_2 less strongly undulate, by having the nodus a little farther out in the forewing, by having both wings a little less narrowed beyond the level of the nodus, and by the following sex characters: In the male the anterior branch of the genital hamule is long, erect, and curved only at the tip, while in *Potamarcha* it is low and hooked, and inconspicuous. In the female the lateral margins of abdominal segment 8 are normal, while in *Potamarcha* they are expanded into conspicuous leaflike lobes. In the female of *Lathrecista* both the sternum and the posterolateral angles of abdominal segment 9 are prolonged beneath segment 10 (the sternum beyond its tip) while these parts in *Potamarcha* are unmodified.

With age *Lathrecista* acquires but little pruinosity, while old males of *Potamarcha* may have the color pattern entirely obscured by it.

LATHRECISTA ASIATICA Fabricius. Plate 6, fig. 73.

FABRICIUS, Ent. Syst. Suppl. (1798) 283, Oriental India; RIS, Cat. Coll. Sélys 10 (1909) 130.

LUZON, Laguna Province, Los Baños, 1 female, July 3, 1932 (*A. B. Baroquillo*), 1 male, no date, no collector; Uube, 1 male, May 8, 1930 (*McGregor et al.*); Mount Maquiling, 1 male, May 30, 1930, no collector; Tayabas Province, Sariaya, 1 male and 1 female, January 4, 1930 (*I. V. Torres*): Rizal Province, Novaliches, 2 males, May 9, 1930 (*A. C. Duyag*), 1 male, May 21, 1930 (*A. C. Duyag*), 1 male, July or August, 1930 (*A. C. Duyag*), 3 males and 2 females, no date, no collector; Makabud, 1 male, June 28, 1930, no collector: Manila, 6 males, June 7, 1930 (*McGregor et al.*): Pampanga Province, Arayat, 1 male, December 28, 1930 (*G. Mejia*): Bulacan Province, Ipo, 1 male, June 26, 1930, no collector: Batangas Province, Tanauan, 2 males, September 10, 1932 (*Pablo Aala*): "Luzon Cretas," 1 male and 1 female, June 3, 1931, no collector: "Luzon," 1 female, no date, no collector. MINDANAO, Zamboanga Province, Kabasalan, 8 males and 1 female, May, 1932 (*Muzzall*), 1 male and 1 female, July, 1932 (*Muzzall*).

POTAMARCHA OBSCURA Rambur. Plate 6, fig. 74.

RAMBUR, Hist. Ins. Neur. (1842) 64, male, female, "Indies"; KARSCH, Berlin Ent. Ztschr. 33 (1890) 371; RIS, Cat. Coll. Sélys 10 (1909) 156.

LUZON, Rizal, Batangas, Cagayan, Isabela, Nueva Vizcaya, Nueva Ecija, Laguna, Tayabas, Bulacan, and Pangasinan Provinces, 68 males and 41 females, all months (*Tomas Carag, Conrado C. Dinulos, Felix Bauoag, Gregorio A. Jayme, Pablo Aala, M. Allen, A. C. Duyag, Pedro Cabreros, M. R. Viloria, J. V. Torres, A. Flores, A. P. Afalla, P. M. Caguicla, Cenon Flor Cruz, J. P. Capili, Baker, A. Celestino, F. A. Caña, T. Faysan, Teofilo Rivera, N. C. Reyes, Amado E. Costes, Marcelo Abelardo, F. T. Aala, I. Cayañga, Elias Lantion, C. Tantoco, A. Barroquillo, Miguel Alba, D. Villadolid, A. Malabayabas, C. Magno, F. Dumaguing,* and *McGregor*). SAMAR, Oquendo, 1 male, December (*F. Reformina*). MINDANAO, Zamboanga Province, Kabasalan, 19 males and 9 females, April, May, July (*Muzzall*).

ONYCHOTHEMIS ABNORMIS Brauer. Plate 7, fig. 88.

BRAUER, zool.-bot. Wien 18 (1868) 170, male, female, Luzon; RIS, Cat. Coll. Sélys 14 (1912) 833.

The long smooth claws that suggested the name of this genus are distinctive, as are also the long strong spines of the tibiæ. The claws lack the usual inferior denticle or terminal cleft. The metallic coloration of the front of the thorax and the white ringed sides of the very much swollen basal abdominal segments are also characteristic.

Hind wing, 42 mm.

LUZON, Laguna Province, Mount Maquiling, male, June 9, 1932: Nueva Vizcaya Province, Dupax, female, December 31, 1930 (*M. R. Viloria*).

Genus TRITHEMIS Brauer

The rather small, very dainty dragon flies of this genus are abundantly represented in the Philippines by three species that may be recognized by the venational characters given in our table of genera, and that may further and perhaps more easily be distinguished by color characters as follows:

1. Veins and stigma reddish; the yellowish area at base of hind wings extends outward to the triangle; frons red above; antenodal cross-veins of fore and hind wings about twelve and one half and ten, respectively .... *aurora.*

Veins and stigma brownish, the latter pale at the ends; yellowish area at base of hind wings small, not reaching the triangle; frons above brownish; antenodals about eight and one half and six, respectively. *pallidinervis.*

Veins and stigma blackish; the blackish area at the base of the hind wings extends outward to the triangle; frons above violet metallic when mature; antenodals about ten and one half and eight, respectively .... *festiva.*

TRITHEMIS AURORA Burmeister. Plate 6, fig. 78.

BURMEISTER, Handb. Ent. 2 (1839) 859, Manila; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 14; NEEDHAM, Proc. U. S. Nat. Mus. 27 (1904) 708, nymph; RIS, Cat. Coll. Sélys 14 (1912) 775.

This reddish species is represented in the collections before us by scores of specimens. The nymph was described and figured by the senior author in 1904 by supposition.[35]

Hind wing, 23 to 34 mm.

Specimens from all localities.

TRITHEMIS PALLIDINERVIS Kirby. Plate 6, fig. 79.

KIRBY, Trans. Zoöl. Soc. London 12 (1889) 327, India; SÉLYS, An. Soc. Esp. Hist. Nat. 20 (1891) 212, Philippines; RIS, Cat. Coll. Sélys 14 (1912) 789.

This is a yellowish species, in which the black stripes on the sides of the thorax and the pale spots on the dorsum of the abdomen are larger and plainer.

Hind wing, 30 to 32 mm.

LUZON, Laguna, Rizal, Ilocos Norte, Pangasinan, Pampanga, Tarlac, Nueva Vizcaya, Nueva Ecija, Bulacan, La Union, and Mountain Provinces, 43 females and 60 males, all months (*Baker, A. Sabado, Tomas Carag, Domingo Fermin, F. Y. Chan, E. Caguicla, F. de Leon Flores, N. Bartolome, C. B. Brizuela, A. Estocapio, V. Juan, R. Denoga, G. Mejia, Luciano Marzan, Fernando Lomboy, C. Manuel, A. F. Costes, A. C. Duyag, Pablo S. Garcia, Manuel Asuncion, Glicerio M. de las Alas, Rodolfo Guerrero, J. Taber, Jr., Gonzalo Villaflores, Bonifacio Espepe, Felix Arriola, D. P. Tabije, W. Macapagal, P. V. Cruz, L. Brawpley, Nicasio Garcia, A. Kabigting,* and *P. C. Gabertan.*

TRITHEMIS FESTIVA Rambur.

RAMBUR, Hist. Ins. Neur. (1842) 92, male, Bombay; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 15, Luzon; RIS, Cat. Coll. Sélys 14 (1912) 796.

This shining black species has no color pattern showing in old specimens.

Hind wing, 26 to 32 mm.

LUZON, Ilocos Norte Province, Piddig, 2 males, January 7, 1931 (*Ignacio Valentin*). MINDANAO, Agusan Province, Santiago, male, April, 1931: Zamboanga Province, Kabasalan, 10 males, May, 1932 (*Muzzall*), male and female, July, 1932 (*Muzzall*).

[35] Proc. U. S. Nat. Mus. 27 (1904) 708, pl. 41, figs. 6, 7; pl. 44, fig. 1.

BRACHYTHEMIS CONTAMINATA Fabricius. Plate 4, fig. 65.

FABRICIUS, Entom. Syst. 2 (1793) 382, Oriental India; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 15, Luzon; RIS, Cat. Coll. Sélys **13** (1911) 587; NEEDHAM, Zoologia Sinica (A) **11** fasc. 1 (1930) 149.

This small yellowish species will be recognized by the diffuse cloud of golden yellow covering the nodal area of the hind wing, and by the venational characters given in our table of genera.

Hind wing, 23 to 25 mm.

The nymph was described by the senior author in 1930 from China.[36]

Specimens from all localities.

Genus CRATILLA Kirby

The representatives of this genus may be recognized by this combination of venational characters: the arculus lies beyond the second antenodal crossvein; there are two or more bridge crossveins; the base of vein A_2 is opposite the anal crossing; and the vein Cu_2 in the hind wing arises from the hind angle of the triangle. The species may easily be distinguished as follows:

1. Wing tips brown: Rpl subtends one cell row............................... *metallica*.
   Wing tips hyaline: Rpl subtends two cell rows............................... *lineata*.

CRATILLA METALLICA Brauer. Plate 6, fig. 75.

BRAUER, Sitzgsber. Acad. Wien **77** (1878) 7, male, female, Malacca, Borneo, Sumatra; RIS, Cat. Coll. Sélys **10** (1909) 152.

This fine species is easily recognized by its shining metallic green color all over the body, its black labrum, its yellow labium with a broad-black median stripe, and its dark-brown wing tips.

LUZON, Laguna Province, Los Baños (?), male and female.

CRATILLA LINEATA Brauer.

BRAUER, Sitzgsber. Acad. Wien **77** (1878) 9, Malacca, Sumatra; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 11, Mindanao; RIS, Cat. Coll. Sélys **10** (1909) 153.

This clear-winged species has a blackish thorax striped along the middorsal carina and dull yellow on the sides, and a yellow labrum and labium.

LUZON, Isabela Province, San Mariano, 1 female. MINDANAO, Davao Province, Mati, 1 male, March, 1927.

Genus LYRIOTHEMIS Brauer

This genus is represented in the collections before us by two species, one of which is new and one of which, the type of the

[36] Zoologia Sinica (A) **11** fasc. 1 (1930) 150.

genus, *L. cleis,* has long been known. These species may be distinguished from others in the fauna by the short, evenly tapering, strongly triquetral and dorsally carinate abdomen, shorter than the wings, by the presence of two or three cubito-anal crossveins in the hind wing, and by the sharply curved tips of veins M_3 and M_4.

LYRIOTHEMIS CLEIS Brauer. Plate 5, fig. 67.

BRAUER, zool.-bot. Wien **18** (1868) 181, 728, male, Mindanao; SÉLYS, An. Soc. Esp. Hist. Nat. **11** (1882) 9; RIS, Cat. Coll. Sélys **9** (1909) 108.

The two specimens of this species that have been before us are old females, blackish on head and thorax, red on the abdomen, and with metallic-green-capped frons.

Hind wing, 41 mm.

LUZON, Mount Banahao, 1 female, May 22, 1933 (*A. Y. Coronel*). MINDANAO, Zamboanga, Kabasalan, 1 female, July, 1932 (*Muzzall*).

LYRIOTHEMIS LATRO sp. nov. Plate 1, fig. 13.

Abdomen, 34 mm; hind wing, 43.

Allied to *L. tricolor* Ris, from Formosa, which is smaller and differs in numerous details.

Male.—Face yellowish, thinly clothed with brownish hairs, showing a little metallic luster on the darkened top of the frons in this teneral specimen; probably strongly metallic when fully mature. Labium wholly yellow except margin of lateral lobes. Lateral and superior marginal sutures of the face and vertex brown. Antennæ and hind margin of occiput brown. Rear of eyes black, invaded by a long trilobed spot of yellow.

Prothorax yellowish, washed with brown on the sides and faintly cross-streaked above with brown. Synthorax fuscous, broadly striped with yellow as follows: A very wide antehumeral stripe, laterally widened at both ends (below the crest and above the collar) several times wider than the narrow fuscous streak that borders on the middorsal carina; a stripe that nearly covers the metepisternum; another yet broader posterior one nearly covering the metepimeron. Antealar sinus yellow. Interalar sclerites mainly yellow, edged with brown. Legs blackish beyond the coxæ, with paler tarsi and claws. Wings (Plate 5, fig. 68) hyaline with only a touch of brown in the extreme base. Ante- and postnodal crossveins 14:9 and 11:8 in fore and hind wings, respectively. Triangle and supratriangles crossed in both wings. Three cells in the forewing subtriangle, and three rows of cells in the space beyond the triangle. Three cubito-anal crossveins in the hind wing. Two bridge crossveins and two under the stigma.

Abdomen broad and regularly tapered from the third segment to the end, strongly triquetral and carinate middorsally, mainly pale (perhaps becoming red in life) with darkened carinæ and a pair of interrupted stripes of brown on the venter.

The anterior lamina of the second abdominal segment is low and nearly bare, broadly bilobed on its free margin with a rather wide rounded notch between the lobes. The large hamules are roughly pentagonal in form, with the inner posterior angle bearing a strong sharp hook (Plate 1, fig. 13).

The brownish superior terminal appendages arched upward and slender in their middle third, dilated towards both ends, the oval apical dilation ending in a mucronate outwardly directed point, underneath this portion a row of four or five denticles. The wider yellow inferior appendage almost as long as the superiors, truncated on the end where it bears a pair of erect black denticles.

Type.—Male. LUZON, Laguna Province, School of Forestry, Los Baños, Feb. 24, 1935 (*Raymundo Laher*).

This species is larger than any of the twenty members of this heterogeneous genus hitherto made known. It agrees very closely in venation with *L. tricolor* Ris except that it has a supratriangular crossvein in the hind wing that is wanting in that species. It differs in numerous details of coloration. It differs markedly from *L. cleis* Brauer by lack of the hooked tips of veins M_3 and M_4.

CROCOTHEMIS SERVILIA Drury. Plate 5, fig. 72.

DRURY, Ill. Ex. Ins. 1 (1770) 112, 113, pl. 47, fig. 6, China; SÉLYS, An. Soc. Esp. Hist. Nat. 11 (1882) 14, Luzon, Bohol; RIS, Cat. Coll. Sélys 13 (1911) 539; NEEDHAM, Zoologia Sinica (A) 11 fasc. 1 (1930) 151.

This is a stout, yellowish or reddish species, clear-winged except for a touch of golden brown at the extreme wing base, and without definite color pattern.

Hind wing, 33 to 35 mm.

The nymph was described and figured by the senior author in 1930.[37]

Specimens from all localities and collectors.

[37] Zoologia Sinica (A) 11 fasc. 1 (1930) 152, pl. 14, fig. 1.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Ictinogomphus tenax* Sélys, male, lateral view of tip of abdomen. (Drawn by T. W. Lew.)

2. *Macromia negrito* sp. nov., male, dorsal view of tip of abdomen.
3. *Macromia negrito* sp. nov., male, lateral view of tip of abdomen.
4. *Gomphidia kirschii* Sélys, male, dorsal view of tip of abdomen.
5. *Gomphidia kirschii* Sélys, male, lateral view of tip of abdomen.
6. *Orogomphus splendidus* Sélys, male, lateral view of tip of abdomen; *d*, superior appendage; *e*, inferior appendage. (After Ris.)
7. *Orogomphus splendidus* Sélys, male, dorsal view of tip of abdomen. (After Ris.)
8. *Mesogomphus balneorum* sp. nov., male, lateral view of grasping organs of segment 2; *a*, anterior lamina; *b*, posterior hamule; *c*, anterior hamule.
9. *Heliogomphus bakeri* Laidlaw, male, dorsal view of tip of abdomen.
10. *Heliogomphus bakeri* Laidlaw, male, lateral view of tip of abdomen.
11. *Mesogomphus balneorum* sp. nov., male, lateral view of tip of abdomen.
12. *Mesogomphus balneorum* sp. nov., male, dorsal view of tip of abdomen.
13. *Lyriothemis latro* sp. nov., male, ventral view of grasping organs of segment 2.
14. *Heliogomphus bakeri* Laidlaw, female, ventral view of segment 9 and the subgenital plate; *f*, subgenital plate.
15. *Macromia negrito* sp. nov., female, sternites of segments 8, 9, and 10 to show subgenital plate.
16. *Idiophya salva* sp. nov., female, sternites of segments 8, 9, and 10.
17. *Agrionoptera bartola* sp. nov., female, sternites of segments 8, 9, and 10.
18. *Macromidia samal* sp. nov., female, sternites of segments 8, 9, and 10.
19. *Hemicordulia mindana* sp. nov., female, occiput.
20. *Hemicordulia mindana* sp. nov., female, lateral view of hamules.

PLATE 2

FIG. 21. *Anax gibbosulus* Rambur, male, dorsal view of tip of abdomen.

22. *Anax gibbosulus* Rambur, male, lateral view of tip of abdomen.
23. *Anax julius* Brauer, male, dorsal view of tip of abdomen.
24. *Anax julius* Brauer, male, lateral view of tip of abdomen. (After Martin.)

FIG. 25. *Anax guttatus* Burmeister, male, lateral view of tip of abdomen.
26. *Anax guttatus* Burmeister, male, dorsal view of tip of abdomen.
27. *Tetracanthagyna bakeri* Campion, female, ventral view of tip of abdomen.
28. *Tetracanthagyna bakeri* Campion, female, lateral view of tip of abdomen.
29. *Tetracanthagyna bakeri* Campion, male, dorsal view of tip of abdomen.
30. *Tetracanthagyna bakeri* Campion, male, lateral view of tip of abdomen.
31. *Indæschna baluga* sp. nov., male, lateral view of tip of abdomen.
32. *Indæschna baluga* sp. nov., male, dorsal view of tip of abdomen.
33. *Oligoæschna zambo* sp. nov., male, dorsal view of tip of abdomen.
34. *Oligoæschna zambo* sp. nov., male, lateral view of tip of abdomen.
35. *Gynacantha subinterrupta* Rambur, male, ventral view of anterior lamina.
36. *Gynacantha hyalina* Sélys, male, ventral view of anterior lamina.
37. *Gynacantha bayadera* Sélys, male, ventral view of anterior lamina.
38. *Gynacantha hyalina* Sélys, male, lateral view of tip of abdomen.
39. *Gynacantha hyalina* Sélys, male, dorsal view of tip of abdomen.
40. *Gynacantha subinterrupta* Rambur, male, lateral view of tip of abdomen.
41. *Gynacantha subinterrupta* Rambur, male, dorsal view of tip of abdomen.
42. *Gynacantha basiguttata* Sélys, male, lateral view of tip of abdomen. (After Ris.)
43. *Gynacantha basiguttata* Sélys, male, dorsal view of tip of abdomen. (After Ris.)
44. *Gynacantha bayadera* Sélys, male, lateral view of tip of abdomen.
45. *Gynacantha bayadera* Sélys, male, dorsal view of tip of abdomen.

PLATE 3

FIG. 46. *Mesogomphus balneorum* sp. nov., male, wings.
47. *Heliogomphus bakeri* Laidlaw, male, wings.
48. *Oligoæschna zambo* sp. nov., male, wings.
49. *Orogomphus splendidus* Sélys, male, portion of base of hind wing. (After Ris.)
50. *Orogomphus splendidus* Sélys, thorax pattern. (After Ris.)
51. *Ictinogomphus tenax* Sélys, thorax pattern.
52. *Macromidia samal* sp. nov., tarsal claw.
53. *Gomphidia kirschii* Sélys, thorax pattern.
54. *Heliogomphus bakeri* Laidlaw, thorax pattern.
55. *Mesogomphus balneorum* sp. nov., thorax pattern.
56. *Macromia gerstaeckeri* Krüger, wings.
57. *Macromidia samal* sp. nov., female, wings.
58. *Idiophya salva* sp. nov., female, wings.

PLATE 4

FIG. 59. *Agrionoptera bartola* sp. nov., wings.
60. *Agrionoptera quatuornotata* Brauer, wings.

FIG. 61. *Orchithemis pulcherrima* Brauer, wings.
62. *Diplacodes trivialis* Fabricius, wings.
63. *Nannophya pygmæa* Rambur, wings.
64. *Tetrathemis irregularis* Brauer, wings.
65. *Brachythemis contaminata* Fabricius, wings.
66. *Neurothemis palliata* Rambur, wings.

PLATE 5

FIG. 67. *Lyriothemis cleis* Brauer, wings.
68. *Lyriothemis latro* sp. nov., wings.
69. *Macrodiplax cora* Brauer, wings.
70. *Urothemis bisignata* Brauer, wings.
71. *Rhyothemis phyllis* Sulzer, wings.
72. *Crocothemis servilia* Drury, wings.

PLATE 6

FIG. 73. *Lathrecista asiatica* Fabricius, wings.
74. *Potamarcha obscura* Rambur, wings.
75. *Cratilla metallica* Brauer, wings.
76. *Orthetrum sabina* Drury, wings.
77. *Raphismia bispina* Hagen, wings.
78. *Trithemis aurora* Burmeister, wings.
79. *Trithemis pallidinervis* Kirby, wings.
80. *Brachydiplax chalybea* Brauer, wings.

PLATE 7

FIG. 81. *Zyxomma petiolatum* Rambur, wings.
82. *Hydrobasileus croceus* Brauer, wings.
83. *Zygonyx ida* Karsch, wings.
84. *Diplacina braueri* Sélys, thorax, pattern.
85. *Diplacina bolivari* Sélys. thorax pattern.
86. *Acisoma panorpoides* Rambur, wings.
87. *Diplacina braueri* Sélys, wings.
88. *Onychothemis abnormis* Brauer, wings.

PLATE 8

FIG. 89. *Tramea limbata* Desjardins, wings.
90. *Pantala flavescens* Fabricius, wings.
91. *Tholymis tillarga* Fabricius, wings.
92. *Camacinia gigantea* Brauer, wings.
93. *Idionyx* sp., nymph.
94. *Idionyx* sp., tip of lateral lobe of labium of nymph.
95. *Idionyx* sp., labium of nymph.

PLATE 9

FIG. 96. *Diplacodes trivialis* Fabricius, labium of nymph.
97. *Diplacodes trivialis* Fabricius, tip of lateral lobe of labium of nymph.
98. *Tetrathemis irregularis* Brauer, labium of nymph.
99. *Tetrathemis irregularis* Brauer, tip of lateral lobe of labium of nymph.

FIG. 100. *Tetrathemis irregularis* Brauer, nymph.
101. *Neurothemis* sp., nymph No. 1, labium.
102. *Neurothemis* sp., nymph No. 2, tip of lateral lobe of labium.
103. *Orthetrum* sp., nymph No. 3, labium.
104. *Orthetrum* sp., nymph No. 3, tip of lateral lobe of labium.
105. *Orthetrum* sp., nymph No. 1, tip of lateral lobe of labium.
106. *Orthetrum* sp., nymph No. 1, labium.
107. *Orthetrum* sp., nymph; *a*, lateral anal appendage; *b*, inferior anal appendage; *c*, superior anal appendage; *d*, dorsal hook; *e*, lateral spine.
108. *Orthetrum* sp., nymph No. 2, labium.
109. *Orthetrum* sp., nymph No. 2, tip of lateral lobe of labium.
110. *Macromia* sp., labium of nymph; *f*, median lobe; *g*, lateral lobe; *h*, mental setæ; *i*, lateral setæ.
111. *Macromia* sp., nymph.
112. *Macromia* sp., tip of lateral lobe of labium; *j*, movable hook; *k*, tooth.
113. *Diplacina braueri* Sélys, nymph. (Drawn by T. W. Lew.)
114. *Diplacina bolivari* Sélys, labium of nymph.
115. *Diplacina bolivari* Sélys, tip of lateral lobe of labium of nymph.
116. *Tholymis tillarga* Fabricius, tip of lateral lobe of labium of nymph.
117. *Tholymis tillarga* Fabricius, labium of nymph.
118. *Tholymis tillarga* Fabricius, nymph.

PLATE 10

FIG. 119. Near ? *Amphiæschna*, nymph.
120. Labium of nymph shown in fig. 119.
121. *Heliogomphus bakeri* Laidlaw, labium of nymph.
122. *Heliogomphus bakeri* Laidlaw, nymph.
123. *Gynacantha* sp., young nymph.
124. *Gynacantha* sp., labium of nymph.
125. *Mesogomphus balneorum* sp. nov., nymph very near transformation.
126. *Mesogomphus balneorum* sp. nov., labium of nymph.
127. *Tetracanthagyna bakeri* Campion, nymph.
128. *Tetracanthagyna bakeri* Campion, labium of nymph.
129. *Gomphidia kirschi* Sélys, labium.
130. *Gomphidia kirschi* Sélys, nymph.

TEXT FIGURES

FIG. 1. Diagrams of venational characters of anisopterous wings. *1*, Diagram of the principal veins and their connections; *2*, *Cordulegaster savi*, wings; *3*, gomphine wing base, male; *4*, libelluline wing base; *5*, arculus and its sectors (M_{1-3} M_3); *6*, *Cyanocharis valga*, forewing; *7*, *Caliphæa consimilis*, part of wing base; *8*, *Telebasis salva*, forewing; *9*, *Telebasis salva*, part of wing base; *10*, *Anomalagrion hastatum*, stigma, female with brace vein *x*.

ABBREVIATIONS

A, Anal vein; *Ac*, anal crossing; *Al*, or *al*, anal loop; *an*, antenodal crossveins; *ap pl*, apical planate; *ar*, arculus; *b*, basal subcostal crossvein; *br*, bridge; *Bs*, midbasal space, space before the arculus; *brs*, basal radial space; *C*, costa; *Cu*, cubitus; *g*, gaff (fused portion of veins Cu_2 and A_1); *h*, hypertriangular space; *M*, media; *m*, membranule, bordering the 3-celled anal triangle of the male hind wing; *ma*, medio-anal link; *mf*, middle fork; *mpl*, median planate; *mr*, midrib (bisector of the anal loop); *n*, nodus; *o*, oblique vein; *p*, patella; *q*, quadrangle; *R*, radius; *rm*, radial sector; *rpl*, radial planate; *s*, subtriangle; *Sc*, subcosta; *sct*, sectors of the arculus; *sn*, subnodus; *sq*, subquadrangle; *st*, stigma; *t*, triangle; *tr pl*, trigonal planate; *u*, point at which petiolation (stalk) of wing base ceases; *x*, brace vein to the stigma.

FIG. 2. *Heteronaias heterodoxa* Sélys; A, Tip of lateral lobe of labium of nymph; B, labium of nymph; C, nymph; D, lateral view of tip of abdomen of male; E, ventral view of tip of abdomen of female; F, wings.

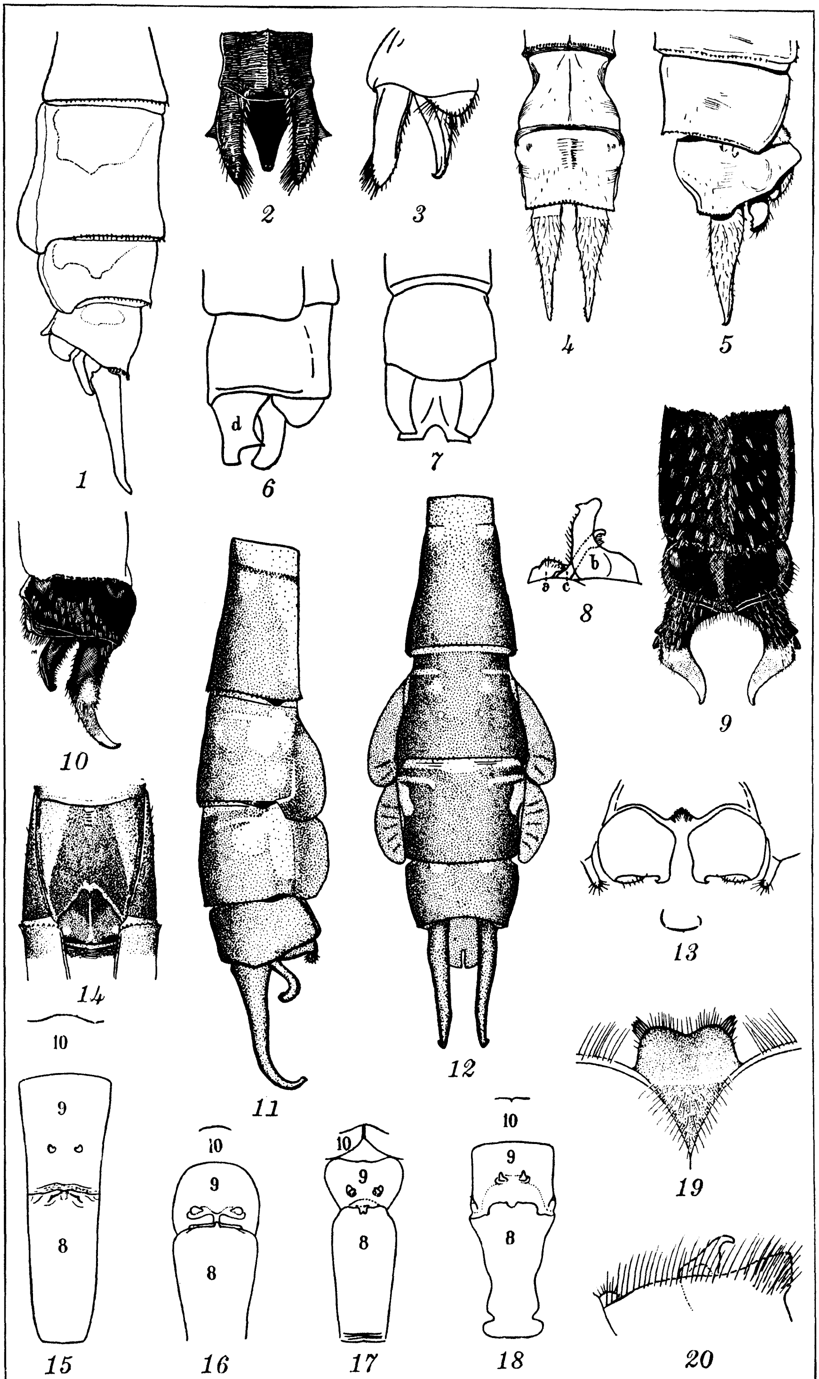
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PLATE 1.

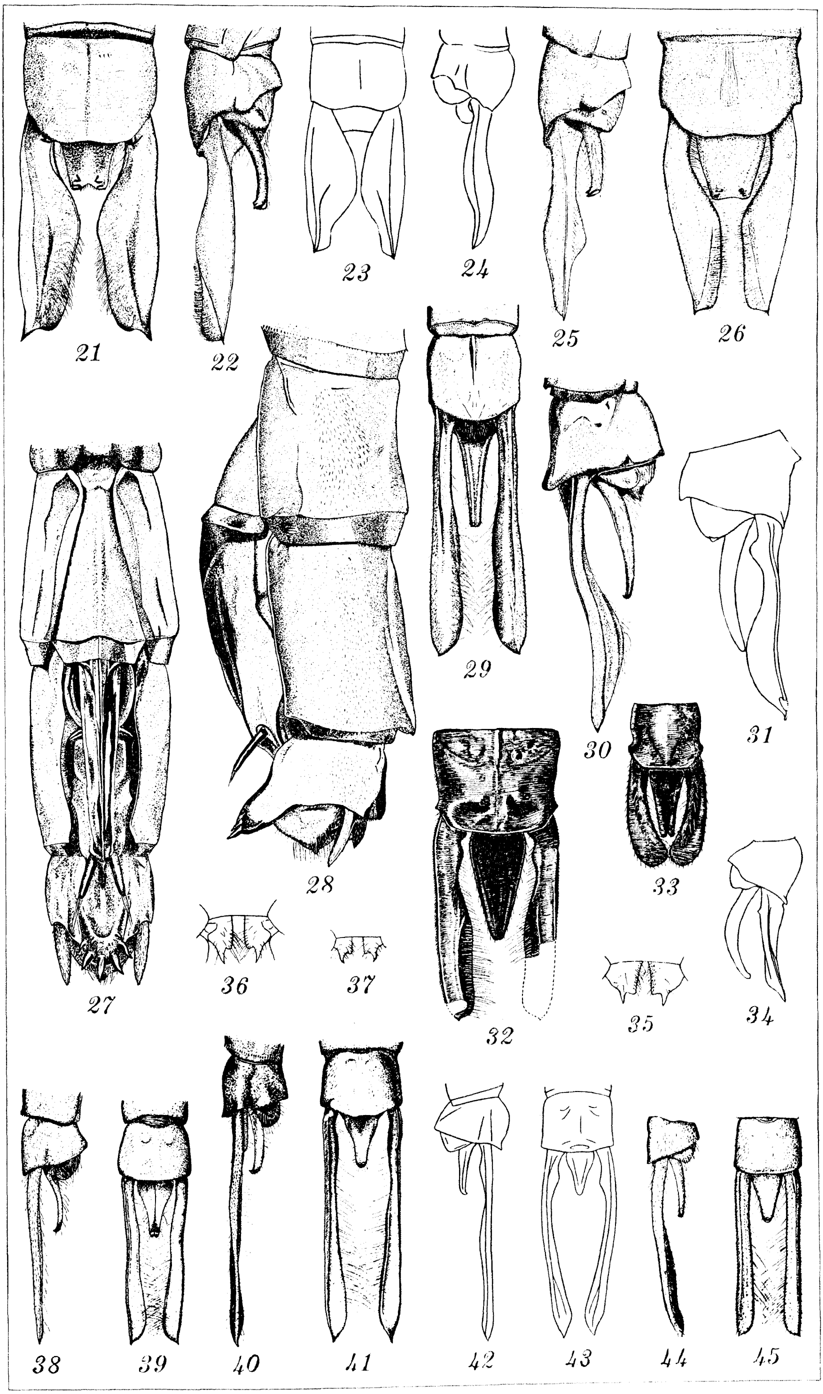
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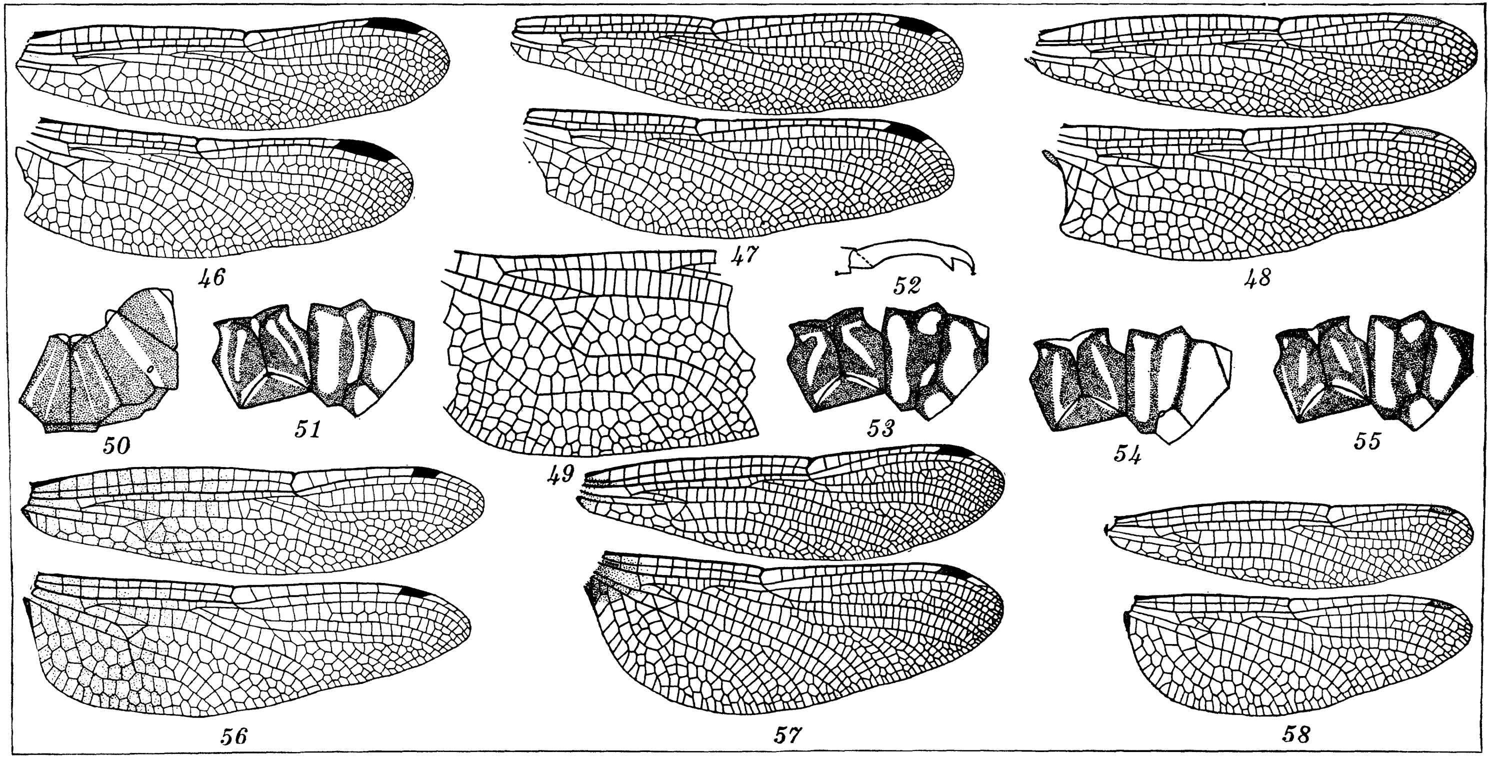
PLATE 2.



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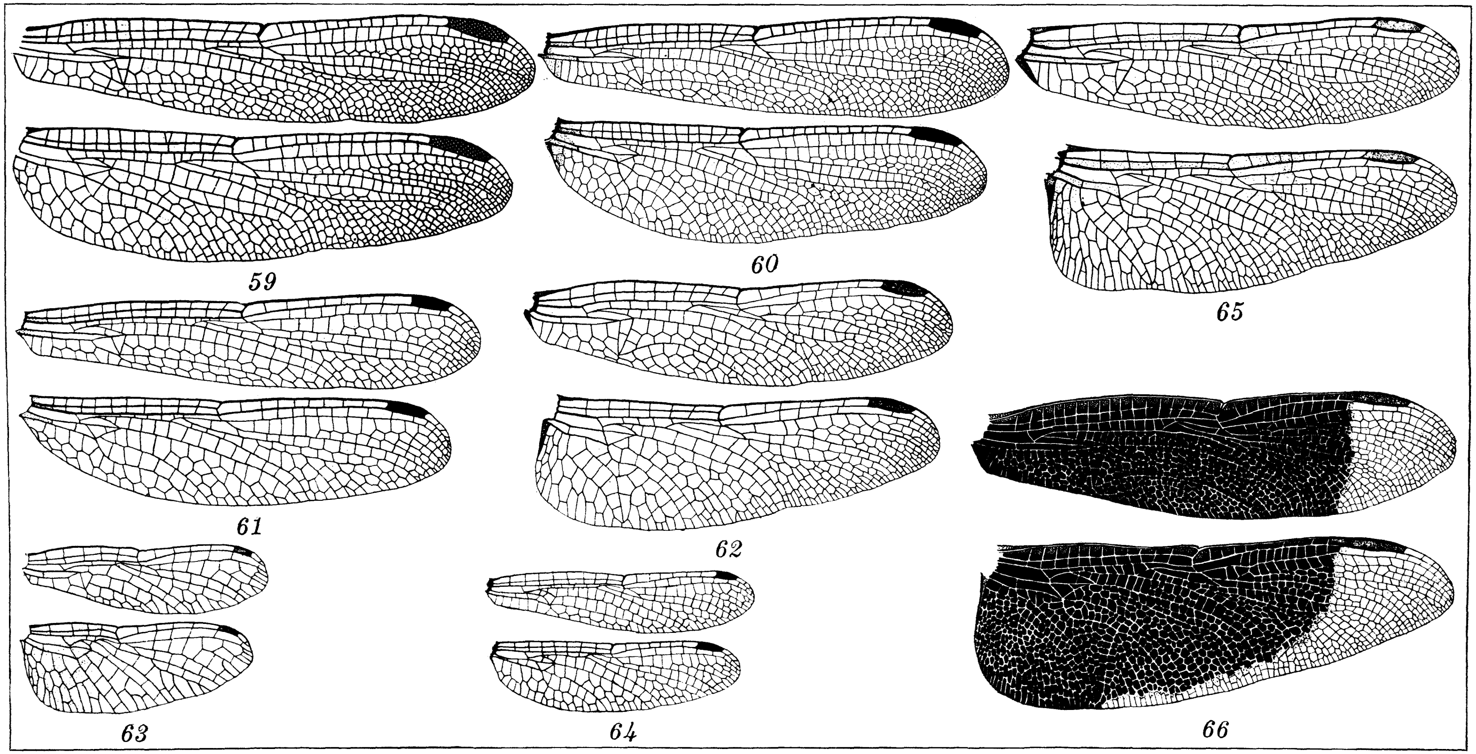

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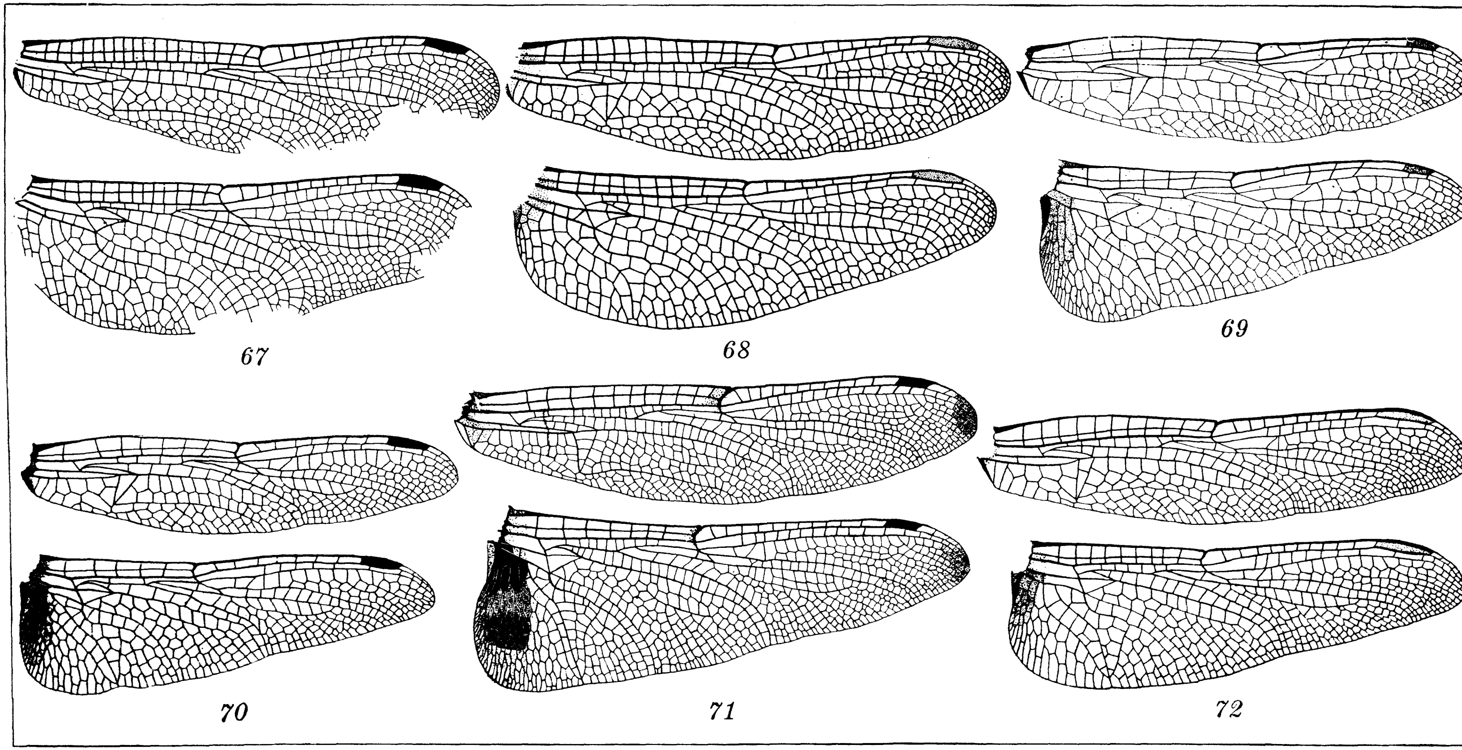

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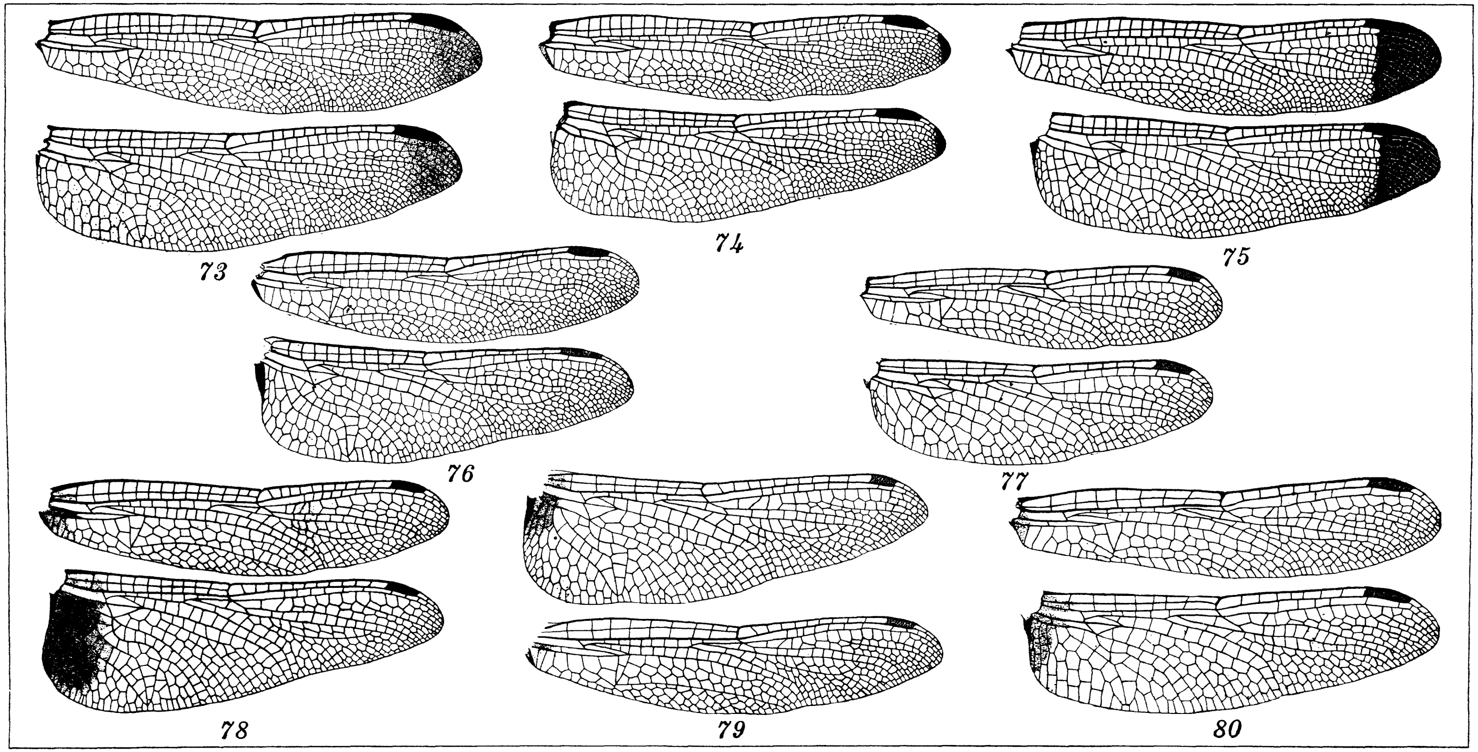

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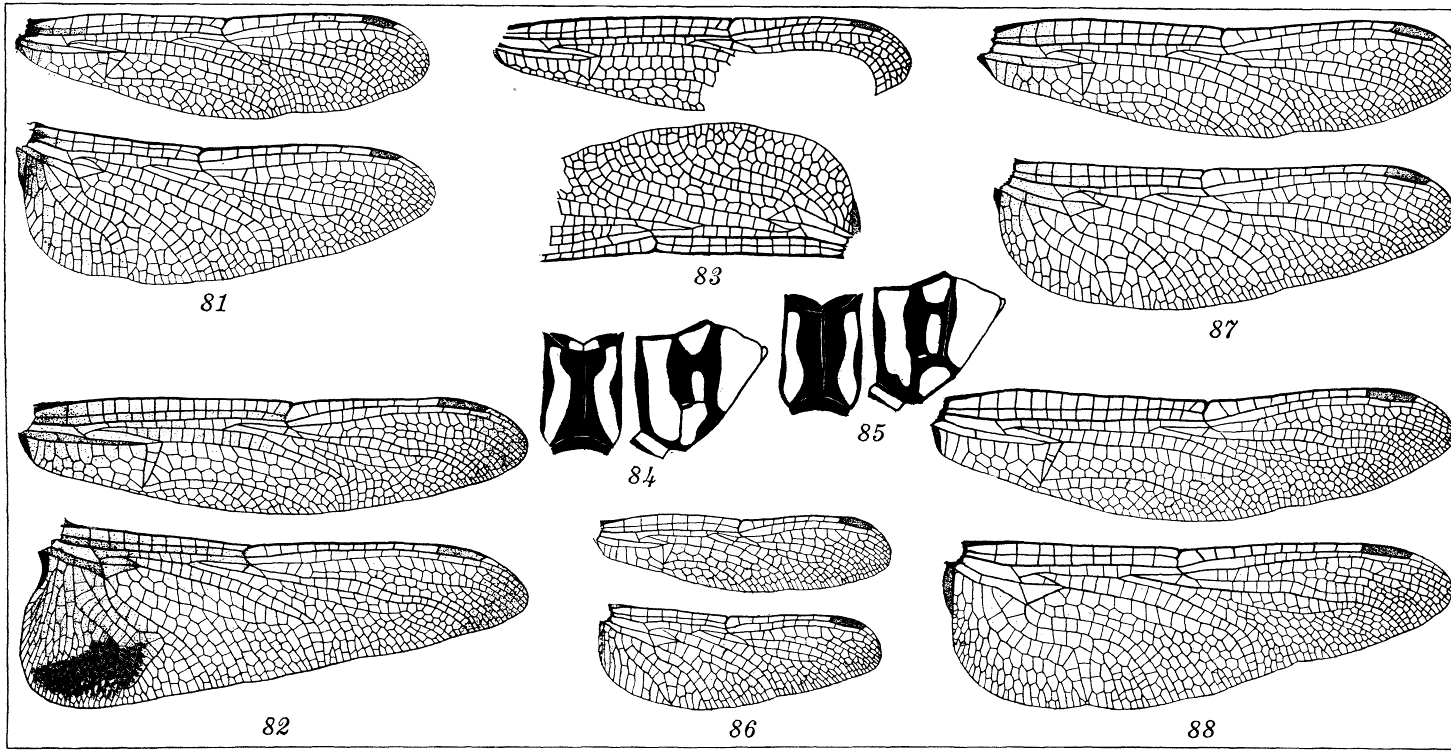

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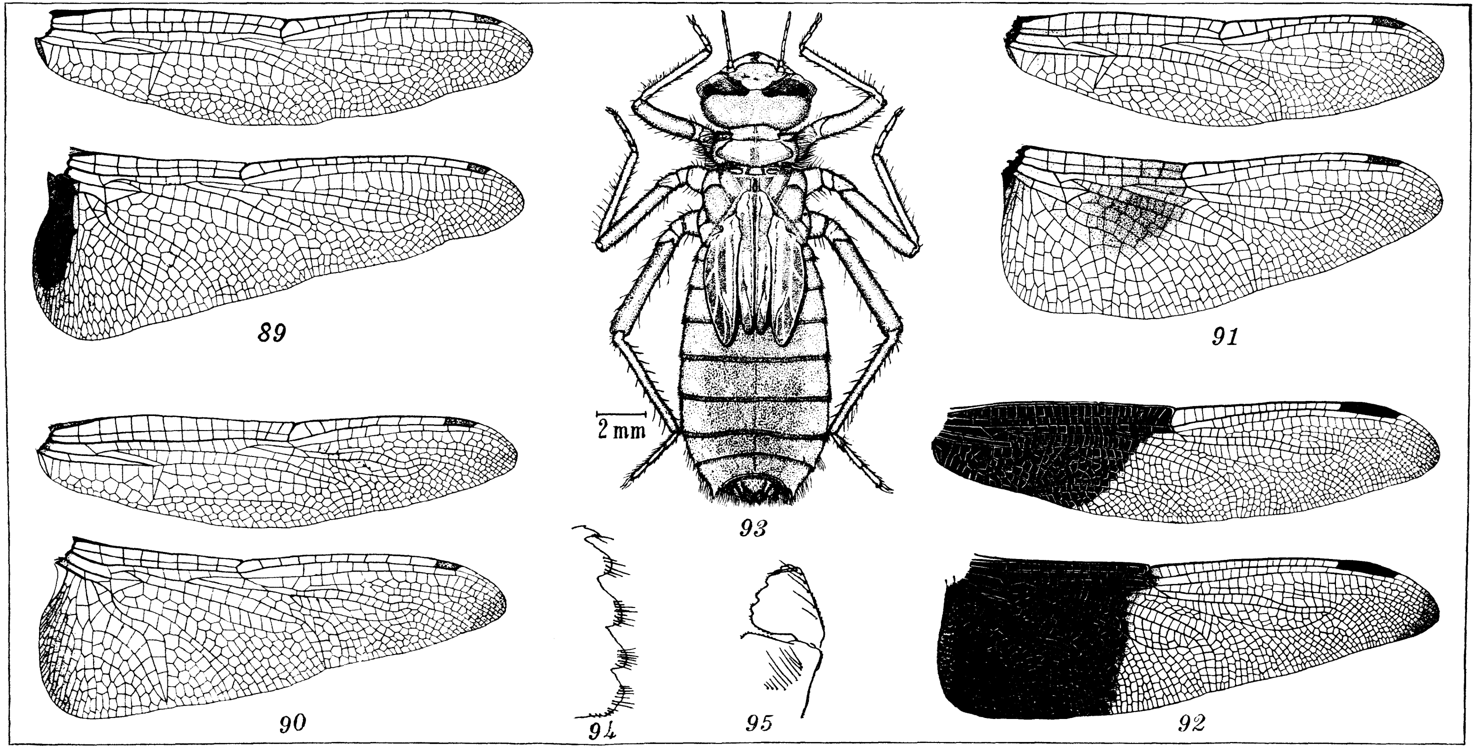

PLATE 8.

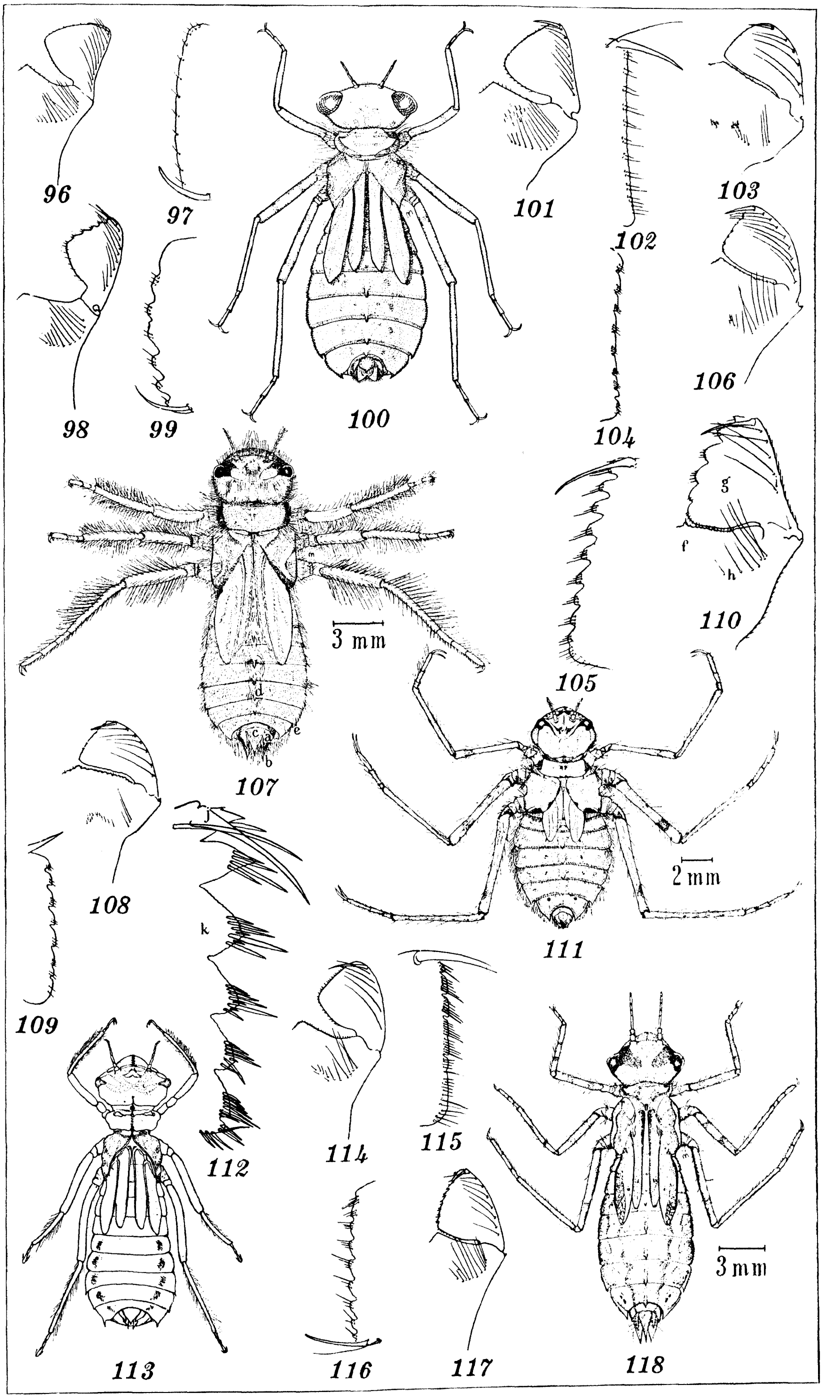
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PLATE 9.

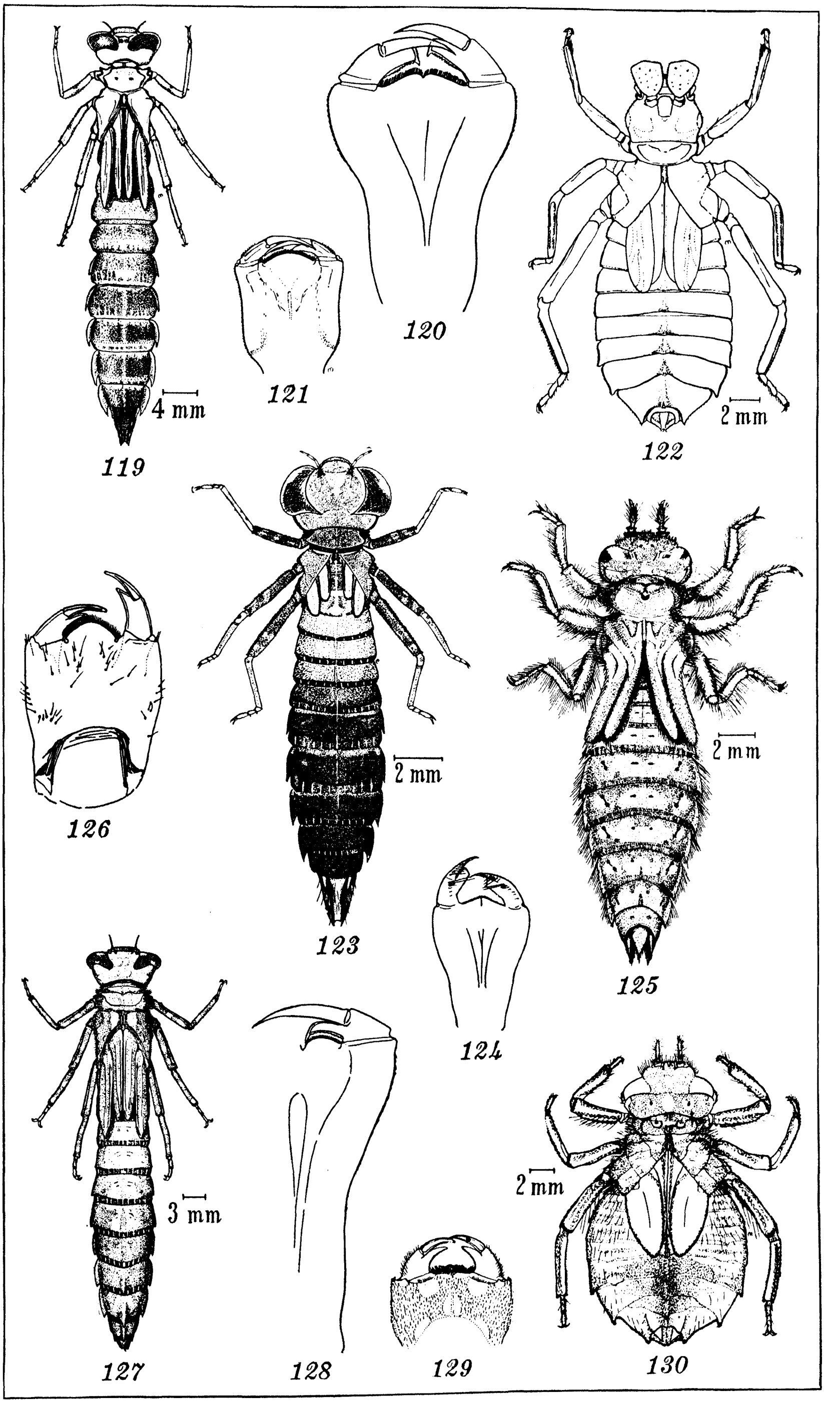
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PLATE 10.

ZWEI NEUE HISPINEN VON DEN PHILIPPINEN (COLEOPTERA)[1]

Von ERICH UHMANN

Stollberg, Erzgebirge, Deutschland

ONCOCEPHALA PHILIPPINICA sp. nov.

In Beitrag 40,[2] Seite 64, habe ich bemerkt, dass *Oncocephala angulata* Gestro von den Philippinen in der Deckenskulptur von *angulata* aus Sumatra soweit abweicht, dass die philippinischen Stücke vielleicht einer neuen Art angehörten. Die Untersuchung einiges Materials aus Java von *angulata* bestätigte diese Annahme. Ihre Unterschiede gegen *angulata* sind in dem erwähnten Beitrag aufgeführt. Von *bicristata* Chapuis unterscheidet sie sich dadurch, dass die Erhabenheiten des 2. Raumes nicht so gleichmässig sind, sondern dass die 2. Erhabenheit nach hinten immer höher ansteigt, um dann ebenso allmählich abzufallen. Bei *acutangula* Gest. besteht diese Erhabenheit aus zwei Höckern, deren letzter spitzig ist; bei unserer Art sind beide zu einem verschmolzen. Hinterecke wie bei *bicristata*. *Oncocephala angulata* ist für die Philippinen zu streichen. 4 bis 4.5 mm.

LUZON, Laguna, 1 (Schultze Sammlung), Holotypus; Mount Maquiling, 1 (G. C. Ladrera, Sammlung Hadden), Paratypus: Tayabas, Malinao, 1 (Baker Sammlung), Paratypus. Im Schlüssel,[3] ist einzufügen:

3a. Die grosse Erhabenheit des 2. Raumes hinten steil abfallend. *angulata* Gestro.

3b. Diese allmählich abfallend .... *philippinica* Uhmann.

ANISODERA DENSE sp. nov.

A. humili Gestro simillima, sed prothorace dense punctato, medio latissimo. Tibiis anticis intus subrectis. 14 ad 15 mm.

Wie ich[4] bemerkte, unterscheiden sich die Stücke, die ich als *humilis* von den Philippinen ansprach, durch den Halsschild von

[1] 66. Beitrag zur Kenntnis der Hispinen (Coleoptera; Chrysomelidæ).

[2] Uhmann, Erich, Beitrag 40, Folia Zoologica et Hydrobiologica Riga 5 (1933) 56–77.

[3] Op. cit. 64, 65.

[4] Op. cit. 59, 60.

denen aus Sumatra. Halsschild der neuen Art in der Mitte am breitesten, bei *humilis* vorn; auf der Scheibe durchaus dicht und stark punktiert, bei *humilis* in der Mitte weitläufiger oder glatt, kaum länger als breit, vorm Schildchen kaum eingedrückt, bei drei Stück dort gewölbt. Körper gedrungener, weil die Decken gleich hinter den Schultern sich verbreitern. Nahtzahn nicht vorhanden, Nahtecke einfach. Vorderschienen vorn am Innnenrand fast gerade oder wenig geschwungen, bei *humilis* dort stark geschwungen-ausgerandet. Geschlechtsauszeichnung des Männchens [5] wie bei *humilis,* letztes Sternit hinten fast gerade abgeschnitten.

[5] Mindanao, Surigao, 4 Männchen (Baker Sammlung), Holotypus und Paratypen.

DIE HENICOPTERA-ARTEN DER PHILIPPINEN (DIPTERA)[1]

Von MARTIN HERING
Berlin, Deutschland

EINE TAFEL

Die durch das eigenartige Geäder leicht kenntliche Gattung der Fruchtfliegen war von den Philippinen bisher nur in einer Art (*Henicoptera proditrix* Osten Sacken) bekannt. Unter diesem Namen erhielt ich von der Firma Dr. O. Staudinger und A. Bang-Haas (Dresden) eine Anzahl Exemplare zugesandt, die untereinander in einigen Punkten verschieden waren und bei genauerer Untersuchung sich als vier verschiedene Arten erwiesen, von denen keine zu der Osten-Sackenschen Art zu stellen war, und die sich vielmehr sämtlich als neu erwiesen. Wie bei den Dacinen muss auch bei dieser Gattung die Zeichnung des Kopfes für die Art-Trennung herangezogen werden. Die Schwierigkeit liegt nun darin, dass diese Kopfzeichnungen bei den beiden Geschlechtern verschieden sind; wie es scheint, ist aber die Thoraxzeichnung bein Männchen und Weibchen gleich, so dass deren Merkmale zur Unterstützung herangezogen werden können. Nur bei einer Art liegen mir auch die Weibchen vor, für die anderen kann vorerst nur die Beschreibung des Männchens gegeben werden; ich hoffe, dass es an Hand der gegebenen Differenzierung auch bald möglich sein wird, die zugehörigen Weibchen aufzufinden.

Bestimmungstabelle der Männchen der philippinischen Henicoptera.

1. Neben den Fühlerwurzeln liegt auf dem Stirnaugenrande je ein schwärzlicher Fleck. Der schwarze Mittelstreifen des Throax isoliert, nicht mit den beiden seitlichen verbunden (Tafel 1, Fig. 2*b* bis 4*b*) .... 2.

   Ein schwarzer Fleck neben den Fühlerwurzeln (wie auch auf dem Untergesicht) fehlt. Der schwarze Mittelstreifen auf dem Thoraxrücken ist am Ende desselben mit den beiden seitlichen verbunden (Tafel 1, Fig. 1). Vorder- und Mittelschenkel einfarbig gelb. Das 2. Segment des Abdomens am Hinterende dunkel gefleckt, im Flügel der Raum zwischen C und R_{4+5} überall braun ausgefüllt. *spoliata* sp. nov.

[1] 8. Beitrag zur Kenntnis der Trypetidæ.

2. Am Abdomen das (1.+)2. Segment mit dunklem Querband, das die beiden seitlichen Streifen verbindet .... 3.
   Das 2. Segment des Abdomens ohne dunkles Querband, die beiden Längsstreifen an den Seiten des Abdomens nirgends vereinigt........ 4.
3. Untergesicht mit dunklem Fleck. Vorder- und Mittelschenkel vor dem Ende hinten mit braunem Fleck. Die braune Binde im Flügel über den ta erreicht in der Analzelle das Braun der Flügelwurzel. *proditrix* O. S.
   Untergesicht einfarbig gelb. Vorder- und Mittelschenkel gelb, die mittleren unten mit einem fadendünnen braunen Längsstrich vor dem Ende. Das Braun der Wurzel des Flügels bleibt von dem der Binde über den ta weit getrennt, da diese Binde nur bis zum Ende der Can reicht .... *interrupta* sp. nov.
4. Der dunkle Mittelstreifen des Thorax ist überall gleichmässig schmal (Tafel 1, Fig. 3*b*). Der schwarze Endfleck des Scutellums ist breiter als lang und erreicht nicht die vorderen zwei Drittel der Schildchenlänge. Der helle Raum in der Cb_1 des Flügels setzt sich kurz vor dem ta in die Csm fort. Alle Schenkel und das Untergesicht einfarbig gelb .... *flavofemoralis* sp. nov.
   Mittelstreifen des Thorax gegen das Ende breit keilförmig erweitert. Der dunkle Endfleck des Scutellums wenigstens so lang wie breit, die Hälfte bis zwei Drittel der Schildchenlänge erreichend (Tafel 1, Fig. 4*b*). Der helle Raum in der Cb_1 setzt sich vorderrandwärts nicht nur in die Csm, sondern auch in die Cm fort. Hinterschenkel gebräunt, Untergesicht mit schwarzer, senkrechter Mittelstrieme. *cuneilinea* sp. nov.

BESCHREIBUNG DER ARTEN

HENICOPTERA SPOLIATA sp. nov. Tafel 1, Fig. 1a und 1b.

Kopf gelb, das Endglied der Fühler verdunkelt, die Stirn mit einer undeutlichen dunkleren Mittellinie vor den Ocellen, die sich bis zur Lunula mehr oder weniger deutlich hinzieht. Thoraxrücken gelbbraun, mit den drei Längsstreifen, die auch *H. proditrix* Osten Sacken besitzt, aber der mittlere erweitert sich allmählich wenig nach hinten und ist am Ende mit den beiden seitlichen breit verbunden. Die beiden seitlichen an der Quernaht breit unterbrochen. Der schwarze Humeralfleck ist rundlich, das Nahtdreieck ganz schwarzbraun. Der schwarze Endfleck des Scutellums ist viel breiter als lang; er erreicht etwa das letzte Drittel des Schildchens. Abdomen gelbbraun, mit den beiden gewöhnlichen Seitenstriemen, die in der hinteren Hälfte des (1. +) 2. Segmentes durch ein breites schwarzbraunes Querband miteinander verbunden sind. Schenkel ganz gelb, die hinteren vorherrschend schwarzbraun. Im Vorderflügel der Raum zwischen C und R_{4+5} ganz braun, das dunkle Querband über den ta von der m angegabelt, der äussere Ast geht über tp zur Cp_3, der innere zum Ende der an, die Can nicht erreichend.

Der Analzellenzipfel ist grösstenteils hyalin. Grösse wie bei *H. proditrix* Osten Sacken.

MINDANAO, Port Banga, Männchen, Typus, 6. 1. 1915.

HENICOPTERA INTERRUPTA sp. nov. Tafel 1, Fig. 2a und 2b.

Die Art gleicht in der Grösse und in den meisten Merkmalen der vorigen, unterscheidet sich aber leicht dadurch, dass die Stirnaugenränder neben den Fühlerwurzeln je einen schwärzlichen Fleck tragen (der dem Weibchen wahrscheinlich fehlen wird). Untergesicht ebenfalls rein gelb. Von den Thoraxstreifen ist der mittlere gleichmässig schmal und wird gegen das Ende des Thoraxrückens ganz undeutlich. Der schwarze Humeralfleck ist länglich, streifenartig. Der Endfleck des Scutellums ist viel schmäler; er überschreitet an den Seiten die Wurzeln der hinteren Schildchenborsten kaum. Beine und Hinterleib wie bei der vorigen Art gezeichnet. Das Nahtdreieck ist kaum verdunkelt. Im Flügel sind die beiden Querbinden über tp und die Discoidalzelle viel breiter, die erstere am Hinterrande des Flügels auch breiter ausgeflossen, die letztere das Ende des Zipfels der Can erreichend, beide durch Gelb oder Braun bis etwas hinter die cu verbunden. Die Binde über den tp ist an der Distalseite nicht gebogen, sondern geht grade zum Hinterrande des Cp_2. Zipfel der Analzelle in den äusseren zwei Dritteln hyalin. Cp_3 an der Wurzel braungelb ausgefüllt.

MINDANAO, Surigao, Männchen, Typus, August, 1916.

HENICOPTERA FLAVOFEMORALIS sp. nov. Tafel 1, Fig. 3a und 3b.

Kopf wie bei den vorigen, der Mittelstreifen auf der Stirnstrieme undeutlicher, deutlich ein rundlicher Fleck über der Lunula. Der dunkle Fleck neben der Fühlerbasis vorhanden, Untergesicht ganz gelb. Auf dem Thoraxrücken die schwarze Mittelstrieme ausserst fein, gleichbreit, am Ende nicht verkürzt. Der schwarze Endfleck des Scutellums viel breiter als lang, nach vorn hin nicht ein Drittel des Schildchens einnehmend. Abdomen mit den beiden seitlichen schwarzen Linien, die vorn auf dem 2. Segment nicht verbunden sind. Beine ganz gelb, auch die Hinterschenkel. Flügel im Vorderrandsteil braun wie bei den vorigen Arten, aber der hyaline Raum in der Cb_1 dringt nach vorn in die Csm ein und erreicht r_{2+3}. Binden wie bei der vorigen Art, die über tp aber schmäler und etwas gebogen, die proximale hakig an cu gebogen und zur Mündung der an gehend, die Can nicht erreichend. Analzellenzipfel ganz gelb, wie auch die Wurzel der Cp_3. Grösse wie bei den vorigen Arten.

LUZON, Limay, Männchen, Typus, 21. Oktober, 1914 (von G. Boettcher gesammelt).

HENICOPTERA CUNEILINEATA sp. nov. Tafel 1, Fig. 4a und 4b.

Männchen.—Kopf wie bei den vorigen Arten, Verdunkelung auf der Stirnmitte undeutlich. Der schwarze Fleck neben den Fühlerwurzeln ist vorhanden. Untergesicht mit einer schwarzen, senkrechten Längslinie. Thoräxrücken mit den drei schwarzen Längslinien, die mittlere hinter der Querlinie der vordersten sa ziemlich plötzlich breit keilförmig erweitert und so verbreitert bis zum Ende des Thoraxrückens verlaufend, dort aber nicht mit den seitlichen Linien verbunden. Nahtdreieck ganz gelb, der schwarze Humeralfleck rundlich. Der Endfleck des Scutellums mindestens so lang wie breit, bis zur Mitte des Schildchens oder noch weiter nach vorn reichend. Schenkel gelb, die hinteren braun. Seitenstreifen des Abdomens vorn nicht verbunden. Flügelzeichnung ähnlich wie bei voriger Art, die Cb_1 erstreckt ihr hyalines Feld aber bis in die Cm hinein und endet erst an r_1.

Weibchen.—Die schwarzen Seitenflecken neben den Fühlerwurzeln fehlen, der senkrechte schwarze Strich auf der Untergesichtsmitte ist vorhanden, im Flügel sind die beiden Querbinden in der Discoidalzelle durch ein hyalines Feld getrennt, dort beim Männchen durch Gelb verbunden.

LUZON, Manila, Männchen, Holotypus; Weibchen, Allotypus; und 3 Paratypen, 1. Juni, 1914.

ILLUSTRATION

TAFEL 1

FIG. 1. *Henicoptera spoliata* Hering sp. nov.; *a*, Flügel; *b*, Thorax.
2. *Henicoptera interrupta* Hering sp. nov.; *a*, Flügel; *b*, Thorax.
3. *Henicoptera flavofemoralis* Hering sp. nov.; *a*. Flügel; *b*, Thorax.
4. *Henicoptera cuneilineata* Hering sp. nov.; *a*, Flügel; *b*, Thorax.

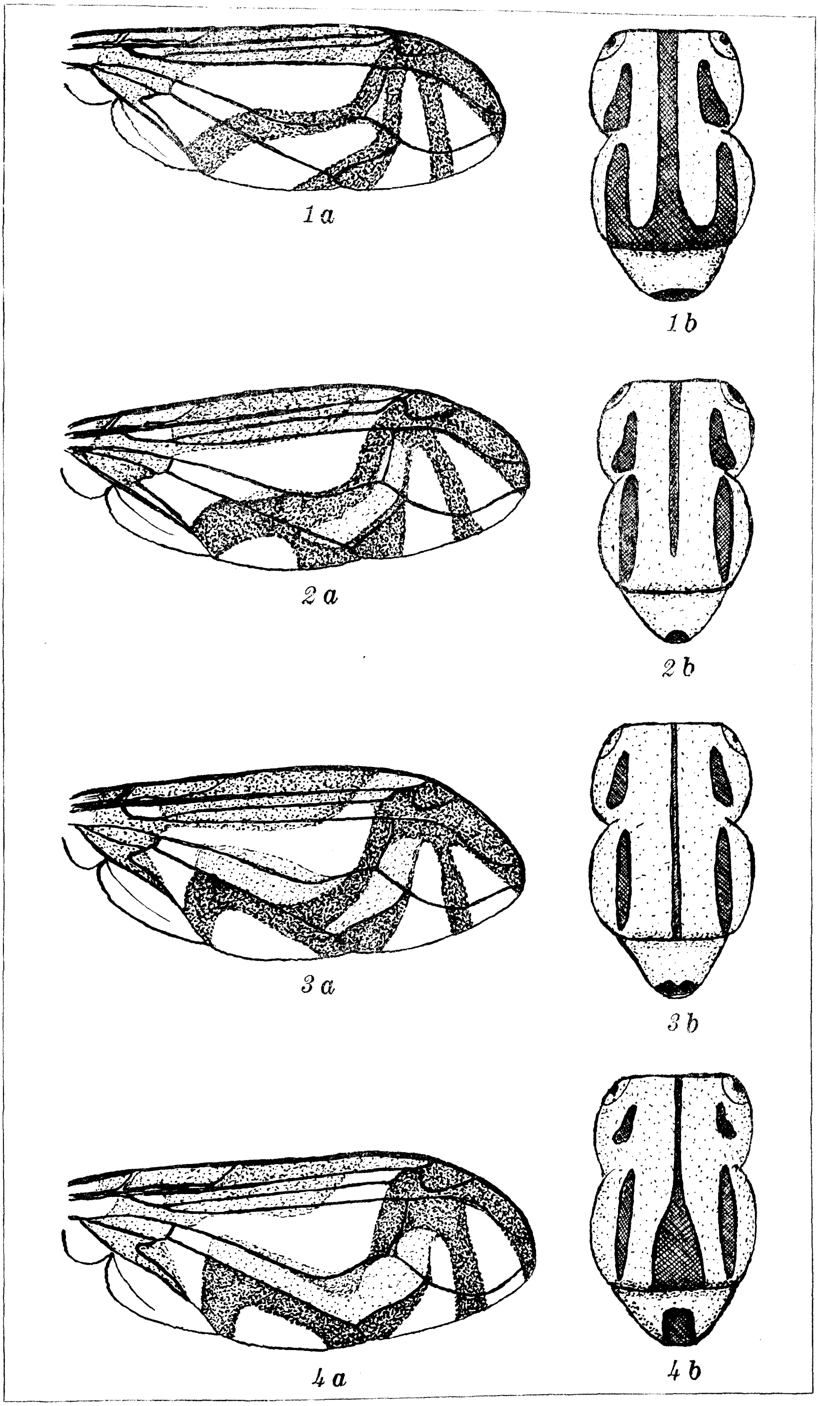

PLATE 1.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American society for testing materials. Committee D–2 on petroleum products and lubricants. Standards on petroleum products and lubricants. Philadelphia, The Society, 1936. 372 pp., illus., tables, diagrs. Price, paper, $2.

American society for testing materials. Committee D–13 on textile materials. Standards on textile materials. Philadelphia, The Society, 1936. 295 pp., illus., tables, diagrs. Price, paper, $2.

American society for testing materials. Pittsburgh regional meeting. Symposium on high-strength construction metals. Philadelphia, The Society, 1936. 126 pp., illus., tables, diagrs. Price, paper, $1.25.

Association of scientific workers. Industrial research laboratories; a list. (Halley Stewart trust publications, 3) London, George Allen & Unwin, ltd., 1936. 46 pp. Price, 3s.6d.

BAHR, GUNNAR VON. Studies on the aetiology and pathogenesis of Cataracat zonularis; an academic treatise. Upsala, Almquist & Wiksells, 1936. 236 pp., plates, diagrs.

BIGELOW, M. A. Sex-education. Rev. ed. New York, The American social hygiene association, 1936. 307 pp. Price, $1.

British association for the advancement of science. Mathematical tables, v. 5. London, The Association, 1935. 291 pp., tables. Price, 20s.

British museum (Natural history). The student's index to the collection of minerals. 27th. ed. London, The Museum, 1936. 39 pp. Price, paper, 1s.

CARVER, A. E., THOMAS HUNT, and WILLIAM WILLCOX. Alcoholism in general practice. London, Constable & Co., ltd., 1936. 131 pp. Price, 7s.6d.

CHASE, CARL TRUEBLOOD. Frontiers of science. New York, D. Van Nostrand co., 1936. 352 pp., front., plates. Price, $3.75.

COOK, E. F., and LAWALL, C. H. Remington's practice of pharmacy; a treatise on the making, standardizing, and dispensing, of official, unofficial, and extemporaneous pharmaceutical preparations, with descriptions of medicinal substances, their properties, uses, and doses, and such other professional service in connection with community health as the pharmacist may be called upon to render. 8th ed. Philadelphia, J. B. Lippincott co., 1936. 2162 pp., illus. Price, $10.

DAWKINS, C. J. M. On the incidence of anaesthetic complications and their relation to basal narcosis. London, published for the Middlesex hospital press by John Murray, 1936. 56 pp., tables. Price, 3s.6d.

DYSON, J. NEWTON. The practice of ionization. London, H. Kimpton, 1936. 178 pp., illus. Price, 6s.

EDWARD LIVINGSTON. Trudeau; a symposium. New York, The Livingston press, 1935. 112 pp., plates. Price, $1.10.

IMMS, A. D. On a new species of Halobates, a genus of pelagic Hemiptera. British museum (Natural history) John Murray expedition, 1933–34. Scientific reports, v. 4, no. 2. London, The Museum, 1936. 8 pp., illus. Price, paper, 1s.

The Institution of petroleum technologists, London. Petroleum technology, 1935. London, The Institution, 1936. 263 pp., tables, plates, diagrs. 7s.6d.

KANE, SAMUEL E. Thirty years with the Philippine head-hunters. New York, Grosset & Dunlap, 1936. 331 pp., illus. Price, $1.

KEMP, TAGE. Prostitution; an investigation of its causes, especially with regard to hereditary factors. Copenhagen, Levin & Munksgaard, 1936. 253 pp., tables, diagrs. Price, 10 kr.

KUBIE, LAWRENCE S. Practical aspects of psychoanalysis; a handbook for prospective patients and their advisors. New York, W. W. Norton & co., 1936. 207 pp. Price, $2.

London. International co-operative congress. British co-operation today; issued by the British co-operative union in celebration of the 14th International co-operative congress, London, September, 1934. Manchester, Co-operative printing society, ltd., 1934. 207 pp., illus., tables, ports. Price, 2s.6d.

London county council. Measles; report of the medical officer of health and school medical officer on the measles epidemic, 1933–34. London, County council, 1936. 62 pp., fold. tables, diagrs. Price, paper, 1s.

MCKAY, W. J. STEWART. Appendicitis; when and how to operate, a guide for the general practitioner. Australia, Angus & Robertson, ltd., 1936. 260 pp., illus. Price, 12s.6d.

Massachussetts institute of technology. Color measurement laboratory. Handbook of colorimetry, prepared under the direction of Arthur C. Hardy. Cambridge, Mass., The Institute, 1936. 87 pp., tables, diagrs. Price, $5.

MULLER, H. J. Out of the night; a biologist's view of the future. New York, The Vanguard press, 1935. 127 pp. Price, $1.50.

NEVEU-LEMAIRE, M. Traite d'helminthologie medicale et veterinaire. Paris, Vigot Freres, Editeurs, 1936. 1514 pp., illus. Price, 175 fr.

PATON, JAMES. Report on the Meteorological observations. British museum (Natural history) John Murray expedition, 1933–34. Scientific reports, v. 2, no. 1. London, The Museum, 1936. 14 pp. Price, paper, 2s.

SEARS, PAUL B. Deserts on the march. Norman, University of Oklahoma press, 1935. 231 pp. Price, $2.50.

Socialist medical association. Gas attacks; is there any protection? London, Lawrence & Wishart, 1936. 32 pp., tables. Price, paper, 6d.

SÖDERMAN, HARRY, and JOHN J. O'CONNELL. Modern criminal investigation. New York, Funk & Wagnalls co., 1936. 461 pp., illus. Price, $3.

STUBBINGS, H. G. Cirripedia. British museum (Natural history) John Murray expedition, 1933–34. Scientific reports, v. 4, no. 1. London, The Museum, 1936. 70 pp., illus., map. Price, paper, 5s.

TATTERSALL, W. M. Mysidacea and Euphausiacea. British museum (Natural history) Great Barrier Reef expedition, 1928–29. Scientific reports, v. 5, no. 4. London, The Museum, 1936. 34 pp., text-figs. Price, 2s.6d.

TATTERSALL, W. M. The Zoöplankton: V. The occurrence and seasonal distribution of the Mysidacea and Euphausiacea. British museum (Natural history) Great Barrier Reef expedition, 1928–29. Scientific reports, v. 2, no. 8. London, The Museum, 1936. 13 pp., text-figs. Price, paper, 2s.

TROISIER, JEAN. Etudes experimentales recentes sur les maladies infectieuses. Paris, Masson et cie, 1935. 277 pp. illus., tables, diagrs. Price, paper, 45 fr.

UDALL, D. H. The practice of veterinary medicine. 2d ed. Ithaca, New York, The Author, 1936. 273 pp., illus., tables. Price, $5.

WEIR, WILBERT WALTER. Soil science; its principles and practice, including basic processes for managing soils and improving their fertility. Chicago, J. B. Lippincott co., 1936. 615 pp., illus., tables, diagrs., maps. Price, $3.50.

REVIEWS

Alcyonaria (Stolonifera, Alcyonacea, Telestacea, and Gorgonacea). By L. M. I. Macfayden. British Museum (Natural History) Great Barrier Reef Expedition, 1928–29. Scientific reports, Vol. 5, No. 2. The Museum, London, 1936. 71 pp., plates, text figs. Price, 5s.

This monograph on the Alcyonaria of the Great Barrier Reef of Australia is a continuation of the work of Prof. S. J. Hickson. The paper describes fifty-one species, of which six are new. This work on the soft corals is accompanied by very good camera-lucida drawings of spicules of a number of forms described, and by excellent photographs of alcyonarian colonies in their natural habitat, taken by Doctor Banton. This work, if taken in connection with the publications of Light and Roxas on Philippine Alcyonaria, will familiarize the student with the extent of this group of animals in Philippine waters.—H. A. R.

American society for testing materials. Proceedings of the Thirty-eighth Annual Meeting, Held at Detroit, Michigan, June 24–28, 1935. The Society, Philadelphia, 1936. Part I, 1488, pp.; Part II, 469 pp., illus. Price, $5.50 each.

The 1935 American Society for Testing Materials Proceedings are published in two parts; part I comprising committee reports and the new and revised A. S. T. M. tentative standards, and part II containing all technical papers, including the Marburg Lecture, "Aircraft: Materials and Testing."

Part I is the report of forty standing committees, covering one hundred thirty-six tentative specifications for ferrous and nonferrous metals, cement, bricks, refractories, protective coatings, petroleum products, rubber, textile, and other materials.

Part II includes thirty-seven technical paper presented at the 1935 annual meeting, together with oral and written discussions.
—F. D. R.

American society for testing materials. Standards on petroleum products and lubricants. Prepared by Committee D–2 on petroleum products and lubricants. The Society, Philadelphia, 1936. 372 pp., illus., tables, diagrs. Price, $2.

The 1936 compilation of the American Society for Testing Materials Standards on Petroleum Products and Lubricants prepared by Committee D–2 is an important manual and valuable guide to chemists and all those interested in these subjects. The publication gives in a concise form the details of all the important methods involved in the analyses of petroleum products and lubricants. The definitions of terms related to these materials will prove very helpful in fostering the use of standard terms in petroleum nomenclature.—T. D. J.

American society for testing materials. Standards on Textile Materials. Prepared by Committee D–13 on textile materials. The Society, Philadelphia, 1936. 295 pp., illus., tables, diagrs. Price, $2.

The 1936 edition contains, besides all American Society for Testing Materials standards on textiles, new methods of testing: pile floor covering, fineness of wool, corded cotton gray goods, yarn slippage in silk, rayon and silk-rayon woven broad goods, and fastness to laundering or domestic washing of dyed or printed cotton fabrics and printed silk or rayon fabrics.

In addition, there are included, a proposed potassium dichromate oxidation method for the determination of total iron in asbestos textiles, a psychrometric table for relative humidity which combines both accuracy and convenience to an exceptional degree, a section comprising many excellent photomicrographs of common textile fibers, and a convenient yarn under conversion table. Also included are proposed methods covering the testing of wool felt and correction of breaking strength to standard regain.

During 1935–1936 changes have been made in standards covering wooden and worsted yarns, definitions and terms, silk and cotton tapes, and tests for small amounts of copper and manganese in textiles; also, cotton yarns, cotton sewing threads, asbestos tape, cotton tape, light and medium cotton fabrics, hose and belt ducks, and methods of testing woven fabrics.—F. D. R.

American society for testing materials. Symposium on High-Strength Constructional Metals. The Society, Philadelphia, 1936. 126 pp., tables, figs. Price, $1.25.

This symposium comprises five extensive technical papers and discussions presented at the 1936 American Society for Testing Materials regional meeting. The papers cover the chemical and physical and manufacturing and fabricating properties of metals and alloys applied for various constructional applications, including buildings, ships, automobile bodies, airplane wings, tanks, and others.

The papers give the latest information and data on carbon and low-alloy steels, corrosion-resisting steels, alloys of copper, alloys of nickel, and alloys of aluminum and magnesium. There are a great many charts and tables of data in the symposium, presenting much of the valuable and extensive information in condensed form.—F. D. R.

American society for testing materials. Symposium on Industrial Fuels. The Society, Philadelphia, 1936. 70 pp., tables, figs., map. Price, $0.75.

The Symposium on Industrial Fuels recently published by the American Society for Testing Materials comprises four extensive technical papers: Coal and Coke, Industrial Fuel Oils, Manufactured gas, and Liquefied Petroleum gas. The subjects covered by the writers are: Historical background, magnitude of the industry, future availability of raw materials, possibility of new processes, tests applied to the materials, significance of tests, utilization of materials, general aspects of the product, and utilization.—F. D. R.

Edward Livingston Trudeau; A Symposium. The Livingston press, New York, 1935. 112 pp., plates. Price, $1.10.

This book consists of four essays; Trudeau's Family Tree, by Lawrason Brown; Trudeau, the Physician, by Allen K. Krause; Trudeau, the Sportsman, by Charles C. Trembley; Trudeau, the Churchman, by Harry A. Pattison.

This group of essays presents various interesting phases of the life and character of Dr. Edward Livingston Trudeau, who was considered one of the outstanding pioneers in the field of sanatorium treatment for tuberculous patients in the United States. The main purpose of this volume is to honor the famous physician and to show the characteristic features of his career and personality.

The first essay traces Trudeau's family tree and shows his distinguished ancestry. Descending from physicians on both sides of the family, he was probably influenced to a great extent by the family tradition in choosing the study of medicine as a life career. Many of Trudeau's ancestors occupied high positions in both the French and English colonial governments.

The second essay describes Trudeau's career as a physician. In his struggle against tuberculosis, a disease from which he himself suffered, Trudeau continually searched for a definite method or line of attack in fighting this dreadful disease.

The third essay vividly described Trudeau's intensive fondness for various kinds of sports, especially shooting. In the search for good hunting places, he was able to visualize a colony of pioneer invalids in the present site of the sanatorium which he founded. His love for sports was so keen that he indulged in them even when he was laid up by the ravages of tuberculosis.

The last essay is devoted to the personality of Doctor Trudeau, particularly giving an insight into the nobility of his character. It shows his deep and abiding faith in God as the Creator of the Universe and in His imminent presence among men. Trudeau's influence on his patients was said to be largely spiritual. He was neither a genius nor a saint, but he was a man of God, ever giving of himself to his friends and patients.

This little book is especially recommended to those readers who are interested in the humanitarian aspects of the struggle which this great pioneer has waged against the ravages of tuberculosis. Undoubtedly this volume, consisting of a group of essays by noted writers, will serve to inspire and encourage those who are inclined toward pioneering work in any kind of humanitarian service.—S. A. F.

Factors in the Sex Life of Seven Hundred Psychopathic Women. By Frances M. Strakosch. State Hospital press, Utica, New York, 1934. 102 pp., tables. Price, $1.

This is a statistical study of the incidence of sex experiences and sex practices in the mentally ill. Comparison is made with similar studies among nonpsychotics. This study shows that sex practices are as extensively indulged in by the nonpsychotic as by the psychotic group.—C. P. P.

Food, Health, Vitamins. By R. H. A. Plimmer and Violet G. Plimmer. Longmans, Green and Co., London and New York, 7th edition, 1935. 178 pp., tables, figs. Price, 3s.6d.

The present edition of this book follows the same line of presentation as the earlier editions, although many changes have been made. This book is a comprehensive survey of the whole problem of nutrition, special emphasis being given to the importance for health of an adequate supply of the several vitamins. The rôle of mineral salts has not been given proper emphasis in the discussion of this problem. The book is written concisely and in plain language to be within the reach of every housekeeper. It is essentially a practical book and can be recommended not only to the busy housewife but also to medical men planning diets for their patients.—I. C.

Handbook of Chemistry and Physics; a Ready Reference Book of Chemical and Physical Data. By Charles D. Hodgman. Chemical rubber publishing co., Cleveland, Ohio, 20th edition, 1935. 1951 pp., tables. Price, $6.

The 20th edition of this handbook is an authentic guide and reference in the sciences of chemistry and physics. It consists of 1951 pages of up-to-date data. The handbook is divided into five sections, approximately equal in size. These sections are indicated by inserts of stiff colored paper on which is printed a summary of the contents of each section. The five sections are: (1) Mathematical tables, (2) Properties and physical constants, (3) General Chemical tables, (4) Heat, Hygrometry, Sound, Electricity, and Light; (5) Quantities and Units—Miscellaneous Tables.—F. D. R.

Heart Disease in the Tropics. By H. O. Gunewardene. Butterworth & Co., Ltd., Calcutta, Madras, 1935. 101 pp., plates. Price, 5 Rs.

Books on tropical diseases are always welcomed by physicians in this part of the world. It is a common experience for students and new physicians, and also for the more experienced practitioners in the Tropics, to be misled by descriptions and symptomatology found in standard text books written for colder countries, descriptions and symptomatology which do not conform to the manifestations of the disease as found in the Tropics. While this is true to a lesser extent of heart diseases, there still exist a few important clinical differences, which, as Gunewardene points out, are enough to modify considerably the clinical picture and the prognosis. If for no other reason than to find out what a man of considerable medical experience in a tropical country (Ceylon) has to say on the peculiarities of heart disease in warm countries, this book should be read by physicians working both in the Tropics and in temperate regions.

The object of the author in writing the ninety pages which constitute the book is, in his own words, "to indicate features in cardio-vascular diseases induced by tropical conditions and by diseases peculiar to the tropics." Some of the author's findings and observations are quite interesting. The emphasis he puts on ankylostoma infestation as a cause of cardiac disability is intriguing. According to the author this causative factor is so prominent in Ceylon that this form of cardiac disease is known there as "poor man's heart disease." In the chapter exclusively dedicated to this topic he gives several interesting data which certainly make a more careful study of ankylostomiasis in the Philippines and other tropical countries imperative. The author calls attention to a presystolic murmur frequently found in these cases; a murmur which is not so definite as that found in mitral stenosis and is not accompanied by a thrill. It is more like the Austin Flint murmur of the so-called "functional mitral stenosis" accompanying aortic regurgitation. The types of cardiac involvement in these cases of ankylostomiasis, according to the author, vary from simple breathlessness accompanied by systolic murmurs at the base or apex, to serious impairment, with a clinical picture of cardiac failure or of subacute bacterial endocarditis. In some cases sudden death is the termination. This would mean either a toxic effect from poisons excreted by the ankylostoma or an effect of direct invasion which would be demonstrated. This view is interesting in the light of recent studies made by Africa, de Leon, and Garcia on fatal cases diagnosed as adult beriberi and acute cardiac failure, where the usual definite specific pathology could not be found. In these cases, heterophyid eggs were found in the heart producing specific tissue changes. The adults are found in the intestines. Although ankylostomiasis is common in the Philippines, it is not usual to observe cases of such severity as Gunewardene describes, and which he mentions to be very common in Ceylon. This at once suggests geographical variation in the manifestation of disease even under similar climatic conditions.

The author's observations on rheumatic disease and high blood pressure practically coincide with our experience in the Philippines; only we seldom find the nonprogressive valvular disease he describes, probably because the cases do not come to the attention of the physician until the disease is advanced enough to produce alarming symptoms.

The little book is as a whole a good example of sound clinical description and observation, and distinctly belongs to the British School.

It should be read by those interested in tropical medical practice.—A. L.

Mechanical Tests for Engineering Materials. By A. M. Roberts. The Draughtsman publishing co., London, 1935–36. 89 pp., illus. tables, diagrs. Price, 4s.

The Association of Engineering and Shipbuilding Draughtsmen has issued this compact manual for testing materials. Particularly interesting is the testing machine used in the measurement of "Creep" of metals subjected to high temperatures. The book is profusely illustrated and should prove of interest to Engineers.—F. D. R.

The Practice of Veterinary Medicine. By D. H. Udall. Norton Printing Company, Ithaca, New York, 2d ed., 1936. 273 pp., illus., tables. Price, $5.

The book is a concise, thorough, to the point, and up-to-date text on veterinary practice. It certainly fills the need of the student, the teacher of ambulatory clinics and medicine, and the practitioner, as it embodies the most recent work, not only on constitutional disorders of herbivorous animals but also on their infections and parasitic diseases and on poisoning. While it is concise, it contains as much detail as one ordinarily cares to know, and, besides, discusses important subjects that have been worked out thoroughly during the last few years.

The author arranged the text into ten main groups: (1) diseases of the respiratory system, (2) diseases of the digestive system, (3) diseases of the kidneys, (4) diseases of the heart, (5) diseases of the blood-forming organs, (6) diseases of the nervous system, (7) diseases of the spine, (8) disorders of metabolism, (9) infectious diseases, and (10) poisoning.

The book is profusely illustrated. The original references appended to the discussion of each disease are of great value to the reader who desires to have more information.

As a whole, the subject matter is well presented. The work should be warmly welcomed by, and should be in the hands of, every practicing veterinarian, teacher, and student, because it is an exposition of the accurate observations on, and the up-to-date methods of handling and treatment of, the most common animal diseases, as acquired by the author and his associates in about twenty years of practice and research. Since no single man can be expected to write on all of the subjects discussed from his own personal experience alone, much of the material contained in this book was necessarily obtained from other good sources.

Many of the diseases are discussed in a manner apparently more complete and more elucidating than in most similar text books in circulation today. Of these, traumatic gastritis in ruminants, chronic mastitis, acetonæmia, milk fever, azoturia, osteoporosis, pregnancy disease of ewes, white scours in calves, navel ill, and Bang's disease may be mentioned.

The book is 11 × 8½ inches, which is an unhandy size, yet the type, although small, is clear and readable, and the paper used is of excellent quality—E. C. F.

Press Photography. By James C. Kinkaid. American photographic publishing co., Boston, 1936. 281 pp., illus. Price, $3.

Press Photography by James C. Kinkaid is a very practical and modern guide to the news cameraman as well as to the amateur and professional. It deals with all the general principles of photographic art, especially for modern newspaper work. The author explains detail by detail all the necessary knowledge to become successful in the line, and also emphasizes the right kind of camera, its make-up, the construction of a darkroom, chemicals for development and fixing, rapid and high speed processing, and many other pertinent topics.

Modern publishers call for more and better illustrations, like photographs, in order to give the reading public graphic news of the day. Action pictures of important events are always seen in newspapers and magazines. Panoramic and other views are also published, which of course are of great importance to historians and scientific men.

This book will greatly aid our news photographers as well as those engaged in photography as a profession.—C. A. S.

Prostitution; an Investigation of its Causes, Especially with regard to Hereditary Factors. By Tage Kemp. Levin & Munksgaard, Einar Munksgaard, Copenhagen; William Heinemann (Medical Books), Ltd., London, 1936. 253 pp., tables, figs. Price, 10 Kr.

Dr. Tage Kemp's book, translated from the original Danish by Miss E. M. Werner Kornerup, is the outgrowth of several years of case study and research. It is an exhaustive work, covering group and individual implications and the scientific and social phenomena forming the background of prostitution. Special attention is given to the causal significance of hereditary factors, inclusive of the psychological and physical, to which the author's investigations were particularly directed. Environmental conditions in childhood and adolescence are also considered. The observations from heredity and environment show a parallel trend, the author concluding on the one hand "that the total mental personality which specially predisposes to prostitution is frequently hereditary" and finding, on the other, "that the childhood and youthful environment of the *propositae* was, on the whole, extremely bad." Doctor Kemp defines the mental characteristics of the propositæ and in a number of specific cases with full records given he analyses the different abnormalities, chiefly psychiatric, exhibited by his medicopsychiatric examination of five hundred and thirty prostitutes. For the borderline group, the majority being maladjusted or pathological and only a small number normal, he suggests a way of treatment. In the discussion of physical diseases, the venereal naturally was emphasized. The aspect of social responsibility or the social determinants is further recognized in the various circumstances in adulthood, in addition to those in early age, which, according to the author, are direct or contributory causes of prostitution. Provisions for the punishment and readaptation of prostitutes are finally illustrated. In his recommendations, Dr. Kemp stresses the early recognition and corresponding care of psychic abnormalities which at present are considered too late, when they have already led persons to ruin; a change in the rules and methods of the police and public welfare authorities, which now are altogether unsuited to the purpose; and "a general reduction of social inequality and in particular improvement of working conditions for female hands."—S. A.

Remington's Practice of Pharmacy. By E. Fullerton Cook and Charles H. LaWall, with the collaboration of Ivor Griffith, Adley B. Nichols, and Arthur Osol, and thirty-two other contributors. J. B. Lippincott company, Philadelphia, 8th ed., 1936. 2162 pp., illus. Price, buckram, $10.

With the first edition of this treatise, published in October, 1885, by the original author, Joseph P. Remington, who was well known as one of the eminent American pharmaceutical educators, and the eighth edition in August, 1936, this standard reference in pharmacy is now beginning its fifty-first year of useful service to science. The different editions of this handbook reflect in many ways the continuous progress that the different branches of the science of pharmacy have attained during the last half of a century. The commendable efforts that Professors Cook and LaWall have exerted in securing the collaboration of their associate editors who are specialists in their lines, both as teachers and workers, have enhanced the value of the revised as well as the new chapters added in the eighth edition. There are many features of the text book that reveal the opportunities afforded to pharmacists in the pursuit of the varied branches of their profession. The volume is full of up-to-date information needed by the pharmacists engaged as chemists, analysts, and manufacturing and dispensing pharmacists. The inclusion in this edition of discussions on subjects concerning the application in pharmacy of physical chemistry, such as colloid chemistry, hydrogen-ion concentration and pH, osmotic pressure, and related properties of solutions, the preparation of isotonic solutions, the thermodynamic considerations of heat, and the measurement of physical constants, has increased to a great extent the scientific value of the chapters of the book dealing with those subjects. There are many changes in the present edition that have not only placed the text in conformity with the changes introduced in the United States Pharmacopœia, Eleventh Revision (U. S. P. XI), and the National Formulary, Sixth Edition (N. F. VI), but has made "Remington's Practice of Pharmacy" more useful as a handbook, both for study and for reference.

As the authors have stated in their preface to the edition under review, the purpose of the original author, the late Professor Joseph P. Remington, of making his "Practice of Pharmacy" a guide and inspiration to the professional pharmacists of America, has dominated every feature of this edition. It may be added that Remington's eighth edition would serve as a guide and inspiration not only to American pharmacists but to all pharmacists the world over.—P. V.

Sugar Factories and Sugar Machinery. By William Kilpatrick. Institution of Mechanical Engineers, London, 1933. 69 pp., illus., tables.

This book is published by the Institute of Mechanical Engineers of Great Britain, being a reprint of the paper read before the Glasgow and West of Scotland Branch in Glasgow, October 5, 1933. The book reviews the various methods of sugar manufacture in use at present in centrifugal sugar factories, and then proceeds with a detailed description of the machinery used in the production of sugar. The tests of electrically driven centrifugals should be of special interest to designers.—F. D. R.

Therapeutique Medicale. IX. Maladies Infectieuses et parasitaires. By M. Loeper. Masson et Cie., 1935. 414 pp. Price, 50 Fr.

This book will prove of great help to all studious practitioners and internists who are anxious to adopt the best in therapeutics. In the first part it treats thoroughly of, and gives minute instructions on, vaccination, serum therapy, bacteriotherapy, chemotherapy, proteinotherapy and hæmotherapy in connection with infectious diseases. In the second part it takes up disinfection, the treatment of the dysenteries, the curative and preventive treatment of tetanus, the treatment and prophylaxis of influenza, the bismuth therapy and bismuth prevention of syphilis, the general principles regarding the treatment of malaria, antityphoid vaccination, vaccination against diphtheria with Ramon's anatoxin, the vaccine and serum therapy of filterable virus diseases, and the therapeutics of vitamins and convalescent serums.

The exposition and discussion of the different subjects are remarkable for their clarity and precision. Throughout the text one recognizes a master who is discussing the subject or giving instructions, thus making the perusal of the book not only highly enlightening but also delightful to read.—A. V. C.

Traite D'Helminthologie Medicale et Veterinaire. By M. Neveu-Lemaire. Vigot Freres, Editeurs, Paris, 1936. 1514 pp., illus. Price, 175 Fr.

In this admirable treatise Professor Neveu-Lemaire discusses in an exhaustive manner the parasitic worms of medical and veterinary interest. The book appears oversized, due to the vast amount of knowledge which has been rapidly accumulating as a result of the active interest sustained by the numerous workers in parasitology. It is divided into four parts, of which part I, which is subtitled General Helminthology, deals with such subjects as the evolution of helminths, their habitat and localization, modes of reproduction, geographical distribution, effects on the hosts, and other general aspects of the subject. Part II, Special Helminthology, takes up the classification and description of the various parasites, their biology, pathology, diagnosis, prognosis, treatment, and prophylaxis. In parts III and IV are appended, respectively, classified lists of the definitive and intermediate hosts of the worms.

In view of the large amount of information contained in the book, it should be welcomed not only by parasitologists and clinicians, but also by general zoölogists and sanitarians. As a volume of reference, its value is somewhat impaired by the lack of a more complete bibliography, for the benefit of those with inadequate cataloguing facilities.—M. T.

Wheat Germ Oil (Vitamin E). By August J. Pacini. The American Physician Inc., New York, 1935. 96 pp. Price, $1.

This little book gives a very good discussion of vitamin E and the wheat-germ oil from which it may be obtained.

Vitamin E is the reproduction (antisterility) vitamin. The importance of this vitamin for vigor and reproduction and the serious effects of its deficiency are presented in a popular review. As the author states, "Surely, if wheat is the staff of life, then the oil from its germ must be the elixir of life."

The book contains important abstracts, and numerous bibliographical references concerning vitamin E.—A. J. H.

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PHILIPPINE NEUROPTEROID INSECTS

By NATHAN BANKS

Of the Museum of Comparative Zoölogy, Cambridge

SIX PLATES

The following descriptions and synopses are largely the result of studying the specimens collected in southern Mindanao by Mr. Charles F. Clagg. Much of Clagg's collecting was done on Mount Apo, which has rarely been visited by entomologists. It is not surprising, therefore, that a number of species are new. Some of the new species are among those sent me by the late Charles Fuller Baker shortly before he died.

Nearly all of the known Philippine neuropteroid insects come from either Luzon or Mindanao. Until more is known of those from other islands there is little value to generalizations on distribution. As far as known the species are very different from those of Formosa, but related to those of the Greater Sunda Islands.

PSOCIDÆ

PSOCUS DOLOROSUS sp. nov. Plate 2, fig. 12.

Head dark brown, clothed with short white hair, eyes of female about two and one-half diameters apart; antennæ extremely long, reaching much beyond wings, almost black, clothed with very long hairs; thorax almost wholly black, sutures between lobes pale; abdomen and legs black.

Forewings mostly hyaline on basal part, on apical part mostly dark brown, stigma wholly black and extending behind on basal part, most of areola postica hyaline, only posterior side dark, discoidal cell pale on basal half, veins all dark, the vein closing discoidal cell also dark, forking of radial sector sometimes very faintly pale, black dot at nodus, and a little before this a brown band obliquely up to medius; hind wings faintly fumose, veins brown.

Stigma rather slender, rounded behind; areola postica narrow above; forks of radial sector fully twice as long as the pedicel, base of radial sector obliquely curved.

Length, to tip of wing, 5.5 mm; antennæ, 8.5.

MINDANAO, Davao Province, Tia Ridge, Mainit River, and Todaya Plateau, all on Mount Apo, altitude 5,000 to 6,500 feet, September 2 to 24 (*Clagg*). Type, Museum of Comparative Zoölogy No. 21743.

PSOCUS ALTICOLUS sp. nov. Plate 1, fig. 8.

Head brown, clothed with short white hair, in female a pale area each side on vertex, eyes of female about three diameters apart; antennæ pale brown, clothed with moderately long hair in female, and very long hair in male; thorax brown, with pale lines between and on sides of the lobes; abdomen brown, somewhat spotted with pale; legs pale.

Forewings hyaline, apical half wholly evenly fumose, leaving the basal third of stigma white, some faint clouds above nodus tend to form a band, and another faint cloud nearer to base, veins largely dark, end of discoidal cell hyaline-white, forking of radial sector also white, also basal fourth of stigmal margin, and on hind margin a white streak for some distance before the nodus. Hind wings scarcely smoky, veins brownish.

Forewing with stigma rather large and broad, almost (but not quite) angulate behind; forks of radial sector almost parallel and longer than pedicel; discoidal cell about one-half as wide at tip as at base; basal part of radial sector curved; areola postica very broad above.

Length, 5 mm.

MINDANAO, Davao Province, Galog River, Tia Ridge, Todaya Plateau, Baroring River, Mainit River, Sibulan River, and Batraeyon, all on Mount Apo, altitude 5,000 to 8,000 feet, August 31 to November 7 (*Clagg*). Type, M. C. Z. No. 21742.

The parallel radial forks are like those of *P. cinereus* Endl., but that species is neither pale on basal part of wings nor as dark on the apical part. Enderlein later put *P. cinereus* in one of his numerous genera split from *Psocus*.

PSOCUS INCOMPTUS sp. nov. Plate 1, fig. 9.

Head brown, sometimes paler on vertex, clothed with short white hair, eyes of male only about one-half diameter apart, of female fully three diameters apart; antennæ dark, in male as long as wings, in female shorter, densely hairy, in male with very long hair; thorax, abdomen, and legs dark brown. Forewings uniform gray all over, stigma no darker than the rest, veins mostly brown, that closing discoidal cell, the forking of radial sector, medius before end of discoidal cell, and end of cubitus white. Hind wings scarcely darkened, veins brown.

Stigma elongate, rounded behind, the widest part but little beyond middle; forks of radial sector slightly divergent, very much longer than pedicel; discoidal cell not twice as wide at base as at tip; areola postica very long above on medius, usually as long or longer than end of discoidal cell.

Length, 4.5 mm; antennæ, male, 4.5.

MINDANAO, Davao Province, Lawa, May 5; La Lun Mountains, July 5 (*Clagg*). Type, M. C. Z. No. 21741.

Differs from allied forms in the faint and even color of the forewings and in the not darker stigma.

STENOPSOCUS DISSIMILIS sp. nov.

Head yellowish brown, nasus darker, antennæ brown, as long as wings, finely short-haired, thorax brown on the lobes, paler between, clothed with moderately short, white hair like that of head; abdomen brown, legs pale. Forewings hyaline, very faintly fumose, hardly noticeable; veins brown, stigma very pale yellowish; hind wings hyaline, veins brownish.

Forewings with stigma but little longer than greatest length of discoidal cell (shorter than in *S. tonkingensis*), somewhat beyond the middle slightly angulate (at the crossvein), before this the side concave, beyond, convex; forks of radial sector about equal to pedicel, plainly divergent; union of radial sector and medius not quite as long as the basal part of radial sector; discoidal cell about one and one-half times as long as apex; areola postica large, triangular, nearly as high as long, the crossvein to medius only one-half the height of cell (in *S. tonkingensis* much longer). Wing broad and evenly rounded at tip, much as in *S. apertus;* the space between radial sector and medius a little wider before than at the crossvein to areola postica (not as wide, however, as in *S. infirmus*).

Length, 4.5 mm.

MINDANAO, Davao Province, Mount Apo, Tia Ridge, altitude 6,500 feet, September (*Clagg*). Type, M. C. Z. No. 21945.

OPHIODOPELMA MULTIPUNCTATA Hagen. Plate 1, fig. 1.

One from Galog River, Mount Apo, Mindanao, altitude 6,000 feet, November 5, agrees with Hagen's type from Ceylon; I give a figure of the forewing.

Key to the Philippine species of Cæcilius.

1. Forewings with a dark longitudinal streak from near base to tip, often with side branches .... 2.
   No such marking .... 6.
2. With a projection from the dark streak across the yellow stigma; all space behind outer median vein dark to the hind margin; space between forks of the radial sector dark .... *plagosus.*
3. No projection from dark streak towards stigma, nor up along upper branch of radial sector, and almost all of space back of the medius pale .... *muggenburgi.*
   A projection towards stigma, or up along the upper branch of radial sector .... 4.
4. No projection towards stigma, but upper branch of radial sector bordered, some clear space between radial sector and medius at apex. *reductus.*
   A projection from the dark streak towards stigma .... 5.
5. Outer space behind medius practically entirely dark .... *deceptus.*
   Outer space behind medius largely pale, the branches narrowly bordered with dark .... *marcidus.*
6. Entire wing dark brown to blackish, no pale spaces whatever, at least in apical half; head and thorax black .... *claggi.*
   Not wholly dark brown to blackish .... 7.
7. Forewing with a brown band just before middle, and one from stigma to hind margin where it connects with the brown bordering the outer margin .... *aridus.*
   No such marks .... 8.
8. Large species, antennæ plainly with black band at tips of joints, wings slightly fumose .... *cincticornis.*
   Antennæ not plainly banded .... 9.
9. Veins pale, plainly dotted with dark, small spots on wing, some tending to form a band behind the stigma; small species .... *guttulatus.*
   Veins not plainly dotted with dark .... 10.
10. Antennæ, except base, jet black; no spots on wing .... *conspicuus.*
    Antennæ wholly pale .... 11.
11. Wings wholly unmarked, no dot even at nodus or on stigma .... 12.
    Wings more or less marked with dark .... 13.
12. Areola postica three times as long as broad.... *Pseudocæcilius innotatus.*
    Areola postica hardly more than twice as long as broad .... *castillus.*
13. A series of dark marks, one in each marginal cell, stigma broad, mostly dark .... *Ophiodopelma multipunctatus.*
    No such series of marks .... 14.
14. Forks of radial sector nearly twice as long as pedicel, areola postica fully twice as long as broad .... *inæqualis.*
    Forks of radial sector not or scarcely as long as the pedicel .... 15.
15. Several veins in apical half of wing with small bordering spots, basal part of radial sector not dark, no dark spot over it to medius. *nitoris.*
    No spots on veins in apical part of wing, except in stigma, basal part of radial sector dark or a dark spot over it to the medius, antennæ of male very long-pilose .... *otiosus.*

CÆCILIUS MARCIDUS sp. nov.

Head in male dark brown, in female paler, eyes in male very large, separated by scarcely more than one-half their diameter, in female by about twice their diameter; antennæ pale, head and antennæ densely clothed with short hair; thorax brown; abdomen paler; legs pale, unmarked.

Forewings with a dark brown streak from base to tip, leaving a wide clear space in front and behind, in apical part but little wider than space between radial sector and medius, which are nearly parallel for most of their length; stigma pale yellowish, a dark spot from the dark streak reaches up to corner of stigma but does not go across, basal part of space between forks of radial sector dark; branches of medius to hind margin bordered with brown, and hind margin of areola postica likewise bordered. Stigma slightly angulate behind, outer part nearly as long as basal part; areola postica subtriangular, a little longer than high and of moderate size; forks of radial sector not nearly as long as pedicel, but somewhat more than one-half as long; union of radial sector and medius about one-half as long as base of radial sector. Hind wings fumose, except pale outer costal area.

Length, 2.5 mm.

MINDANAO, Davao Province, Calian, June 13 and 17 (*Clagg*). LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 21749.

In one wing of one specimen the areola postica is connected by a crossvein to the medius.

CÆCILIUS CONSPICUUS sp. nov. Plate 2, fig. 18.

Head pale yellowish, unmarked, hairs extremely minute, eyes of male very large and projecting in front as well as laterally, not quite one-half their diameter apart; basal three joints of antennæ yellowish, beyond antennæ deep black and rather heavy in the male, hairs dense, but short. Thorax with three large shining brown spots above, pleura pale as also legs, unmarked; abdomen pale, but dark above at base and at tip.

Wings hyaline, unmarked, veins yellowish, stigma also pale yellowish. Forewings very long and slender, stigma also very long, but low and broadly rounded behind; areola postica rather small and low, fully twice as long as high; forks of radial sector almost as long as pedicel, union of radial sector and medius about as long as base of radial sector which is curved.

Hind wings with upper branch of radial sector plainly oblique.

Length, 4 mm.

LUZON, Mountain Province, Baguio (*Baker*). Type, M. C. Z. No. 21746.

CÆCILIUS CLAGGI sp. nov. Plate 1, fig. 4.

Head brown to black, with many moderately short hairs, some each side on vertex longer, in female eyes small and nearly three diameters apart, in male eyes very large and only about one diameter apart; antennæ dark, in both sexes with long hairs but those of male about one-half longer than those of female; thorax, abdomen, and legs blackish. Both wings wholly blackish, as also the veins, a slightly paler area in forewing just beyond the end of anal veins.

Forewings rather broad; stigma very long, moderately broad, but rounded behind; areola postica about twice as long as high, evenly rounded above; forks of radial sector not quite as long as pedicel; union of radial sector and medius very short; hairs on margin dense, but not very long.

Length, 3.5 mm.

MINDANAO, Davao Province, Mount Apo, Kidapayan Trail, altitude 7,000 to 8,000 feet, September 20; La Lun Mountains, July 5; Calian, January 1; Lawa, May 5 (*Clagg*). Type, M. C. Z. No. 21747.

CÆCILIUS NITORIS sp. nov. Plate 1, fig. 2.

Head white, unmarked, clothed with rather long hairs, in male the eyes not a diameter apart; antennæ pale, with rather long hair; thorax and abdomen pale brown, legs whitish, unmarked.

Forewings hyaline, with partly pale and partly dark veins; at forking of cubitus from medius several brown spots tending to form a band; small brown spots in base of apical forks, along outer margin of areola postica, at tip of stigma, and in forking of radial sector and medius; one brown spot along medius, and one along radial sector near middle of wing. Beyond the stigma the margin quite broad, and tapering around the tip; stigma elongate, rounded behind; areola postica quite high and short (in one specimen not quite as high as figured); forks of radial sector hardly one-half as long as pedicel; margin of wing with quite long hairs.

Hind wings hyaline, veins pale, upper branch of radial sector transverse.

Length, 2.2 mm.

LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 21751.

CÆCILIUS OTIOSUS sp. nov. Plate 1, fig. 7.

Head brown, clothed with moderately long hair; eyes of male very large, much less than one diameter apart; antennæ pale, with extremely long hairs; thorax with three large brown spots on the lobes; abdomen brown, legs pale, scarcely marked with dark.

Forewings hyaline, veins pale; outer part of stigma dark and a slight extension behind it, a large dark spot tending to form a band over forking of cubitus and medius, and a dark spot at end of anal veins. Stigma long, rounded behind; areola postica rather high, longer than high, triangular; margin of wing very broad beyond stigma, tapering around tip; forks of radial sector fully equal to pedicel.

Hind wings hyaline, veins brownish.

Length, 2.5 to 3 mm.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,000 feet, September 10 (*Clagg*). LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 21750.

Sometimes the basal spot is not so distinct, but the veins here are heavily black; in one specimen (perhaps different) the head is paler and the areola postica is lower.

CÆCILIUS PLAGOSUS sp. nov.

Head black (no pale area on vertex) clothed with short pale hair, eyes of female very small, antennæ pale, with very short hair; thorax dark brown, legs pale. Forewings with a dark streak through from base to tip, and occupying most of wing, in outer part reaching to hind margin, a triangular pale area over basal part of areola postica reaching up to medius, before the end of anals a small pale spot on margin, and before this a large triangular whitish spot reaching two-thirds across wing. Stigma yellow, behind and beyond it a clear area; a dark process from the main dark streak up and across stigma (as in *dolobratus*); stigma angulate behind, the areola postica large, a little longer than high and evenly rounded; forks of radial sector not nearly as long as stalk; union of radial sector and medius about as long as base of radial sector.

Hind wings fumose except outer costal part, but branch of radial sector to margin bordered with brown.

Length, 3 mm.

LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 21748.

Cæcilius dolobratus has the cell between forks of radial sector pale, areola postica hardly one-half as large, and antennæ dark.

PSEUDOCÆCILIUS INNOTATUS sp. nov. Plate 2, fig. 19.

Head and thorax yellowish brown, head with some fine short hairs and scattered much longer ones, particularly by the side of eyes and on vertex; eyes in male large, hardly one diameter apart, vertex roundly concave (not angularly); antennæ pale yellowish, in male with very long scattered hairs; thorax with dense short hairs, and a few long erect ones; abdomen pale, legs also, unmarked. Wings very faintly yellowish, unmarked, veins and stigma pale. Stigma very long and slender, rather blunt at tip; areola postica fully three times as long as broad, evenly rounded above; forks of radial sector not as long as pedicel; union of radial sector and medius much longer than base of radial sector; in anal area a long fusiform strip of minute scales or spicules; outer marginal hairs crossed as usual; in hind wings the upper branch of radial sector is strongly oblique.

Length, 3 mm.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,000 feet, September 9 (*Clagg*). Type, M. C. Z. No. 21744.

Differs from *P. testaceus* Endl. in shape of stigma, shorter hairs on veins, shorter base of radial sector, and other characters.

EPIPSOCUS PROMINENS sp. nov. Plate 1, fig. 10; Plate 2, fig. 17.

Face shining black, sides of head back of antennæ pale, vertex pale, short hairs on face, longer ones on vertex; antennæ pale; eyes of male very large, not quite their short diameter apart, projecting greatly in front as well as above and laterally; the face exceptionally elongate, about twice as long as usual; thorax and abdomen brown; legs pale, tips of tibiæ darker, hind legs very long.

Wings hyaline; forewing with the stigma almost wholly brown, a small pale space at base, and a smaller one near tip; extreme tip of wing dark, veins brown, long-haired. Stigma long and slender, broadly rounded behind; forks of radial sector about as long as pedicel; areola postica elongate, over twice as long as high, highest near base, outer part sloping; crossvein from radial sector to medius longer than base of radial sector, but not longer than base of medius.

Forewing, length, 5 mm.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,000 feet, September 22 (*Clagg*). Type, M. C. Z. No. 21753.

This species must be related to *E. longiceps* Endl., from Java, hardly more than one-half the size, with a face said to have a V-mark and legs more marked.

MICROPSOCUS BASALIS sp. nov. Plate 1, fig. 6.

Head brown to almost black, with scattered, moderately short, pale hairs; eyes of female about three diameters apart, of male fully twice as large and not two diameters apart; ocelli large, close together; antennæ pale yellowish brown, with moderately short hairs. Thorax brown, haired like head; abdomen brown; legs pale, unmarked.

Forewings largely brown, but with many clear spots, similar in arrangement to that of *M. erosus* Endl., but the brown more definite and not broken up by numerous small spots; base of stigma with a large clear spot (dark in *M. erosus*). Clear spots on margin of each apical cell around to just before cubitus, the one beyond stigma double; between radial sector and medius three other spots, between radius and medius (towards base) two large pale spots, one curved; in most specimens the outer dark marks appear to form a curved band. Wing somewhat broader than in *M. erosus,* but venation very similar, the intermediate median cell often much wider than figured for *M. erosus,* but variable. Hairs along margin very evenly spaced.

Length, 1.8 mm.

MINDANAO, Davao Province, Calian, June 12 (*Clagg*). Type, M. C. Z. No. 21752.

SEOPSIS TRICOLOR sp. nov. Plate 1, fig. 3.

Head brown, above almost purplish or reddish brown, clothed with very minute appressed white hair; ocelli in a moderately low triangle, the posteriors rather large, about two diameters apart and more than twice as far from eyes; antennæ very fine, with scattered long hairs; thorax also brownish, but not so dark as head; abdomen pale brown; legs pale on femora, tibiæ dark, and hind tibiæ with rather small erect bristles.

Forewings dark, largely with dark scales, a broad oblique stripe of yellowish to golden scales, starting from near hind margin at end of basal third, and extending out to near tip of wing where there is a circular patch of jet black hair; the lower border of the yellow stripe edged with snow white, white scales in front and behind the apical black spot; just before the black spot two divergent lines of white scales across the black from the yellow stripe to costa, and about at middle a patch or two lines of white from yellow stripe to margin. Hind wings faintly infuscate, rather darker near tip. Fringes short and mostly dark, but two white patches near tip of forewing.

Length, 3.5 mm.

MINDANAO, Davao Province, Baroring River, 7,000 feet; Galog and Mainit Rivers, 6,000 feet; Tia Ridge, 6,500 feet; all on Mount Apo, September to November; Lawa, May 5 (*Clagg*). Type, M. C. Z. No. 21755.

SEOPSIS LUZONICA sp. nov. Plate 1, fig. 5.

Head dull yellowish, or brown, with a pale band across, interrupted by ocelli, and with two dark marks each side on vertex, clothed with minute appressed white hair; ocelli in a moderately low triangle, posteriors about twice as far from eyes as from each other; antennæ pale, very short and fine, with scattered long hairs; thorax brown, with fine white hairs; abdomen brown above, pale beneath; legs pale, tibiæ with some fine bristles.

Forewings brown, clothed with tawny to golden scales, and with many snow white ones intermingled, the white mostly on posterior and outer part without definite pattern, a large spot of tawny scales at tip of wing. Hind wings hyaline, apical third infuscate, veins brown. Fringes of both pairs rather short, mostly of dark hair.

Length, 2.2 mm.

LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 21754.

PERLIDÆ

Key to the Philippine species of Neoperla.

1. Wings black .... *atripennis*.
   Wings yellowish or yellowish brown .... 2.
2. Forewings with a clear space near middle; ocelli fully one diameter apart, scars much nearer to eyes than to ocelli .... *hermosa*.
   Forewings without a clearer space near middle .... 3.
3. Cubital fork arising near first cubital crossvein in a broad angle, sometimes beyond the crossvein; smaller species .... 4.
   Cubital fork arising much before the first cubital crossvein in a very acute angle; usually larger species .... 7.
4. Ocelli but little, if any, more than one diameter apart and twice as far from the lateral scars .... 5.
   Ocelli farther apart, and not twice as far from the lateral scars .... 6.
5. Wings and veins wholly pale yellowish .... *clarissa*.
   Wings and veins brownish .... *consimilis*.
6. Wings hyaline, veins yellow .... *bakeri*.
   Wings fumose, veins brownish .... *claggi*.
7. Lateral carina of face usually not extending back of inner angle of eye; radial crossvein nearly straight across .... 8.

Lateral carina of face usually extending back of inner angle of eye; radial crossvein very plainly oblique; rarely crossveins among radial branches .... 11.
8. Antennæ dark; tibia slightly darker than femur; ventral plate somewhat angulate behind .... 9.
Antennæ pale; tibia not darker than femur .... 10.
9. Ocelli large, larger than lateral scars .... *viscayana.*
Ocelli not larger than lateral scars; dark cloud on clypeus; ocelli rather farther apart than usual; often one or more crossveins among the branches of radial sector .... *recta.*
10. Pronotum broadly margined with pale; lateral carina of face extended back .... *pallescens.*
Pronotum wholly brownish .... *pallicornis.*
11. Antennæ darkened beyond first joint; crossveins not darkened.... *obliqua.*
Antennæ not darkened beyond basal joint .... 12.
12. Eyes short, round; head not darkened; radial crossvein only slightly oblique; lateral border of pronotum broadly pale yellow.... *pallescens.*
Eyes elongate, almost pointed behind; head darkened; lateral border of pronotum not broadly pale yellow .... *apoana.*

Neoperla incerta Klap., 1921, one female from Mindanao; the author says ocelli as close to eyes as to each other. This description fits none I have seen, but in *N. recta* the ocelli approach this condition; the ventral plate is shown angulate behind, so *N. incerta* is doubtless a synonym of *N. recta.*

Folga luzonica Navas, 1918, is also the same as *N. recta.*

Neoperla pastellsi Navas, 1925, is probably *N. obliqua,* judging from Navas's figure of the ocelli and his description.

NEOPERLA PALLESCENS sp. nov.

Face pale brownish; basal joint of antennæ also brown, beyond pale; palpi pale; no distinct spot around ocelli; pronotum broadly pale yellow on the sides, more than one-half of middle brownish; thorax and abdomen yellowish; legs and setæ also pale yellow; wings pale yellowish, veins yellow. Eyes short and nearly circular; ocelli moderately large, about one and one-half diameters apart, fully twice as far from the eyes; lateral scars about as large as ocelli, and scarcely nearer to eyes than to ocelli; lateral face ridges continued back of eyes. Pronotum only a little broader in front than long, anterior angles not prominent, sides rounded and tapering a little behind; ventral plate of female evenly and slightly convex.

Forewings with cubital fork arising at an acute angle long before first cubital crossvein, but there is an oblique medial crossvein (hardly complete) just before it; all costal crossveins thickened, two beyond end of subcosta, radial crossvein scarcely oblique, radial sector with two branches beyond crossvein; second anal vein parallel to first, third anal not sinuous; seven or eight medial crossveins, five or six cubital crossveins.

Hind wings with about six cubital crossveins, radial sector with two branches beyond crossvein.

Expanse, 30 mm.

MINDANAO, Kolambugan (*Baker*). Type, M. C. Z. No. 22101.

NEOPERLA APOANA sp. nov.

Head more or less embrowned, without definite marks; palpi brownish; first joint of antennæ usually brown, beyond paler; legs pale, tibia no darker than femur, latter sometimes darkened near tip; pronotum brownish, often paler on sides; sternum and abdomen pale, as also the setæ, meso- and metanotum usually showing a pale median stripe. Wings scarcely infuscate, veins pale yellowish brown, some crossveins often faintly margined with brown, costal veins paler; in hind wings all veins pale.

On head the lateral carina extending backward beyond angle of eye; ocelli of moderate size, hardly two diameters apart, sometimes a little more, twice as far from eyes; lateral scars elliptical, slightly oblique, usually as near or nearer to eye than to ocellus; pronotum usually as wide as head, anterior corners often angulate and prominent, behind narrowed, but not as much as in *N. recta,* anterior margin moderately convex, rugose as usual; ventral plate straight across; last dorsal segment evenly convex.

Forewings with cubital fork arising at an acute angle long before first crossvein; two to five crossveins beyond end of subcosta, numerous costals, usually all of them thickened, about seven to nine median crossveins and five to six cubitals, radial sector 3- or 4-branched, radial crossvein plainly oblique.

Hind wings with five to eight cubital crossveins, radial sector 3- or 4-branched.

Expanse, 37 to 45 mm.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 6,000 feet, October 18 to 23, many specimens (*Clagg*). Type, M. C. Z. No. 22102.

Separated from *N. obliqua* by paler antennæ, darker venation, slightly closer ocelli, and larger size.

NEOPERLA CLAGGI sp. nov. Plate 2, fig. 21.

Extremely similar in structure and size to *N. bakeri,* differing in darker body and legs, and wings fumose throughout, veins brownish; male with long anterior process of clasper heavier than in *N. bakeri* and the lower process shorter and blunter; ventral plate of female straight across.

Ocelli two diameters or a little more apart, and fully twice as far from eyes; lateral scars a little farther from ocelli than the latter are apart, and plainly nearer to eyes; pronotum almost as wide as head, corners and sides rounded. Forewing with one or two crossveins beyond subcosta; two or three costal crossveins before end fine (not thickened as others), radial sector usually 2-branched beyond radial crossvein.

MINDANAO, Davao Province, Mainit River, altitude 6,500 feet, October 27, and Galog River, 6,000 feet, October 18, both on Mount Apo (*Clagg*). BASILAN (*Baker*), a slightly smaller specimen. Type, M. C. Z. No. 22103.

NEOPERLA PALLICORNIS sp. nov.

Face yellowish, faintly brownish in middle, antennæ wholly pale; pronotum pale brownish; thorax and abdomen mostly yellowish, setæ also, the tips but little darker; wings faintly yellowish, veins yellow. Lateral carinæ of face not extending back; ocelli one and one-half diameters apart, and fully twice as far from eyes, eyes rather elongate, somewhat pointed in front and behind; lateral scars moderately large, fully as close to ocelli as to eyes.

Pronotum much broader in front than long, anterior angles sharp, prominent, sides much sloping behind; margin of ventral plate straight. Forewings with cubital fork arising at acute angle much before crossvein; costals all thickened, two crossveins beyond subcostal; radial crossvein scarcely oblique; radial sector with one or two branches beyond crossvein; second anal almost parallel to first, third anal slightly sinuate; about six crossveins in both median and cubital areas. In hind wings four or five cubital crossveins.

Expanse, 24 mm.

LUZON, Laguna Province, Mount Maquiling, 2 females (*Baker*). Type, M. C. Z. No. 22104.

A male, which probably belongs with these females, differs in having the head and basal joint of antennæ somewhat darkened, and the veins are faintly brownish; the genitalia have the apical process stouter towards base than in *N. recta*, and there is no tubercle or process in front of it, only a small scabrous area.

HEMEROBIIDÆ

Key to the Philippine species of Archæomicromus.

1. Four or five radial sectors; outer gradates irregular, not parallel to inner series .... *igorotus*.
   More radial sectors; outer gradates in a more even row .... 2.

2. Five to six radial sectors; wings scarcely marked; tibiæ not banded, first median cell usually shorter than second, hardly if any longer than its pedicel to the basal crossvein.. *pusillus.*
   Seven to ten radial sectors; wings more marked with dark; tibiæ often banded with dark .... 3.
3. Front and midtibiæ bifasciate, hind tibiæ with three bands behind, also marks on femora; seven radial sectors; first median cell longer than second; three dark spots along basal cubitus........................... *pictipes.*
   Hind tibiæ without bands .... 4.
4. First median cell plainly shorter than second; eight to nine radial sectors; veins between gradate series pale, almost unmarked, front tibiæ bifasciate; pronotum with two dark spots.................................... *placidus.*
   First median cell fully as long or longer than second, and very much longer than its pedicel.. 5.
5. Seven to eight radial sectors; upper three of inner gradates not much separated from others; veins between gradate series much marked, as elsewhere; top of head and pronotum black; only small spot before stigma .... *nigrifrons.*
   Ten radial sectors; upper three of inner gradates widely separated from others; upper end of outer row much incurved; veins between gradate series scarcely marked; both gradate series heavily bordered; head and pronotum pale; large spot before stigma................................. *gratus.*

MICROMUS (ARCHÆOMICROMUS) PICTIPES Banks.

I know only the type from Baguio, Benguet Subprovince, Luzon (*Baker*).

MICROMUS (ARCHÆOMICROMUS) IGOROTUS Banks.

LUZON, Laguna Province, Mount Maquiling and Los Baños: Mountain Province, Baguio (*Baker*).

MICROMUS (ARCHÆOMICROMUS) PUSILLUS Gerst.

From many localities in Luzon. *Micromus philippinus* Navas, 1926, is the same species.

MICROMUS (ARCHÆOMICROMUS) GRATUS sp. nov.

Tawny or faintly rufous; vertex dark each side by the eye, basal joint of antenna dark brown, beyond brownish; pronotum with a dark spot on each side, lateral lobes of mesonotum dark; abdomen brown; legs pale, front and midtibiæ faintly bifasciate with brown. Forewings with anal area narrowly dark brown, and a dark brown spot over connection of median and cubitus with an extension towards radius; inner and outer gradates dark brown and mostly bordered; several long streaks on radius; a large brown spot before stigma, a small one at end and another between them; radial sectors and branches of medius but little marked, but not yellowish, scarcely at all marked between the gradate series.

Hind wings with outer gradates, cubitus and its branches, and some veins near upper base dark, stigma dark.

Wings moderately narrow; in forewing most of the gradates in fairly even series, but the upper three of inner row widely separated from the others, the upper four of outer row turn that row inward; ten radial sectors; medius forks long before second cubital crossvein; first median cell longer than second, and very much longer than its pedicel; outer cubitus connected to medius by a distinct crossvein; basal cubital cell much widened before first cubital crossvein.

Forewing, length, 10 mm; width, 3.7.

MINDANAO, Davao Province, Mount Apo, Tia Ridge, altitude 6,500 feet (*Clagg*). Type, M. C. Z. No. 20207.

MICROMUS (ARCHÆOMICROMUS) PLACIDUS sp. nov.

Yellowish; face from between antennæ down on clypeus darker; basal joint of antennæ scarcely dark; pronotum with a large dark spot on each side, dark spots or stripes over lateral lobes of mesonotum; front and midtibiæ with two dark bands.

Forewings with several brown bands occupying most of anal area, a dark brown spot over connection of medius and cubitus, and both series of gradates dark brown, the inner row bordered; costals with a few dark spots, larger one before and after stigma, outer forks more or less dark, including the branches of medius, radial sectors before inner gradates also partly dark but almost wholly pale yellowish between the two series of gradates.

Hind wings with outer gradates, cubitus, and some veins near base dark.

Wings moderately narrow; eight or nine radial sectors, gradates (9 and 11) in nearly even almost parallel series, in inner row the upper two well separated, the medius forks much before second cubital crossvein, cubitus forked near this crossvein, outer fork connected to medius by a short crossvein; first median cell much shorter than second, but nearly as long as its pedicel.

Forewing, length, 6.8 mm; width, 2.5.

SAMAR (*Baker*). Type, M. C. Z. No. 20205.

MICROMUS (ARCHÆOMICROMUS) NIGRIFRONS sp. nov.

Face brown, a yellowish band below antennæ, vertex and pronotum black; basal joint of antennæ black, beyond brown; abdomen dark; legs yellowish, front femora dark, none of tibiæ plainly marked.

Forewing with anal region almost wholly dark brown and a prominent dark brown spot over connection of medius and cubitus, gradates dark and slightly bordered with brown, radial sectors and branches of medius mostly dark, with occasional pale streaks or spots, costals partly dark, small spots each side of stigma.

Hind wings with outer gradates dark brown, veins beyond and behind them more or less dark, venation before them mostly pale yellowish.

Forewings moderately narrow; in one wing cubitus connected to medius by a short crossvein, in the other united with it for a short distance, first median cell as long as second and very much longer than its pedicel; seven to eight radial sectors, eight inner gradates, ten outer, in nearly parallel series, the upper ones of the inner row not especially separated, outer row a little incurved at upper end; the medius forks long before second cubital crossvein.

Forewing, length, 7 mm; width, 2.8.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 6,000 feet (*Clagg*). Type, M. C. Z. No. 20206.

MICROMUS (MICROMUS) ANGUSTIOR Weele.

Common in the Philippines, especially in Luzon. *Nenus luzonica* Navas is the same species; *N. novitus* Navas, from Japan and Formosa, is very similar, but I think distinct. *Micromus linearis* Hagen, from Ceylon, also goes in this subgenus. The type of *Micromus* is *variegatus,* and in that the cubitus in hind wing runs into the medius, just as in the species of *Nenus*.

Key to the Philippine species of Hemerobius.

1. First median cell no longer than second, inner series of gradates incomplete and uneven; last radial sector with four branches before outer gradates .... *tagalicus.*

   First median cell much longer than second, sometimes twice as long; last radial sector with three branches........ 2.

2. Second subradial space much longer than first, space between the two gradate series not much narrower than the space beyond outer gradates .... *claggi.*

   Second subradial space not noticeably longer than first; space between the two gradate series narrower than the space beyond the outer gradates .... 3.

3. Male genitalia with lower process slender, projecting downward to lower edge of abdomen. Veins more dotted........ *rizali.*

   Male genitalia with lower process projecting outward, from the side small and knoblike, inwardly pointed; outer space of wing unusually wide; veins not or scarcely dotted........ *vagans.*

HEMEROBIUS CLAGGI sp. nov.

Yellowish; a dark brown mark under each eye; pronotum broadly dark on each side, mesonotal lobes scarcely darkened; legs pale, unmarked.

Forewings with most veins interruptedly brown and pale, sometimes in streaks, often in dots; gradates and a few basal crossveins dark brown, margin with some pale yellowish spots, otherwise brown; stigmal area slightly darkened; hyaline line in costal area very distinct.

Hind wings with veins not dotted, but either pale brown (mostly near base) or yellowish, most of the gradates brown, stigma brownish.

Forewings with three radial sectors, the last one with three forks (not counting tiny apicals); second subradial cell much longer than first; gradates subparallel, intermediate area about as broad as apical area; six in inner gradates, seven in outer row; crossvein from medius to radius hardly its length before first radial sector; first median cell nearly twice as long as second.

Forewing, length, 7.5 mm; width, 3.

MINDANAO, Davao Province, Mount Apo, Kidapayan Trail, altitude 7,000 to 9,000 feet, September 18 to 20 (*Clagg*). Type, M. C. Z. No. 20209.

HEMEROBIUS VAGANS sp. nov. Plate 2, fig. 24.

Yellowish; a brown stripe below each eye; pronotum broadly black on sides; legs unmarked. Forewings with veins marked with dark brown, mostly in streaks; gradates wholly dark brown, an irregular dark brown spot over the connection from cubitus to medius; stigma not strongly marked.

Hind wings with veins mostly pale brownish, outer gradates and cubitus darker. Forewing with three radial sectors, the last forked three times; first and second subradial spaces subequal; gradates (four and six) nearly parallel, space between the two rows much narrower than the apical area which is unusually broad; first median cell much longer than second. Male appendages not very prominent, the curved tip tapering to a point inwardly, before it a smaller process or tooth, seen from the side the tip somewhat knob-shaped.

Length, forewing, 7 mm; width, 2.8.

MINDANAO, Davao Province, Mount Apo, Seliban River, altitude 7,000 feet, September 11 (*Clagg*). Type, M. C. Z. No. 20208.

HEMEROBIUS RIZALI Banks. Plate 2, fig. 13.

LUZON, Benguet Subprovince, Baguio (*Baker*).

Hemerobius inversus Navas, 1927, is also from Baguio, and the description agrees except that Navas gives more gradates in inner than in outer series, a variable point; for his 5-branched last radial sector, he probably counts the two small ones near tip.

HEMEROBIUS TAGALICUS Banks.

LUZON, Nueva Vizcaya Province, Imugan (*Baker*).

Hemerobius baguiensis Navas, 1923, also from Baguio, is said to have a dark head, very long antennæ, and three radial crossveins; it would seem to be very different and perhaps of another genus.

Navas also describes *Megalomus exillatus* from the Philippines.

CHRYSOPIDÆ

The Chrysopidæ obtained by Clagg in Mindanao have induced me to go over all our Philippine species, and I have prepared synoptic tables of the two principal genera, *Ankylopteryx* and *Chrysopa.*

ANKYLOPTERYX BRAUERI sp. nov.

Whitish or pale yellowish; a black spot each side under eye, one each side on the clypeus, last joint of the maxillary palpi marked with dark; a black spot at middle of front and midtibiæ, the tips of the tarsi black, no dark elsewhere on the body.

Wings with venation largely pale; in forewings the outer ends of first few costal crossveins dark; origin of radial sector, several of radial crossveins toward stigma, and some branches of anal vein dark. Gradates, especially inner row, dark, inner row often faintly dark-bordered, a distinct brown cloud over the first two; in hinder and outer part of wing a dozen or more faint brown clouds, in outer part of wing these often in the bases of the marginal forks. Hind wings with similar faint clouds, but hardly as many, elsewhere venation pale, except second cubital crossvein dark.

The wings, in shape and venation, are generally similar to those of *A. doleschali,* and the divisory cell is as small as in that species. There are about six to eight gradates in each series, the outer series nearly parallel to the outer margin, the gradates of the inner series often rather widely separated from each other, the first two close together and transverse (as in *A. trimaculata* and *A. nonelli*).

Pronotum plainly longer than broad, narrowed in front.

Length, 10 mm; forewing, length, 13.5 to 14.5; width, 6.

MINDANAO, Davao Province, Batraeyon, and Galog, Seliban, and Sibulan Rivers, all on Mount Apo, altitude 6,000 to 8,000 feet, September to early October (*Clagg*). Type, M. C. Z. No. 20164.

ANKYLOPTERIX CLAGGI sp. nov.

Pale yellowish, face with the usual black spots below each eye and on sides of clypeus; also three black dots, one below base of each antenna, and one between the two; no other dark spots on head, none on tibiæ; tips of tarsi pale.

Pronotum nearly twice as broad as long, unspotted, mesonotum with faint dark marks in front and at base of forewings. Venation greenish; forewing with costa at base and two or three of the basal costal crossveins black, origin of radial sector and the first crossvein behind it black, several radial crossveins before stigma, both series of gradates dark, inner series darker than outer; a branch from cubitus to hind margin of wing near middle black and broadly black-margined; very faint clouds of brown on some of the marginal forks, a few crossveins near base of wing dark, including hind part of base of second cubital cell, a few cubital crossveins also faintly margined; stigma green. Hind wings with green veins and stigma, a few faint clouds near hind margin.

Forewings with costal area at base less broad than usual (but much more than in *Chrysopa*); divisory cell triangular, of fair size; about eight gradates in each series, far apart, outer row parallel to outer margin, inner row directed towards stigma; radial sector about as curved as usual in the genus.

Length, 9 mm; forewing, length, 13; width, 5.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January (*Clagg*). Type, M. C. Z. No. 20165.

By the narrower costal area this species approaches *Chrysopa* and particularly *Ch. nigribasis* Bks., and the latter species may be removed to *Ankylopteryx*. However, in *A. claggi* the face marks and the much curved radial sector are characteristic of *Ankylopteryx*.

Key to the Philippine species of Ankylopteryx.

1. No divisory veinlet in third cubital cell.......... *anomala*.
   This veinlet present, setting off a small cell in upper basal part of third cubital cell .... 2.

2. Front and midtibiæ with a median dark spot .... 10.
   Front and midtibiæ unspotted .... 3.
3. Black across base of mesothorax .... 4.
   Not so marked .... 5.
4. Three large black spots in each wing, costal area as wide as usual at base, average size .... *nonelli.*
   No large dark spots on wings, costal area not near as wide as usual, small size .... *Chrysopa nigribasis.*
5. Wings unmarked, veins wholly pale .... *perpallida.*
   Wings more or less marked .... 6.
6. Forewings with some of the discal veins broadly margined with yellowish brown .... 7.
   Forewings without such yellowish marks .... 8.
7. Last crossvein between radial sector and medius giving off two branches, radial sector extremely sinuous, many brown clouds .... *obliqua.*
   That crossvein not giving off two branches, radial sector less sinuous, fewer brown clouds .... *nervosa.*
8. Only outer gradates black, radial sector strongly sinuous .... 9.
   All gradates black, and also a broadly margined branch of cubitus to hind margin; three dark dots on face .... *claggi.*
9. No dark spot over base of inner gradates .... *polygramma.*
   A dark spot over base of inner gradates, stigma distinct, divisory cell usually 4-sided .... Ceylon species.
10. No dark spot over base of inner gradates, outer gradates only black, radial sector very sinuous, stigma indistinct .... *polygramma.*
    A dark spot over lower base of inner gradates, stigma and a spot near end of anal vein usually also present .... 11.
11. Divisory cell very small, 2- or 3-sided .... 12.
    Divisory cell normal, often 4-sided .... 13.
12. Stigma usually marked, pronotum with a spot each side .... *doleschali.*
    Stigma not marked, pronotum without spots, outer gradates dark. *braueri.*
13. Thorax unmarked, stigma marked .... *punctata.*
    Thorax with some dark spots .... 14.
14. Mouth pale, smaller species, stigma not marked .... *borneensis.*
    Mouth dark, stigma usually and a spot near end of anals dark. *octopunctata* (*trimaculata*), *candida* (*sigillaris*).

CHRYSOPA EXCELSIOR sp. nov.

Head rather dark, discolored, but without black marks; antennæ, palpi, and legs pale; thorax pale yellowish, pronotum with a black spot each side near middle of extreme lateral margin. Forewings with longitudinal veins pale, many crossveins dark, at least in part; costals for one-half way out, most of radials, origin of radial sector, medials, both series of gradates, cubitals, and anals marked with dark; stigma yellowish; in hind wings venation pale.

Forewings with costal area as broad as radial area; postcubital area about twice as broad as cubital area; divisory veinlet ending much beyond crossvein; about seven crossveins in each gradate series, inner series irregular, the first towards base, third, fourth, and fifth close together and more transverse than first and second; outer series even, about as near to inner row as to outer margin, to which it is parallel.

Pronotum nearly as long as broad, a little narrowed towards front.

Length, 10 mm; forewings, length, 15; width, 5.

MINDANAO, Davao Province, Mount Apo, Seliban River, altitude 7,000 feet, September 13 (*Clagg*). Type, M. C. Z. No. 20166.

CHRYSOPA NOTULATA sp. nov.

Head pale, unmarked, likewise palpi, antennæ, and legs; thorax yellowish, pronotum with two small dark submedian spots in the front part, and faint short lines in the hind part. Forewings with longitudinal veins greenish, many costals on basal part black, but not the first two or three, several radials dark in middle, some branches of cubitus and a few in anal area dark; inner gradates dark, outer series pale, origin of radial sector and bases of branches of radial sector pale, stigma pale greenish.

Hind wings with greenish venation; forewings with costal area as broad as radial area; divisory veinlet ends much beyond crossvein; second crossvein from anal to cubitus scarcely oblique; about seven veinlets in each gradate series, first and second more basad, others in even row, about parallel to outer row, but nearer to radial sector than to outer row, outer row thus much nearer to outer margin than to inner gradates; postcubital area only about one-half wider than cubital area.

Pronotum much broader than long, scarcely narrowed in front.

Length, 11 mm; forewing, length, 15; width, 5.

MINDANAO, Davao Province, La Lun Mountains, May 3 (*Clagg*). Type, M. C. Z. No. 20167.

CHRYSOPA DEROTA sp. nov. Plate 2, fig. 16.

Head pale, unmarked; palpi, antennæ, and legs pale, thorax also, pronotum with a dark spot each side towards, but not on, the lateral margin.

Forewings with longitudinal veins greenish, most of costal crossveins, nearly all of radials, base of radial sector, bases of branches of radial sector, medials, most of cubitals, and anals in part dark; both series of gradates dark; stigma yellowish green; hind wings with pale venation.

Forewings with costal area plainly not as broad as radial area; divisory veinlet ending much beyond the crossvein; seven or eight veinlets in each gradate series, fairly evenly placed, the rows subparallel and also to the outer margin, inner row about as near to the outer as to radial sector, outer row as near to the inner as to the outer margin; postcubital area not nearly twice as broad as the cubital area.

Pronotum much broader than long, scarcely narrowed in front.

Length, 9 mm; forewing, length, 12; width, 4.5.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,500 feet, October 22 (*Clagg*). Type, M. C. Z. No. 20168.

A specimen, not fully colored, from Sandakan, Borneo, may belong to this species.

CHRYSOPA MINDANENSIS sp. nov. Plate 1, fig. 11.

Pale yellowish; face, palpi, antennæ, and head unmarked, except two very small black spots on front of the vertex near middle; thorax green on sides, broadly yellow through the middle, pronotum faintly reddish on sides; abdomen green on sides, a pale median stripe above; legs wholly pale.

Wings with longitudinal veins green; forewings with gradates and many crossveins dark, several costals towards base at least in part dark, the first few radials at least partly, several cubitals, divisory veinlet, origin of radial sector, and some anal crossveins dark; stigma greenish; hind wings with green veins, no marks, except inner gradates somewhat darkened. Forewings moderately long, cubitus swollen towards base, divisory ends just beyond crossvein; eight to ten in each gradate series, outer row subparallel to outer margin, and very much nearer to margin than to inner series, inner row also subparallel to outer margin, about as near radial sector as to outer row.

Pronotum much broader than long, a little narrowed in front.

Length, 9 mm; forewings, length, 12.5; width, 4.5.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 26 (*Clagg*). Type, M. C. Z. No. 20169.

CHRYSOPA APOANA sp. nov. Plate 2, figs. 22 and 23.

Head, antennæ, and palpi pale, unmarked; pronotum pale, with a large black spot each side behind, no marks on rest of thorax; legs pale. Wings with longitudinal veins mostly pale, but radial sector for a short distance and median by the second cubital cell black; costal crossveins for nearly halfway out more or less black, radial crossveins at first black, then black only in the middle, a few medial and a few cubital crossveins towards base black, outer gradates black, inner pale; stigma greenish, a few anal crossveins also dark; hind wings with wholly pale greenish venation.

Pronotum broader than long, narrowed towards front. Wings moderately long, many of the crossveins a little more oblique than usual, radial crossveins beyond first five or six oblique and sinuous, the last few short ones straight across (like those in *C. obliquata*); hairs on veins not as long as in *C. obliquata*. About eight veinlets in each gradate series, veinlets often shorter than the distance apart, outer series nearly parallel to outer margin, inner row about as near to outer row as to radial sector and nearly parallel to outer row, divisory veinlet ending much beyond crossvein.

Length, 10 mm; forewing, length, 15; width, 5.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,000 feet, September 22 (*Clagg*). Type, M. C. Z. No. 20170.

This species (with my *Ch. obliquata*) will go in the Navasian genus *Scoliochrysa*, because of the sinuous veins in the radial area; the character varies so gradually to the straight veins of typical *Chrysopa* that the genus is but a synonym of *Chrysopa*.

Key to the Philippine species of Chrysopa.

1. Antennæ black or almost black .... 2.
   Antennæ pale .... 4.
2. Forewing more than 15 mm, head reddish, hairs on veins very short. *ruficeps*.
   Forewing less than 15 mm .... 3.
3. Basal joint of antennæ with a black mark .... *flaveola*.
   Basal joint of antennæ unmarked .... *eurycista*.
4. Apical cells of forewing containing golden iridescent spots .... *splendida*.
   No such golden spots .... 5.
5. Stigma very plainly dark at one or both ends, dark marks on head, and on thorax above and below base of front wing .... 6.
   Stigma not plainly dark at either end, no such marks on thorax .... 9.
6. Tibiæ with black spots near base and at middle, pronotum margined; usually but three or four veinlets in each gradate series .... *bakeri*.
   Tibiæ without black marks, a black spot between antennæ, usually five veinlets in each gradate series .... 7.
7. Costals largely black, as also most of radials, and bases of the branches of radial sector .... *rizali*.
   Costals scarcely, if at all, dark .... 8.
8. Two spots on vertex, and a large spot each side on pronotum towards front .... *valdezi*.
   No spots on vertex or pronotum, at most very small faint ones. *caliptera*.

9. Second joint of antennæ dark .... 10.
   Second joint of antennæ pale .... 11.
10. Face mostly dark with red or brown, with red spots below antennæ. *atrioris.*
   Face pale .... *azygota.*
11. Thorax with black across base of mesothorax, costal area broad at base .... *nigribasis.*
   Not so .... 12.
12. At least one row of gradates dark, as also some other crossveins .... 13.
   Gradates pale, as is rest of venation .... 21.
13. Radial crossveins near stigma very oblique and sinuous .... 14.
   Radial crossveins scarcely oblique and not sinuous .... 15.
14. A large black spot on each side of pronotum .... *apoana.*
   No such spots on pronotum .... *obliquata.*
15. A dark mark on each side of face from eye to mouth .... 16.
   No dark mark on face, costals towards base partly black .... 17.
16. Costal pale, only two gradate series .... *ilota.*
   Costals and radials largely dark, a partial third (intermediate) row of gradates .... *winkleri.*
17. A distinct black spot near each lateral margin of pronotum .... 18.
   No such black spots .... 19.
18. Inner gradates irregular, third, fourth, and fifth close together; costal area as broad as radial area .... *excelsior.*
   Inner gradates in fairly even row; costal area not so broad as radial area .... *derota.*
19. Basal joint of antennæ reddish on outer side, the red showing also between antennæ and eyes, inner gradate series extended basally. *alticola.*
   Basal joint of antennæ not reddish, no red on head .... 20.
20. Outer gradates pale, thorax with a broad yellow median stripe. *mindanensis.*
   Outer gradates dark, pronotum with a pair of small submedian dark spots .... *notulata.*
21. Postcubital area scarcely, if at all, broader than cubital area, pronotum broad, inner gradates reduced to three or four .... *isolata.*
   Postcubital area plainly broader than the cubital area .... 22.
22. Pronotum twice as broad as long, and with a median yellow stripe. *maquilingi.*
   Pronotum not twice so broad as long .... 23.
23. Inner gradate series with upper veinlet fully twice as near to radial sector as to outer gradate row .... *tagalica.*
   Inner gradate series with upper veinlet not nearly twice so close to radial sector as to outer gradate row .... *morota.*

Chrysopa procubitalis Navas is, I think, *C. ruficeps* McLachlan.

Chrysopa faceta Navas is *C. splendida* van der Weele.

Chrysopa buruana E. Petersen is close to and probably the same as, *C. bakeri;* the type of *C. bakeri* has the outer margin very dark, but one from Luzon is more like Petersen's figure; a specimen from Basilan lacks the spots on the vertex.

Chrysopa boettcheri E. Petersen is surely *C. bakeri.*

Chrysopa herasi Navas, and I think *C. unicolor* Navas also, are the same as *C. morota* Bks.

Chrysopa maquilingi is a new name for *C. inconspicua* Navas, 1926; Navas had used the same name for a West African species in 1914.

Chrysopa formosana E. Petersen is, according to a paratype sent me by M. E. Petersen, different from *tagalica,* having the inner gradates much nearer to the outer ones, and differing in other respects. However, specimens later sent me as *C. formosana* from the Philippines are *C. tagalica* Bks.

Chrysopa nigribasis Bks. approaches *Ankylopteryx,* and I have inserted it in both tables. The costal area is broader, and the radial sector more curved than usual in *Chrysopa,* but not as much so as in normal *Ankylopteryx;* however, the new *A. claggi* is more like *C. nigribasis* in these respects.

Chrysopa winkleri Navas is the basis of his genus *Bornia,* based on the extra series of gradates; the number of veinlets in this extra series is variable, probably never complete, and other species of *Chrysopa* sometimes show one or two extra veinlets; on that character the genus is invalid.

Chrysopa obliquata and *C. apoana* would go in the Navasian genus *Scoliochrysa,* based on the oblique and sinuous radial crossveins in a Papuan species. The amount of obliquity is variable and in several other species plainly a little oblique, so that that generic name must fall.

Chrysopa splendida Weele is the basis of *Glenochrysa,* but this species is plainly related to *C. rizali* and *C. bakeri* (*buruana*).

If these generic names are to be valid, others should be given for the section *nigribasis,* for the section of *ruficeps, flaveola,* and others, for the section of *morota, tagalica,* and others, as well as for numerous other sections in other countries. The Navasian genus *Cintameva* has already been shown to be typical *Chrysopa,* and the genus *Chrysocera* Weele is based on a character only in male appendages and of variable development, so also falls to *Chrysopa.*

OSMYLIDÆ

HELIOSMYLUS MONTICOLUS sp. nov.

Face yellowish, basal joints of antennæ also, beyond brown, vertex brownish, pronotum also brown, darker on sides, rest of thorax and abdomen brown, latter dark brown above; legs pale, faint spots on tibiæ.

Forewings with largely brown veins, many bordered, five or six brown streaks between subcosta and radius, the veins adjoining brown; a large brown spot each side of the pale yellowish stigma; outer gradates heavily brown, a spot over and near next to last median crossvein, and another before that. Hind wings with spots, stigma, outer gradates, and some along median before it brown, other veins pale brownish, the outer border with some pale places.

Forewing with about fifteen or sixteen radials, about seventeen cubital crossveins, and thirteen branches to radial sector; veins densely haired as in *H. fraternus.*

Forewing, length, 21 mm; width, 7.

MINDANAO, Davao Province, Seliban River, altitude 7,000 feet, September 3; Galog River, altitude 6,000 feet, November 4; Baroring River, altitude 7,000 feet, November 9; all on Mount Apo; La Lun Mountains, July 4 (*Clagg*). Type, M. C. Z. No. 20204.

Paler and much less heavily marked than *H. fraternus* Bks., from Kinabalu; the latter species has but thirteen radial crossveins.

Key to the Philippine species of Spilosmylus.

1. Only two places with dark lines on subcosta and radius........................ 2.
   Four or more places with dark lines on subcosta and radius................ 3.
2. An amber streak reaching towards wing tip somewhat behind radial sector; apical costal area with two or three oblique brown marks; bulla very large; venation of forewing almost wholly pale; hairs on costal crossveins pale, but little longer than width of cell; fifteen to seventeen radial crossveins before stigma.......................... *formosus.*
   No such amber or brown streaks; many crossveins dark brown; pronotum with four brown spots, as also on mesonotum; some erect hairs on costal crossveins are black and equal the width of two cells; only twelve radial crossveins .... *proximus.*
3. Forewing with amber or golden bands, two across wing and one or two longitudinal towards tip; fourteen radial crossveins before stigma. *inquinatus.*
   Forewing without such amber marks; usually twelve radial crossveins before stigma .... 4.
4. Four pairs of black lines on subcosta and radius, and a narrow black line between; marginal forks practically wholly pale; many crossveins wholly dark, no veins dotted with dark, bulla small; first anal crossvein scarcely oblique .... *alticolus.*
   Five or six pairs of black lines on subcosta and radius, longitudinal or other veins marked with brown or dotted; first anal crossvein plainly oblique .... 5.
5. No interlineal lines between subcosta and radius; first crossvein from median to radial sector ends on first branch of radial sector.. *modestus.*

Interlineal lines between subcosta and radius, sometimes interrupted with snow white; first crossvein from median to radial sector at or before origin of first branch of sector.. *apoanus.*

SPILOSMYLUS INQUINATUS McLachl.

Specimens from Luzon and Samar. The amber marks on the wings are characteristic; *S. lineatus* Navas, 1912, and *S. nephelius* Navas, 1926, agree in their descriptions with *S. inquinatus.*

SPILOSMYLUS FORMOSUS Banks.

Only the type, from Surigao, Mindanao.

SPILOSMYLUS MODESTUS Gerst.

One from "Philippines, Thorey," Hagen collection, others from Sandakan, northern Borneo. Extremely close to *S. tuberculatus* Walker; I find about the only difference is that in *S. modestus* there are more crossveins in the middle of the wing that are wholly white than in the two *tuberculatus* that I have from the Malay Peninsula.

SPILOSMYLUS PROXIMUS sp. nov.

Yellowish; face with faint dark spots below antennæ and on clypeus, vertex slightly darkened, antennæ pale; pronotum pale, a pair of dark spots in front part, and more elongate ones in hind part; four rounded dark spots on mesonotum and on anterior and lateral lobes; pleura and legs pale, tibiæ unmarked; abdomen faintly brownish. Forewings pale, a small dark cloud near middle of hind border; venation mostly very pale, costals unmarked, longitudinal veins scarcely at all dark, many crossveins in middle of wing wholly dark. Subcosta and radius with dark lines in only two places, the first near middle of wing, no line between these veins, and this space scarcely yellowish. Many of the hairs on costal crossveins, especially towards base, extremely long, erect, and black.

Hind wings with venation almost wholly pale.

Forewing with first crossvein from median to radial sector much before first branch of radial sector; twelve radial crossveins before stigma, twelve cubital crossveins, eleven branches of radial sector.

Forewing, length, 19 mm; width, 7.

MINDANAO, Davao Province, Galog River, altitude 6,000 feet, October 22 (*Clagg*). Type, M. C. Z. No. 20201.

SPILOSMYLUS ALTICOLUS sp. nov.

Head pale, face polished, without distinct marks; antennæ pale yellow, as also pronotum, latter with a black spot on each side in front and behind, meso- and metanotum pale, unmarked, as likewise pleura; legs pale, unmarked; abdomen rather darker near tip.

Forewings hyaline; most veins pale, none dotted with dark; subcosta and radius with four pairs of black lines, and a narrow black line in membrane between, this space scarcely yellowish; costals wholly pale, many other crossveins dark, and branches of radial sector often partly dark; outer marginal forks pale, but a faint brown cloud parallel to outer margin, a little way back from it; bulla small, with two submedian dark lines, and a spot each side. Hind wings almost wholly pale, but the outer two rows of gradates dark, as also some streaks on radius and subcosta. Forewing with twelve radials, before stigma, twelve cubital crossveins, ten branches to radial sector, and first anal crossvein scarcely oblique (in most species very plainly so).

Forewing, length, 16 mm; width, 6.

MINDANAO, Davao Province, Mount Apo, Sibulan River, altitude 7,000 to 8,000 feet, September 6 (*Clagg*). Type, M. C. Z. No. 20202.

SPILOSMYLUS APOANUS sp. nov.

Head yellowish, polished, a faint dark mark on middle of lower face; antennæ pale yellowish; pronotum also yellowish and without definite marks, meso- and metanotum as well as pleura pale, unmarked; abdomen scarcely darker near tip; legs pale, faint marks on front and midtibiæ. Wings hyaline, veins pale, but often dotted with brown or with brown streaks, many crossveins through middle area of wing wholly dark brown and slightly bordered, the next to last median crossvein very broadly bordered, forming a prominent spot. Five pairs of streaks on radius and subcosta, the space between plainly yellowish, with a dark stripe between each pair of streaks, in some places that space hyaline white and the dark streak broken in the middle to form two exclamation marks. Bulla very similar to that of *S. modestus* and with a faint brown cloud above it; outer marginal forks mostly brown; usually a few small clouds of brown in apical gradates dark, and most other veins marked or dotted with brown. Forewings with twelve radial crossveins before stigma, one beyond, ten branches of radial sector, eleven or twelve cubital crossveins, first anal crossvein very oblique; first median crossvein to radial sector ends on the sector at or before the working of sector.

Forewing, length, 17 mm; width, 6.

MINDANAO, Davao Province, Seliban River, altitude 7,000 feet, September 3; Galog River, altitude 6,000 feet, September 8 and 12; both on Mount Apo (*Clagg*). Type, M. C. Z. No. 20203.

Three females (?) without bulla, from Seliban River, Galog River, and Tia Ridge, apparently belong with the specimens cited above; they are similar in markings, but the veins are more dotted and with fewer brown streaks; the subcosta and radius show a few dark streaks, and in some places an intermediate dark line. This species closely resembles *S. modestus;* but the dark streaks between radius and subcosta, and the first median crossvein ending before the fork, as well as the lack of pronotal marks, separate it.

CONIOPTERYGIDÆ

PARASEMIDALIS TAGALICA sp. nov. Plate 2, fig. 15.

Head yellowish, antennæ blackish brown, thorax above pale, with a large rounded brown spot on each lateral lobe of mesonotum, pleura and legs pale; wings an even gray color, unmarked. Antennæ of male very heavy, joints in basal part more than twice as broad as long. Forewing with crossvein from radial sector to radius well out on the fork; crossvein from cubitus to medius ending on medius nearly its length before the fork. Hind wing with crossvein from radius to sector out on the fork, no distinct crossvein from radial sector to medius.

Length, 1.8 mm.

MINDANAO, Davao Province, Calian, June 20; Lawa, May 5 (*Clagg*). Type, M. C. Z. No. 20210.

HELICOCONIS NOTATA Navas.

MINDANAO, Davao Province, Mount Apo, Seliban and Mainit Rivers, altitude 6,000 to 8,000 feet, September 8 to 10 (*Clagg*). LUZON, Mount Banahao.

SPILOCONIS INTERRUPTA sp. nov. Plate 2, fig. 14.

Face yellowish, dull; palpi dark; vertex pale, very much elevated, fully twice as broad as long, truncate in front, anterior corners rounded. Basal joint of antennæ and the next two yellowish, then eight joints blackish, then two yellowish, then five blackish, the rest pale. Notum and pleura brown, legs pale. Wings of an even gray color, no spots, radial sector and apical crossveins narrowly margined with hyaline; base of radial sector and crossvein back to medius wholly hyaline; medius with a small swelling a little before, and another about equally far beyond, the crossvein; median and cubital crossveins interstitial, the three apical crossveins also forming a straight line across; radius near the base much bent.

Length, 2 mm.

MINDANAO, Davao Province, Mount Apo, Batraeyon, altitude 8,000 feet, September 14 (*Clagg*). Type, M. C. Z. No. 20211.

SERICOSTOMATIDÆ

GŒRA DISPARILIS sp. nov. Plate 5, fig. 44.

Head with yellowish hair, maxillary palpi with dark, white-tipped hairs; basal joints of antennæ pale, beyond brown and towards tip nearly black; most of the hairs on basal joint of antenna and on upper side of thorax dark with white tips; similar hairs on veins of forewings, particularly the costa, here some with the basal part plainly thickened, the fringe of similar black hairs, but usually without white tips; membrane of forewing, which is brownish, clothed with short golden hairs; hind wing gray to mostly black hair, fringe black; legs rather yellowish, tarsi darker, spurs black; abdomen dark brown. Venation of forewing normal (much as in *G. conclusa*), fork 1 going back almost halfway on discal cell. Hind wings with apical cells very long and slender, discal cell also very long, fork 2 reaching almost halfway to base of wing, fork 3 reaching back almost as far as fork 1. Female with hind tibiæ more curved even than in male, and in both a few of the short yellow spines of tarsi on the apical part of tibiæ.

Male genitalia on the plan of *G. impar* Ulmer, a pair of long, median, smooth, dark pieces close together, with blunt (not acute) tips, basad of these a pair of 2-jointed hairy flaps (*impar* shows only the apical joint), outside a very bristly lateral piece, longer than in *G. impar;* beneath, the lower plates show no inner, lobelike, hairy extension like that in *G. impar,* and the long, smooth, pear-shaped appendages with tapering tips reach almost as far out as the superior median pieces.

Sixth ventral segment with only three (five in *impar*) spines, the median one longer and, though enlarged at tip, the tip slightly bilobed.

Forewing, length, 9 mm.

MINDANAO, Davao Province, Mount Apo, Batraeyon, altitude 8,000 feet, September 14, and Sibulan River, altitude 2,000 feet, November 13 (*Clagg*). Type, M. C. Z. No. 22048.

GŒRINELLA APOANA sp. nov. Plate 5, figs. 49 and 51.

Brown, thoracic notum sometimes slightly yellowish, wings brown, costal area of forewings heavily black-haired; basal joint of antenna dark brown, beyond very pale; legs yellowish, spurs brown. Basal joint of antenna as long as head width, plainly a little bowed outward, densely clothed on inner side with short black hair, elsewhere with longer brown hairs; palpi at tip with dense short hair. Forewings with discal cell about as long as its pedicel; fork 1 only a little way back on discal cell, fork 2 as far back as 1, fork 3 rather broad at base, not as far back as base of discal cell; lower branch of cubitus at the crossvein bending down and uniting with anal for a short distance.

Lateral male appendages rather heavy, upcurved, inner tip with an elongate lobe or process, on outer tip a stiff tuft of dense black hair, so that the appendage appears bifid; superior appendages slender and forked, but from above the forking scarcely visible.

Female similar to male; basal antennal joint about as long as in male, but not bowed, and with much long hair; forewings with discal cell almost equal to its pedicel; forks 1 and 2 as in the male, fork 3 also just as long as fork 2, fork 5 not reaching back to the crossvein; second anal vein bending down before its end so that it almost touches the hind margin.

Expanse, 16 to 17 mm.

MINDANAO, Davao Province, Mainit River, altitude 6,000 feet, September and October; Galog River, altitude 6,000 feet, September 1 to November 8; and Sibulan River, altitude 7,000 to 8,000 feet, September 6; all on Mount Apo (*Clagg*). Type, M. C. Z. No. 22049.

GŒRINELLA BICOLOR sp. nov. Plate 5, fig. 45.

Head and thorax yellowish, abdomen and wings brown, antennæ dark brown, apical part almost black, legs yellowish, darker towards tips, hind tibia broadly dark in the middle. Basal joint of antenna longer than width of head, straight, densely long-haired all around. Vertex with partly yellowish hair from the warts, thorax with mostly gray hair, on sides some yellowish.

Forewing with discal cell extremely long and slender, much longer than its pedicel, fork 1 reaching back on discal cell much more than width of cell, fork 2 reaching back on discal cell nearly width of cell, fork 3 arising plainly before fork 2, fork 5 reaching back to crossvein; apical cells all very long and narrow.

Expanse, 24 mm.

MINDANAO, Davao Province, La Lun Mountains, July 4 (*Clagg*). Type, M. C. Z. No. 22050.

CALAMOCERATIDÆ

ANISOCENTROPUS NITIDUS sp. nov. Plate 5, figs. 46, 50, and 52.

Head yellowish to gray, a tuft of yellowish hair inward from each eye and below antenna, some yellowish hairs on vertex; antennæ with basal joint pale, then brownish, especially above, for six to eight joints and gradually becoming pale, and below snow white for most of length. Thorax yellowish, rather brown in middle above, shining; legs pale, hind legs more gray to brown, the apical half of tarsi snow white, tibia and basal part of tarsus with long fringe, spurs scarcely darker than legs. Maxillary palpi with yellowish gray to almost brown hair, some short hairs nearly black; first and second joints subequal, third almost twice as long as second, fifth as long as third, fourth and sixth subequal, and each about two-thirds of fifth.

Forewings almost uniform brown, shining, sparsely clothed with short black hairs, denser towards the tip, the fringe here black, costal area slightly darker than elsewhere, veins a little darker than wing; hind wings gray, with gray hair.

Forewing slenderer than in most species; radius runs out parallel to subcosta till near tip where it forks, continuous curve running into costa, branch running into first apical sector. A crossvein from subcosta to radius above middle of discal cell, latter moderately slender; fork 1 back on discal cell hardly its width, fork 2 a still shorter distance on discal cell, fork 3 going a little before the radio-median crossvein, and the same distance before median crossvein, fork 4 hardly reaches crossvein and fork 5 to just a little before crossvein. Hind wing with fork 1 very long and slender, forks 2 and 3 much shorter and subequal, fork 5 about as long as 3, but much wider throughout, crossvein back to medius very oblique.

Male genitalia with a pair of slender superior appendages, tipped with long stiff hairs, a smooth, reddish, lateral spine shorter than superior appendage, and a pair of lower appendages, also shorter than the superior pair, and with extremely long hairs from near tip.

Forewing, length, 10 to 12 mm.

MINDANAO, Davao Province, Mainit River, altitude 6,000 to 6,500 feet, September 14, 22, and 24, October 23 and 24; Galog River, altitude 6,000 feet, September 26 and November 6; Sibulan River, altitude 8,000 feet, September 6; all on Mount Apo (*Clagg*). Many specimens. Type, M. C. Z. No. 22052.

This species resembles *Ganomena pallicorne* McLachlan, but is much smaller.

LEPTOCERIDÆ

Key to the Philippine species of Œcetis.

1. In hind wing the crossvein runs to medius before forking of medius.... 2.
   In hind wing the crossvein connects the forks.... 4.
2. Antennæ of male thickened on the basal part; size moderate. *crassicornis*.
   Antennæ of male not thickened; very small species.... 3.
3. In forewing besides the hairs there are black broad-tipped scales along the veins; fork 4 does not reach the crossvein, crossvein from radial sector to medius before end of discal cell.... *apicipennis*.
   In forewing no such scales; fork 4 reaches the crossvein, crossvein from radial sector to medius just beyond end of discal cell.... *claggi*.
4. Anastomosis in one transverse line; fork 4 hardly reaches crossvein; fringe extremely long .... *pilosa*.
   Anastomosis widely disjointed; fork 4 goes back before crossvein; fringe moderate .... *separata*.

Œcetis apicipennis Banks was described as a *Setodes;* it is very similar to *Œcetina angusta* Banks, of Borneo; both have the peculiar black scales; these and some of the others will doubtless constitute new genera some day.

ŒCETIS CLAGGI sp. nov. Plate 6, fig. 56.

Head, legs, and antennæ pale yellowish, almost white, latter annulate with brown; thorax and abdomen more rufous. Forewings nearly clear, crossveins brown; membrane and veins and margin with many long pale hairs; hind wings pale, with pale hair and fringes.

Forewings very slender, front and hind margin nearly parallel, discal cell extremely long and slender, fork 1 back scarcely a bit on discal cell, fork 4 reaching scarcely before crossvein; crossvein at end of discal cell a little before crossvein to medius, crossvein from medius to fork 4 a considerable distance before the others, branch of cubitus still farther before the last crossvein; anal vein running out a long distance beyond this branch close and parallel to the hind margin. Hind wings with crossvein ending long before fork of medius, fork 3 no longer than its pedicel; work 5 fairly long.

Male genitalia with a pair of large elliptical plates above, covered with short white hair, arising from below a pair of long upcurved slender spines.

Forewing, length, 4.5 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 26 (*Clagg*). Type, M. C. Z. No. 22055.

ŒCETIS SEPARATA sp. nov. Plate 6, figs. 57 and 59.

Pale yellowish; white hair on head and thorax above, abdomen white till near yellowish tip; antennæ, palpi, and legs pale yellowish, antennæ narrowly annulate with brown, very slender (not as in *Œcetodella*). Wings faintly grayish, with long fine gray to yellowish hair, very long on veins, fringe mostly pale, some brown patches along outer side, fringe beyond ends of anal veins very long and bright yellow; veins gray, over most of the forkings brown spots, one at end of anals, and one on subcosta at about middle of discal cell, crossveins brown, no spots at ends of apical veins; hind wings nearly hyaline, with yellowish gray hair and fringe.

Forewings with the anastomosis much disjointed, the radiomedian crossvein long before the end of discal cell, median crossvein about halfway between them, discal cell longer than second apical vein, fork 1 back on discal cell about width of the cell. Hind wings with crossvein connecting forks as in *Œcetodella*.

Genitalia somewhat on the plan of *Œ. scutata* Ulmer, from Sumatra, but parts slenderer; lower appendages curving up nearly twice as far as in that species; median superior piece elongate, widened near middle, then narrowed a bit before the scarcely rounded tip; superior lateral appendages projecting from each side of median piece and longer than it, almost touching the end of lower appendages.

Forewing, length, 7 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 29 (*Clagg*). Type, M. C. Z. No. 22056.

ŒCETIS PILOSA sp. nov. Plate 6, fig. 58.

Pale yellowish, antennæ with tips of joints dark, male antennæ not swollen on basal part, thorax and tips of abdomen slightly reddish brown. Forewings faintly gray, with extremely long dark hairs on veins and along margins, posterior fringe more than one-half the width of wing; along outer half of costa the hairs very dense, making a brown streak, among the bases of these hairs are shorter ones, some of them snow white, and also some iridescent scales; between the veins are very few hairs, mostly towards base; at anastomosis three tufts of black hair, another at base of fork 1 on upper edge of discal cell, a patch of dark brown hair at end of anal vein, three or four apical veins brown at tips; hind wings with brown hair on veins and along margin, the fringe behind in places longer than width of wing.

Forewing with discal cell much longer than its pedicel, fork 1 back on discal cell a little more than cell width, fork 4 not quite reaching to crossvein; crossveins of anastomosis nearly on a transverse line, and slightly brown. In hind wing the crossvein connecting the forks, fully twice its length from base of forks, the forks subequal in length, fork 5 rather short. Male genitalia show above at base a broad membranous plate, bent down on sides, tip broadly trilobed, lateral lobes ending in a dark knob, median lobe broad; ventral appendages hardly noticeable from side, moderately slender, tips slenderer, in one view with a deep inner emargination and an apical rounded lobe; two intermediate processes very slender, reddish.

Forewing, length, 7 mm.

LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 22057.

TRIÆNODES BOETTCHERI Ulmer.

MINDANAO, Davao Province, Mount Apo, September to November.

Besides the row of black spots across the apical field, there are several black tufts on the anastomosis, and one near hind margin about halfway to end of anal vein.

SETODES FLAVIPENNIS sp. nov. Plate 6, figs. 60 and 62.

Pale yellowish; face, vertex, and thorax with white hair; forewings with rather bright yellowish hair, faintly annulate with brown in apical part; apical fringe yellowish, but a little brownish near extreme apex; hind wings hyaline, with long, white posterior fringe; legs yellowish; abdomen brown, with brown to greenish venter. In hind wings fork 1 small, but distinct, fork 3 a little shorter than pedicel, fork 5 large, a little before forking of median. In forewing pedicel of fork 1 fully one-third of fork, fork 3 a little before fork 1.

Male genitalia with upper appendages long and slender, but close together at base, inferior appendages with an erect bristly process above, and a smaller, more pointed one just beyond it. Penis with two divergent lobes at tip, seen from side there are two spines, the intermediate processes extremely slender.

Length, 5 mm.

NEGROS, Occidental Negros Province, Victorias, October 21, 1927, and November 1, 1927, at light (*W. D. Pierce*). Type in the United States National Museum; paratype, M. C. Z. No. 22053.

This species is evidently related to *S. spinosella* Ulmer, but the genital parts differ.

ALLOSETODES ASSIMILIS sp. nov. Plate 6, figs. 61 and 64.

Head with gray hair below, yellowish on vertex; antennæ pale, very plainly annulate with brown; palpi with brown hair, legs pale, tibiæ and tarsi brown. Forewings largely black, more uniformly so than in *A. plutonis,* with long black hair and small iridescent scales which appear golden in certain views; fringe black; hind wings dark, with black hair, and brown to black fringes. Forewing with discal cell much longer than its pedicel, fork 1 but little more than one-half its pedicel, fork 2 truncate at its base, third apical vein arising from near middle of end of discal cell, fourth and fifth apical cells also truncate at base, the branch of cubitus running into the anal vein which here almost touches the margin; in hind wings, which are very slender and pointed at tip, fork 1 very short, fork 2 nearly halfway to base of wings, with a short pedicel, median vein about opposite base of discal cell stopping and running no farther basad.

Male genitalia very similar to those of *A. plutonis;* with three slender pieces at base above, the median one forked at tip and hairy only at tip, side pieces shorter, with long bristles; below this is the long, down-curved, smooth median piece, somewhat shorter than in *A. plutonis;* below are the ventral appendages, from the side the basal part is thick, though at one place much constricted, and bears above near its base a slender upward projection tipped by a very long bristle (not seen in *A. plutonis*).

Forewing, 5 to 5.5 mm.

MINDANAO, Davao Province, Sibulan River, altitude 7,000 to 8,000 feet, August 31; Todaya Plateau, altitude 5,000 feet, September 12; Galog River, altitude 6,000 feet, September 26; all on Mount Apo (*Clagg*); Mount Mayo, altitude 4,000 to 5,000 feet, January 28 (*Clagg*). Type, M. C. Z. No. 22054.

When I described this genus (1931) I figured the venation of a denuded wing which proved to be abnormal; I have denuded another wing of *A. plutonis* and find it similar to that of *assimilis,* here figured, and much like that of *Triænodes.* The anal vein, however, runs in the apical part so close to the hind margin as almost to touch it, and in *A. plutonis* the anal vein runs out at the end of the branch from the cubitus. In *A. plutonis* fork 2 is not so broad at base as in this species and not one-half as broad as the second apical cell; the hind wings are slenderer and more pointed than in *Triænodes*, thus the name may be retained, at least as a subgenus.

HYDROPSYCHIDÆ

HYDROPSYCHE FORCIPATA Ulmer. Plate 3, fig. 31.

What I take to be this species is common on Mount Apo up to 6,000 feet, and in other parts of Mindanao. The apical part of the claspers is as Ulmer figures them, the tip of the superior appendage has the pair of slender caliperlike pieces; in all my specimens there is a distinct swelling below the base of these processes not shown by Ulmer. The penis has the apical part as Ulmer figures it, but before this there is a flat process with a pair of teeth above at base, and each lateral part with two sharp teeth directed backward. However, I think there is no doubt about the identification; all my specimens are dry.

HYDROPSYCHE RIZALI sp. nov. Plate 4, figs. 39 and 41.

Head densely clothed with yellowish hair; thorax above with appressed yellowish hair; antennæ yellowish, narrowly banded with brown; palpi and legs pale yellowish, also spurs. Forewings yellowish, densely transversely marmorate with brown, apical fringe black in patches; hind wings pale. Discal cell about two and one-half times as long as broad; fork 1 with a pedicel one-half of discal cell, fork 2 black on discal cell less than width, fork 3 back as far as the dot of fork 2, forks 4 and 5 as far back as base of discal cell.

Hind wings with fork 1 plainly shorter than its pedicel, fork 2 back on discal cell more than one-half length of cell. Male genitalia somewhat similar to those of *H. forcipata*, apical parts of superior appendage not curved out, but from side suddenly bend downward, apical part of claspers not as sinuous as in *H. forcipata*, penis with an elongate flap each side of tip similar to that of *H. forcipata*, but not nearly as large, tip with two sharp teeth, a pair of scabrous, elongate processes directed backward.

Forewing, length, male, 11 mm; female, 14.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 26 (*Clagg*). Type, M. C. Z. No. 22066.

Its size and appearance are those of *H. faurei* Navas, of which I have a female from Haight's Place, Mountain Province, Luzon; but the male genitalia (as figured by Navas) are very different; the terminal parts of the females also differ somewhat.

Key to the Philippine species of Hydropsychodes.

1. Wings yellowish, more or less marmorate with brown .... 3.
   Wings black, with white spots or bands .... 2.
2. With four or five narrow white bands on forewings, one of them subapical, one basal .... *albocincta.*
   With several large, mostly costal, and numerous other small pale spots, none in apical area .... *costalis.*
3. Apical part of clasper widened towards tip, and excised on outer side. *excisa.*
   Apical part of clasper tapering .... 4.
4. Apical part of clasper short, thick at base, pointed at tip .... *masi.*
   Apical part of clasper slender throughout .... *normalis.*

HYDROPSYCHODES NORMALIS sp. nov. Plate 4, fig. 40.

Head and thorax above with pale yellowish gray hair; antennæ pale, annulate with brown; palpi, legs, and spurs pale yellowish. Forewings yellowish, densely speckled and marmorate with brown, often, towards tip especially, quite dark, much darker than in *H. masi*, sometimes as in that species with dark patches near ends of veins; hind wings yellowish gray.

Forewings with discal cell fully two and one-half times as long as broad, fork 1 with pedicel two-thirds of fork, fork 2 only a very short distance back on discal cell, fork 3 hardly reaching the dot of fork 2, forks 4 and 5 start about opposite crossvein from medius to radial sector. In hind wing fork 2 goes back on discal cell about width of latter. Male claspers very slender, the apical part also very slender; superior appendage broad and nearly truncate at tip, with a lobe below each corner; penis slender, enlarged at tip in two lobes with point downward.

Forewing, length, 6 mm.

MINDANAO, Davao Province, Libby, December 9 (*Clagg*); many specimens. Type, M. C. Z. No. 22063.

Readily separated from *H. masi* by the slender apical part of claspers.

HYDROPSYCHODES ALBOCINCTA sp. nov. Plate 4, fig. 43.

Head black, white hair on face, vertex with long, nearly black hair; antennæ pale, annulate with brown; palpi dark brown; thorax dark, with mostly dark hair, some white on pronotum;

legs with dark femora and tibiæ, usually pale on base of tibiæ, tarsi partly pale, with some dark spaces.

Forewings black, with five white bands, one over the base, a second before end of basal third, forked behind, one over base of discal cell, one from stigmal region not reaching across, and one subapical, slightly curved, and also not reaching across; hind wings wholly dark.

Forewing with discal cell hardly two and one-half times as long as broad, fork 1 with a very short pedicel, fork 2 only a trifle back on discal cell, fork 3 not reaching opposite the dot of fork 2, forks 4 and 5 about opposite middle of discal cell; hind wings with fork 2 back on discal cell not width of latter.

Male genitalia with claspers slender, the apical part especially so, tip sharp and incurved, superior appendage broad, nearly truncate at tip, with a rounded projection at each corner; penis similar to others, with two lobes at tip, more separated than usual.

Forewing, length, 5.5 to 6 mm.

MINDANAO, Davao Province, Lawa, Mount Apo, Galog, Mainit, and Seliban Rivers, September 17 to November 4 (*Clagg*). Type, M. C. Z. No. 22064.

HYDROPSYCHODES MASI Navas.

I have a paratype; it has the apical part of the clasper short and stout at base as figured by Ulmer for *H. marmorata,* based on a female. If Ulmer's identification is correct, *H. marmorata* is the female of *H. masi.*

Key to the Philippine species of Diplectrona.

1. With more than one white band on forewing .... 2.
   With but one or no white band on wings .... 4.
2. The two median dark bands with a golden center; third band much wider than second .... *exquisita.*
   Median dark bands without a golden center; the third, or stigmal, band but little, if at all, wider than second .... 3.
3. Forewing all black, except three white bands, the third entire. *trifasciata.*
   Forewing yellowish except along costa and the apical area, third band broken .... *tricolor.*
4. Wings wholly dark, no pale band .... 7.
   Wings with pale median band, or almost wholly pale .... 5.
5. Head and thorax dark; wings dark, with a pale median band. *cinctipennis.*
   Head and thorax yellowish, with yellow hair .... 6.

6. Forewing fairly dark, with a distinct median pale band............ *fasciata.*
 Forewing mostly pale yellowish, with a black streak over stigmal area, pale band indistinct .... var. *stigmatica.*
7. Forewing 8 mm long; male claspers scabrous beneath................ *scabrosa.*
 Forewing 5 mm long; male claspers not scabrous beneath............ *bidens.*

DIPLECTRONA SCABROSA sp. nov. Plate 4, fig. 38.

Head black, front shining, some dark hair below and on vertex; antennæ and palpi black, latter paler near tip; pronotal lobes yellowish and with yellowish hair, rest of thorax black, lobes in front of wings yellowish; legs yellowish, tarsi dark, as also spurs; abdomen brown.

Wings entirely blackish, clothed with short black hair, upper base of median cell and first anal vein towards base very narrowly margined with hyaline, a hyaline dot over end of anal vein; hind wings as dark as the forewings. Hind wing with the venation much like that of *fasciata,* fork 5 widened near base as in that species; forewing with the crossvein back from base of median fork widely disjointed at the cubitus.

Male appendages with basal part of claspers very much roughened below and with stiff hairs, apical portion of clasper very slender and pointed; superior processes with tips sharp and outcurved.

MINDANAO, Mount Apo, Sibulan River, altitude 700 to 800 feet, September 6 (*Clagg*). Type, M. C. Z. No. 22059.

I have a female *Diplectrona* from Mount Maquiling, Luzon, which may be *D. bidens* Ulmer. It is wholly dark and of the right size, the legs yellow brown, tarsi paler. The crossvein back from base of median fork is continuous as usual; fork 5 of hind wing hardly widened near base.

DIPLECTRONA FASCIATA var. STIGMATICA var. nov. Plate 5, fig. 48.

Specimens from Mount Apo are larger and very much paler than the typical *fasciata;* wing not darkened except for a prominent long dark streak over stigmal region; white band present, but scarcely noticeable on account of pale yellowish background; yellowish cast on base of forewing of typical *fasciata* here extending out to the white band; hind wing with a slender, curved, dark streak over and behind the union of subcosta and radius. Head and thorax yellowish.

Male genitalia very similar to those of *fasciata,* the superior processes not curving outward as much as in *fasciata,* tip of penis, in side view, showing a slender, curved prong above, which I cannot find in *fasciata.*

Expanse, 18 to 21 mm.

MINDANAO, Davao Province, Mount Apo, Mainit River, altitude 6,000 feet, September 7, 10, 14, and 22, October 21; Galog River, altitude 6,000 feet, October 23, November 4 (*Clagg*): Zamboanga (*Clark*). LUZON, Mountain Province, Baguio (*Baker*). Type, M. C. Z. No. 22061.

DIPLECTRONA TRICOLOR sp. nov. Plate 4, fig. 37.

Face yellowish, front dark, vertex mostly pale and with yellowish hair, palpi brown, antennæ with basal part pale, then gradually marked with brown until almost wholly brown; thorax yellowish, with yellowish hair; legs pale yellowish, front tarsi and spurs darker; abdomen brown above, pale beneath, appendages pale. Forewings with three white bands and a part of a fourth near base, apical band interrupted, upper portion with a projection towards tip of wing where there is a white spot along the margin; veins with black hairs, general surface with appressed yellowish hair, along the costal border and in most of the apical area densely covered with dark brown hair, costal parts shading behind into pale, a pale streak in the interruption of apical band; the three white bands fairly narrow and subequal.

Hind wings pale, with mostly scattered dark hair, the apical part dark brown, here a large white spot opposite the subapical band of forewings. Venation of hind wings very similar to that of *fasciata*, but fork 5 scarcely, if at all, wider near base, and thus not approaching the vein in front as closely as in *fasciata*. Forewings with crossveins extremely faint, that closing the median cell most distinct, that from the base of the median fork back across cubitus not visible; discal cell rather slenderer than in *fasciata*.

Male appendages with apical part of claspers very slender; superior processes with apical point sharp and much outcurved.

Expanse, 20 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 3,000 to 4,000 feet, January 28 (*Clagg*). Type, M. C. Z. No. 22058.

DIPLECTRONA EXQUISITA sp. nov. Plate 4, fig. 35.

Head black, with snow-white hair, palpi dark brown, antennæ with basal joint pale, beyond dark brown for about fifteen joints, beyond white; thorax brown, pronotum with white hair; legs brown, tips of front femora pale, front and midtibiæ with appressed white hair on outer side, mid- and hind tarsi white on basal half, upper spurs partly white, apical spurs brown; abdomen dark brown.

Forewings with three white bands, between them, and towards base, and the apical part brown; the two submedian brown bands contain a band of golden hair; first white band much wider behind than in front, second white band narrower than first, a little wider in front than behind, third white band about twice as broad as second, narrowly interrupted in middle by brown along a vein, behind not quite reaching hind margin; near tip of wing three small white spots between veins, and trace of a fourth. Hind wings fumose, brown in apical and costal parts, here a large white spot opposite the third white band of forewing, a white costal streak opposite the middle white band of forewing.

Hind wings with venation similar to that of *fasciata,* but fork 5 is not widened near base. Forewings also with venation similar to that of *fasciata,* all the forks rather more elongate than in that species. Male appendages with claspers much as in *fasciata,* the apical part with blunt tip, the basal part with tawny hair below; superior processes with a slender, sharp, outturned tip.

Expanse, 14 mm.

LUZON, Laguna Province, Mount Maquiling (*Baker*). Type, M. C. Z. No. 22060.

TINODES TAGALICA sp. nov. Plate 3, fig. 30.

Black; head with some white hair in front and between the antennæ, darker hair on vertex; palpi dark, especially the large joints; antennæ brown, narrowly annulate with pale at tips of joints; legs dark; in male the base of midtibia and the whole of midtarsus white, spurs dark; wings dark, with black hair.

Forewings with discal cell scarcely twice as long as broad at tip, fork 2 back a trifle on the discal cell, fork 3 about two-thirds as long as fork 2, fork 4 about equal in length (but base before) to fork 3, fork 5 reaching back to before base of discal cell. In hind wings fork 2 back to the crossvein to medius, fork 3 with a short pedicel.

Male genitalia with a broad superior basal piece, beneath it a slender, reddish, down-curved piece with a tiny process at tip, on each side the very slender lateral appendages, very hairy, and below a pair of rather heavy elongate pieces with a small projection at lower tip. Female ovipositor upcurved, nearly one-half the length of abdomen.

Forewing, length, 4.5 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 27; Mount Apo, Mainit River, altitude 6,000 feet, September 14; Sibulan River, altitude 2,000 feet, November 13; and Baroring River, altitude 7,000 feet, November 9 (*Clagg*). Type, M. C. Z. No. 22067.

TINODES ADJUNCTA sp. nov. Plate 3, fig. 32.

Head brownish, with yellowish to dark hair; antennæ brownish, annulate with pale; palpi brown; thorax pale in middle, brown on sides; legs pale, spurs brown, tarsi brownish.

Forewings dark, clothed with short golden and black hairs; hind wings gray, with scattered black hairs. In forewings discal cell a little more than twice as long as broad, fork 2 back about one-half cell width on discal, fork 3 a little longer than its pedicel, fork 4 hardly as long as fork 3, fork 5 plainly a little longer than fork 4.

Hind wings with fork 2 back to crossvein, fork 3 back a little before crossvein, fork 5 large and wide. Male genitalia with a broad basal piece above, with a median process, a pair of slender lateral bristly appendages, a broad lower plate, and a broad median reddish piece, down-curved, with a pair of spines before tip and below a pair of recurved spines.

Forewing, length, 5 mm.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 6,000 feet, and Todaya Plateau, altitude 5,000 feet, October 2 (*Clagg*). Type, M. C. Z. No. 22068.

POLYPLECTROPUS GRANDIS sp. nov. Plate 4, fig. 36.

Head clothed with golden hair, some more tawny hair near posterior middle of vertex; pronotum also with tawny hair, also on the sides of mesonotum, but that on middle of mesonotum pale yellowish; antennæ yellowish, each joint rather broadly marked with brown; palpi yellowish, basal joints more brown; legs dull yellowish, femora more brownish, spurs tawny.

Forewing rich brown, quite densely marked with square to rounded pale yellow spots, most of them between the veins, nearly all of them small, but a much larger one near middle of posterior margin; no spots in basal part of fork 2 or in adjoining areas; a few of the spots tend to form bands, but most of them do not; hind wings dark, with blackish hair.

Forewings with fork 1 about as long as its pedicel, fork 2 starting at end of discal cell, fork 3 two-thirds as long as fork

2, fork 4 reaching back a little before median crossvein, fork 5 reaching nearly to base of median cell.

Male genitalia appressed to tip of abdomen so as to be inconspicuous; two long spines subparallel seen from behind, bending downwards, each arising from an elongate plate, the lower part of which is scabrous; ventral pieces jet black and with a spinelike process directed backward from near their tips, seen from above these pieces are very broad and nearly truncate.

Forewing, length, 10 mm.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 8,000 feet, October 18 (*Clagg*). Type, M. C. Z. No. 22069.

POLYPLECTROPUS ULMERI sp. nov. Plate 3, fig. 28.

Head and thorax densely clothed with yellowish hair; antennæ, palpi, and legs yellowish. Forewings brown, with many small, narrow, transverse patches of yellow hair, most numerous beyond the middle and tending to form transverse bands; fringe almost wholly brown; hind wings with blackish hair and fringes.

Venation similar to that of other species; fork 1 shorter than its pedicel, fork 2 starting from the discal cell, fork 3 hardly more than one-half of fork 2, fork 4 scarcely longer than 3, fork 5 very long.

Male genitalia remarkable in having the spinelike processes extremely long and slender, wholly down-curved, and subparallel to each other (much longer than in other species) ; median superior appendage a rather slender spinelike process deeply forked at tip; ventral pieces extremely hairy, rather long and heavy, and separated by their width.

Forewing, length, 5 mm.

LUZON, Laguna Province, Los Baños (*Baker*). Type, M. C. Z. No. 22070.

Genus DOLOCLANES novum

A philopotamine; ocelli present; posterior warts large; spurs, 2, 4, 4; midtibia of female not dilated; palpi with first three joints large, fourth rather more slender, last as long as third and fourth together, much more slender, slightly curved, the apical part appearing as a separate segment.

Discal cell very short, closed (though faintly) in both wings, in forewings above with an oblique crossvein towards radius but not reaching that vein; in forewing forks 1 to 5 present, in hind wings forks 1, 2, 3, and 5, fork 5 in both wings very large and long; in forewings forks 1 and 2 reaching discal cell, in hind wings fork 2 reaching discal cell, fork 1 very short, its upper edge running into radius near end of radius.

Type of the genus, *Doloclanes montana* sp. nov.

Distinct by the very short discal cell with extremely long pedicel, the incomplete crossvein above discal cell, and by the first apical vein of hind wing running into radius.

DOLOCLANES ALTICOLA sp. nov. Plate 3, figs. 25, 27, and 29.

Head dark, clothed with mostly dark hair; palpi brown; antennæ brown, barely annulate with pale; thorax dark, with mostly dark hair, some paler on sides; legs brown, especially front legs and spurs, hind legs more yellowish brown, tibia with long hair. Wings dark, with dark hair, apical fringe black, a hyaline spot over end of discal cell and behind it.

Forewings with discal cell hardly twice as long as broad, fork 1 back on discal cell two-thirds of cell, fork 2 scarcely back on discal cell, fork 3 fully two-thirds of fork 2, but much longer than pedicel, fork 4 fully as long as fork 3, fork 5 extremely long, almost back to forking of medius.

Hind wings with fork 1 shorter than pedicel, its upper vein running into radius fully width of cell before end, fork 2 back to discal cell, very slender, fork 3 hardly more than one-half of fork 2, fork 5 very long.

Male genitalia with two slender pieces above, the lower pieces 2-jointed, basal joint broad and heavy, apical about as long, slender (except base), and with a down-curved tip, between them the intermediate piece, which has a blunt tip and extends scarcely beyond the basal part of lower appendage.

Forewing, length, 4 to 4.3 mm.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 6,000 feet, October 19; and Mainit River, altitude 6,500 feet, October 22 (*Clagg*). Type, M. C. Z. No. 22072.

DOLOCLANES MONTANA sp. nov. Plate 3, fig. 26.

Head yellowish brown, with mostly pale hair, some hairs on each side of vertex dark; palpi pale brown; antennæ pale; thorax with mostly pale hair, some on outer sides of pronotum dark; legs pale, hind tibiæ very hairy. Wings dark, clothed with short black hair and fringes; a faint hyaline mark at end of discal cell and over crossvein behind to medius.

Forewings with discal cell about twice as long as broad, with an extremely long pedicel; fork 1 going back on discal cell less than one-half width of cell, fork 2 back a trifle on discal cell, fork 3 only about one-half as long as fork 2, hardly as long as its pedicel, fork 4 slightly longer than 3, fork 5 reaching back almost to forking of medius.

Hind wings with discal cell also very short, fork 1 short, its upper edge running into the radius as the latter ends, fork 2 back to discal cell, fork 3 not one-half length of 2, pedicel much longer than fork, fork 5 large and long.

Male genitalia with a pair of parallel, subclavate, superior appendages, below a pair of longer, 2-jointed appendages, basal part heavy and broad at base, apical part about two-thirds of basal and more slender, within is a median piece with a slender, upcurved, spinelike tip.

Forewing, length, 5 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 27 (*Clagg*). Type, M. C. Z. No. 22071.

ECNOMUS RIZALI sp. nov. Plate 5, fig. 54; Plate 6, fig. 63.

Head dark, with mostly dark hair, some yellowish between antennæ; antennæ dark, annulate with pale; palpi dark, thorax with yellowish hair through middle, dark on sides; legs yellowish to yellow-brown, tarsi dark, annulate with pale.

Forewings brown, with many, small, scattered patches of golden hair, the larger ones at intervals near hind margin; hind wings gray, with black hair and fringes. Forewings with discal cell a little more than twice as long as broad, fork 1 about as long as its pedicel, longer than fork at end of radius, fork 2 back a trifle on discal cell, fork 3 about twice as long as its pedicel, fork 4 back a trifle on crossvein, fork 5 not as long as fork 4.

Hind wings with fork 2 plainly longer than its pedicel, fork 5 shorter than 2.

Male genitalia from above show two long, slender, slightly curved processes, with the lower appendages heavy and their tips recurved within, from the side the lower appendages have a long basal part, and a slenderer, upcurved, apical part.

Forewing, length, 5 mm.

MINDANAO, Davao Province, Mount Mayo, altitude 4,000 to 5,000 feet, January 27 and 28 (*Clagg*). Type, M. C. Z. No. 22073.

Key to the Philippine species of Chimarrha.

1. Radial sector just before discal cell not bent, discal cell triangular, no bare space before it .... *recta.*
   Radial sector just before discal cell plainly bent, and a smooth space behind and sometimes above it........ 2.

2. Length of forewings less than 4 mm .... 3.
   Length of forewings plainly more than 4 mm .... 4.
3. Crossvein at end of discal cell and one behind it white; antennæ and palpi fulvous .... *leucophlebia.*
   Crossvein not white; antennæ and palpi brown .... *alticola.*
4. Discal cell triangular, base almost pointed; forewings about 6 mm long. *tagalica.*
   Discal cell almost quadrangular, much widened near base; forewings about 5 mm long .... *luzonica.*

CHIMARRHA TAGALICA sp. nov. Plate 5, fig. 53.

Head and thorax yellowish, clothed with pale golden hair; palpi (except pale base) brown; antennæ pale, very narrowly annulate with dark and becoming brownish towards tip; legs pale dull yellowish, front tibiæ and tarsi brown; spurs brown.

Forewings clothed with short yellowish and black hairs producing a uniform dull yellowish color, a large bare space just beyond the forking of radius, fringe dark brown on costa, more gray along hind margin; hind wings gray.

Forewings with radial sector from base to discal cell strongly bent to form the bare cell, and also a smaller, slightly swollen, bare space behind radial sector just before discal cell; discal cell triangular, tip slightly oblique. Forks 1 and 2 sessile on discal cell, fork 3 subequal to its pedicel, fork 5 back as far as base of discal cell. Male genitalia showing two long, straight, hairy, pale inferior appendages, a dark brown, somewhat clavate, lateral appendage, and between these two membranous processes, each tipped by a long, straight black spine.

Forewing, length, 6 mm.

MINDANAO, Davao Province, Mount Apo, Galog River, altitude 6,000 feet, October, 19; Mount Mayo, altitude 4,000 to 5,000 feet, January 26 (*Clagg*). Type, M. C. Z. No. 22075.

CHIMARRHA ALTICOLA sp. nov. Plate 5, fig. 55.

In size, in the shape of discal cell, and the bent radial sector before it, and the short fork 3 this species agrees closely with the figure of *C. leucophlebia* Navas from northern Palawan. The median cell, however, is more elongate, and all apical cells are very much longer, so the discal cell is about twice its length from the tip of wing.

Head dark, hair pale yellowish, but a dark tuft on vertex each side by the eyes; palpi and antennæ dark brown (fulvous in *leucophlebia*); yellowish or fulvous hair on thorax as well as some dark hair.

Wings dark, clothed with black hair, in certain lights showing scattered golden hairs, end of discal cell no paler than other veins (white in *leucophlebia*); fork 1 extends back a little on discal cell, but fork 2 does not, fork 3 much shorter than its pedicel. Hind wings with fork 1 going back a little on discal cell, the latter only about one-half as long as in forewing, fork 3 very short.

Legs pale yellowish, hind tibia and tarsi darker, spurs brown.

Male genitalia with a pair of heavy lower appendages, somewhat bent, tip oblique and faintly concave, tipped with a tapering incurved piece.

MINDANAO, Mount Apo, Sibulan River, altitude 7,000 to 8,000 feet, September 6, Galog River, altitude 6,000 feet, November 4; Mount Mayo, altitude 4,000 to 5,000 feet, January 26 (*Clagg*). Type, M. C. Z. No. 22074.

ILLUSTRATIONS

PLATE 4

FIG. 35. *Diplectrona exquisita* sp. nov.; forewing, genitalia above, clasper, and penis.
36. *Polyplectropus grandis* sp. nov.; genitalia below, and side.
37. *Diplectrona tricolor* sp. nov.; forewing, part of hind wing, genitalia above, and clasper.
38. *Diplectrona scabrosa* sp. nov.; genitalia above, clasper.
39. *Hydropsyche rizali* sp. nov.; genitalia, above.
40. *Hydropsychodes normalis* sp. nov.; genitalia, above.
41. *Hydropsyche rizali* sp. nov.; genitalia, side.
42. *Hydropsychodes normalis* sp. nov.; genitalia, side.
43. *Hydropsychodes albocincta* sp. nov.; forewing.

PLATE 5

FIG. 44. *Gœra disparilis* sp. nov.; genitalia, above, below, clasper.
45. *Gœrinella bicolor* sp. nov.; forewing.
46. *Anisocentropus nitidus* sp. nov.; palpus.
47. *Diplectrona fasciata* Ulmer; lower piece from side.
48. *Diplectrona fasciata* var. *stigmatica* var. nov.; lower piece from side, genitalia from above.
49. *Gœrinella apoana* sp. nov.; genitalia, above.
50. *Anisocentropus nitidus* sp. nov.; genitalia, side.
51. *Gœrinella apoana* sp. nov.; forewings of male and of female.
52. *Anisocentropus nitidus* sp. nov.; forewing.
53. *Chimarrha tagalica* sp. nov.; genitalia, side, and forewing in part.
54. *Ecnomus rizali* sp. nov.; genitalia, above.
55. *Chimarrha alticola* sp. nov.; genitalia, below, and side.

PLATE 6

FIG. 56. *Œcetis claggi* sp. nov.; forewing, genitalia, side.
57. *Œcetis separata* sp. nov.; genitalia, side, and forewing.
58. *Œcetis pilosa* sp. nov.; forewing, genitalia, side, and clasper, below.
59. *Œcetis separata* sp. nov.; genitalia, above.
60. *Setodes flavipennis* sp. nov.; genitalia side, penis above.
61. *Allosetodes assimilis* sp. nov.; forewing.
62. *Setodes flavipennis* sp. nov.; superior appendages from above.
63. *Ecnomus rizali* sp. nov.; genitalia, side.
64. *Allosetodes assimilis* sp. nov.; genitalia, side.

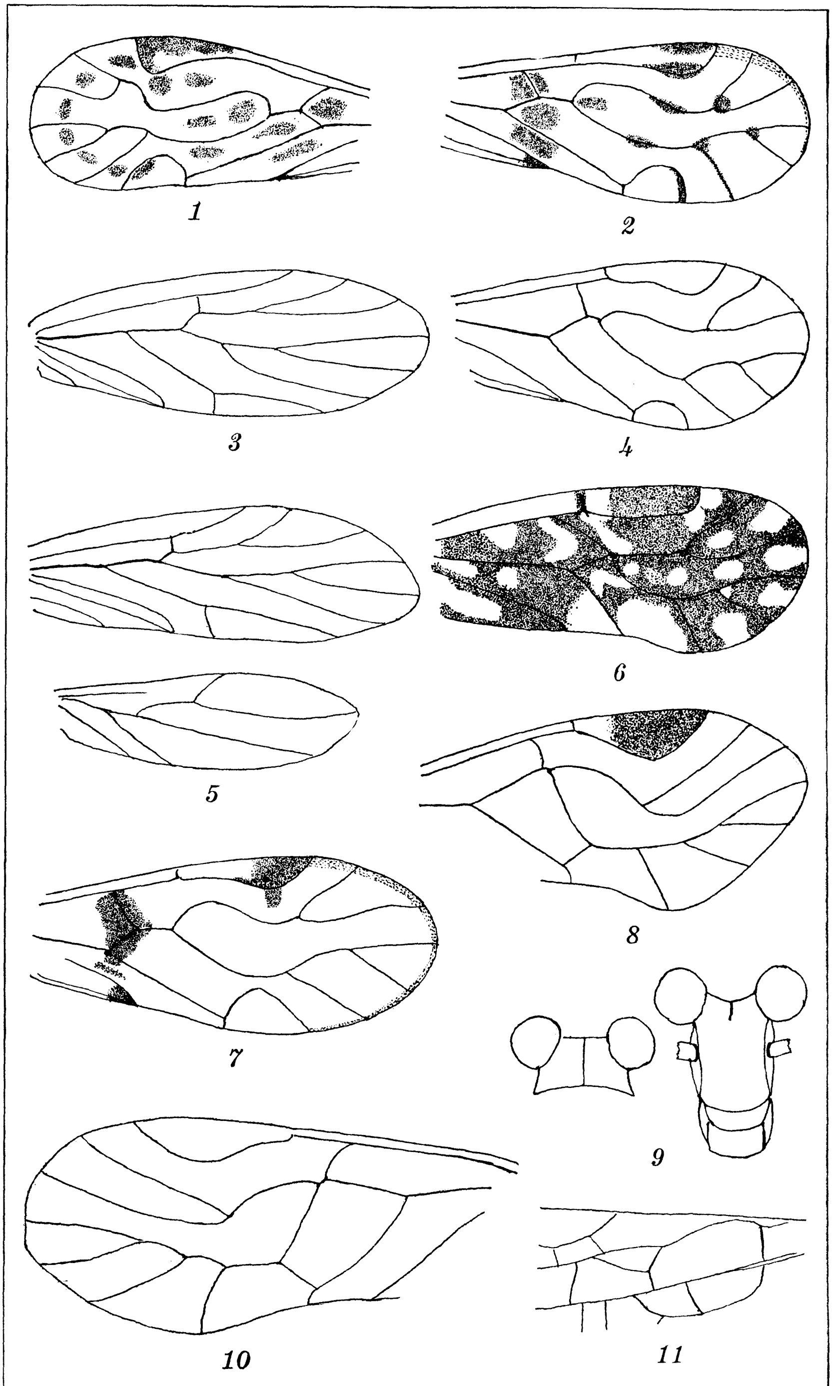
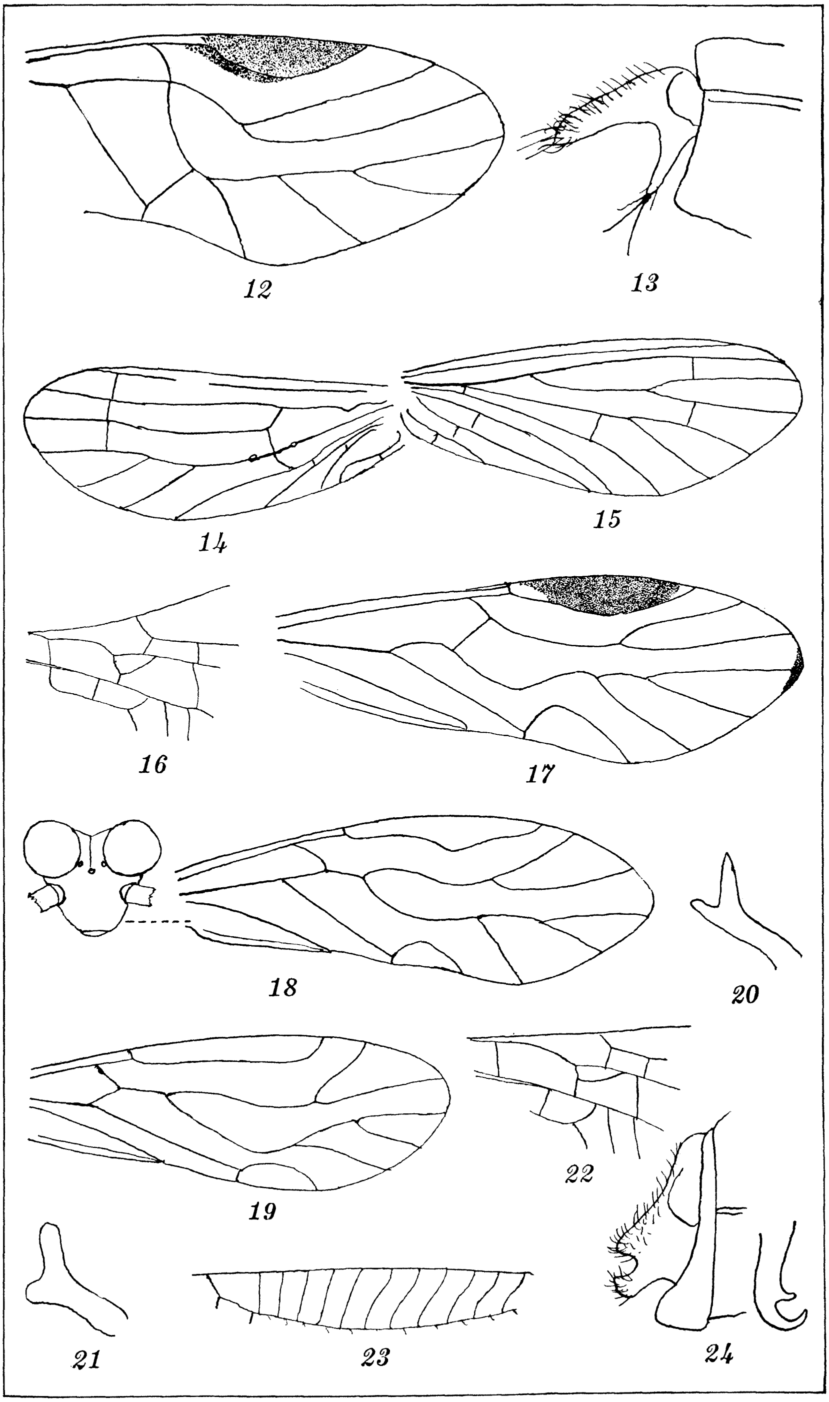


PLATE 1.



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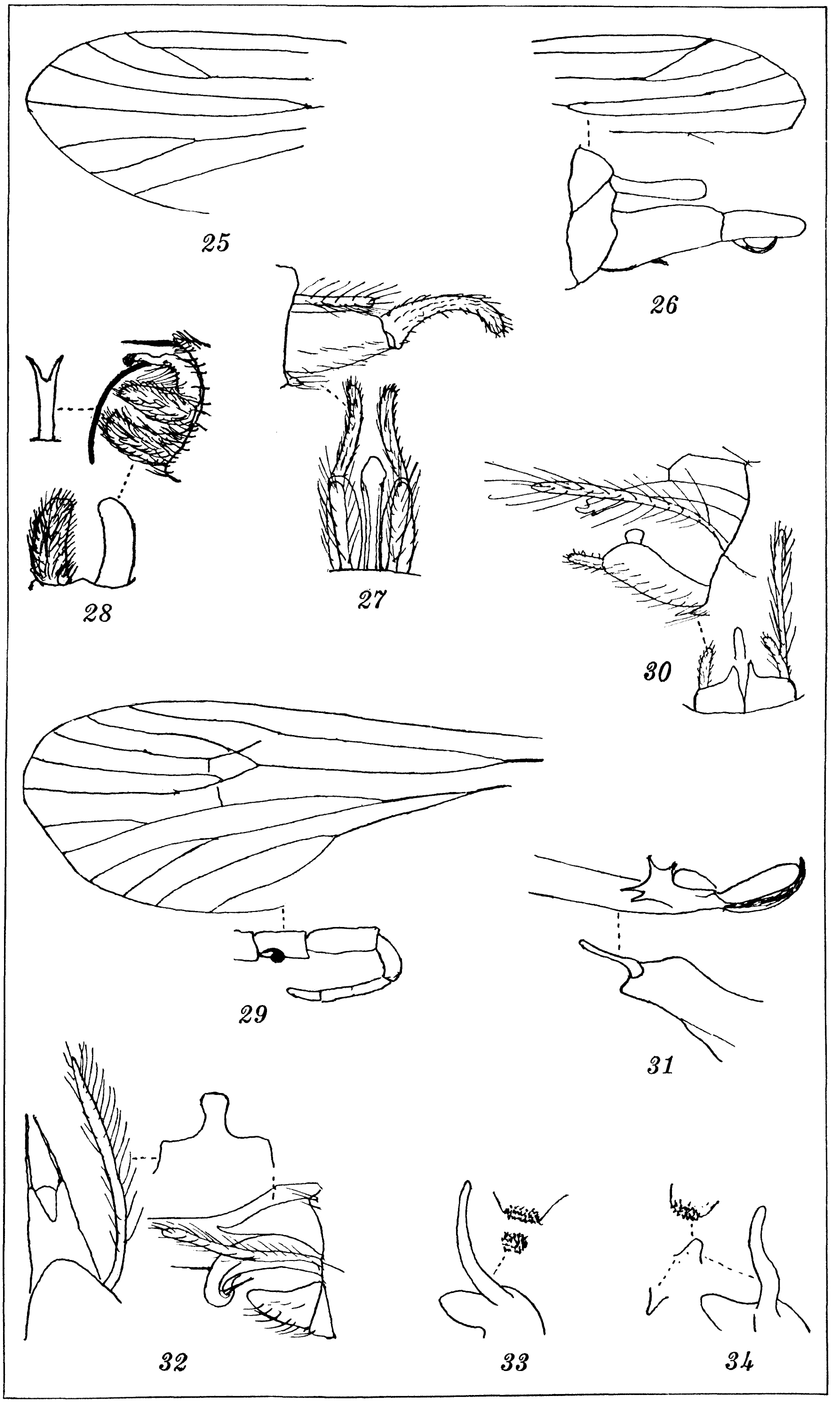

PLATE 3.

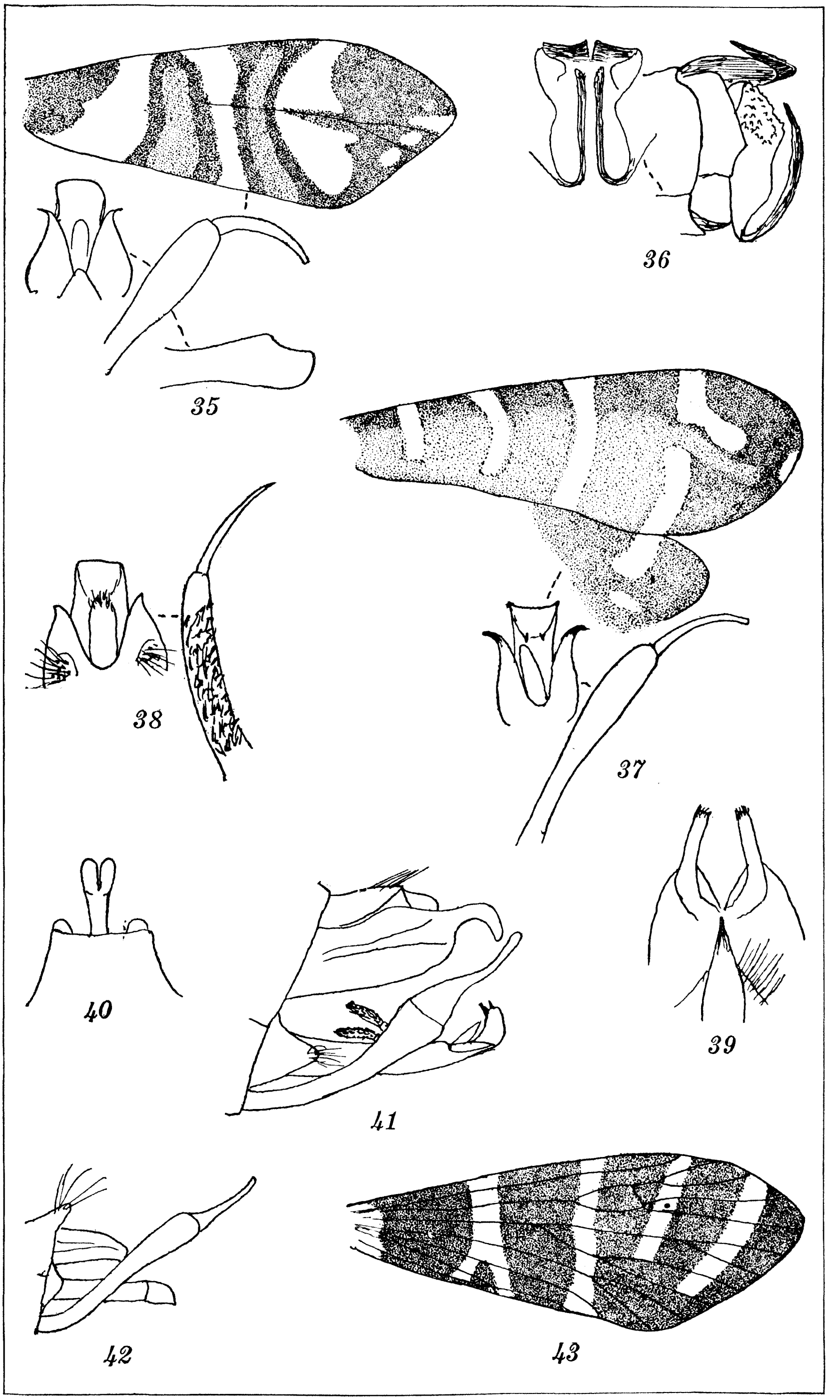

PLATE 4.

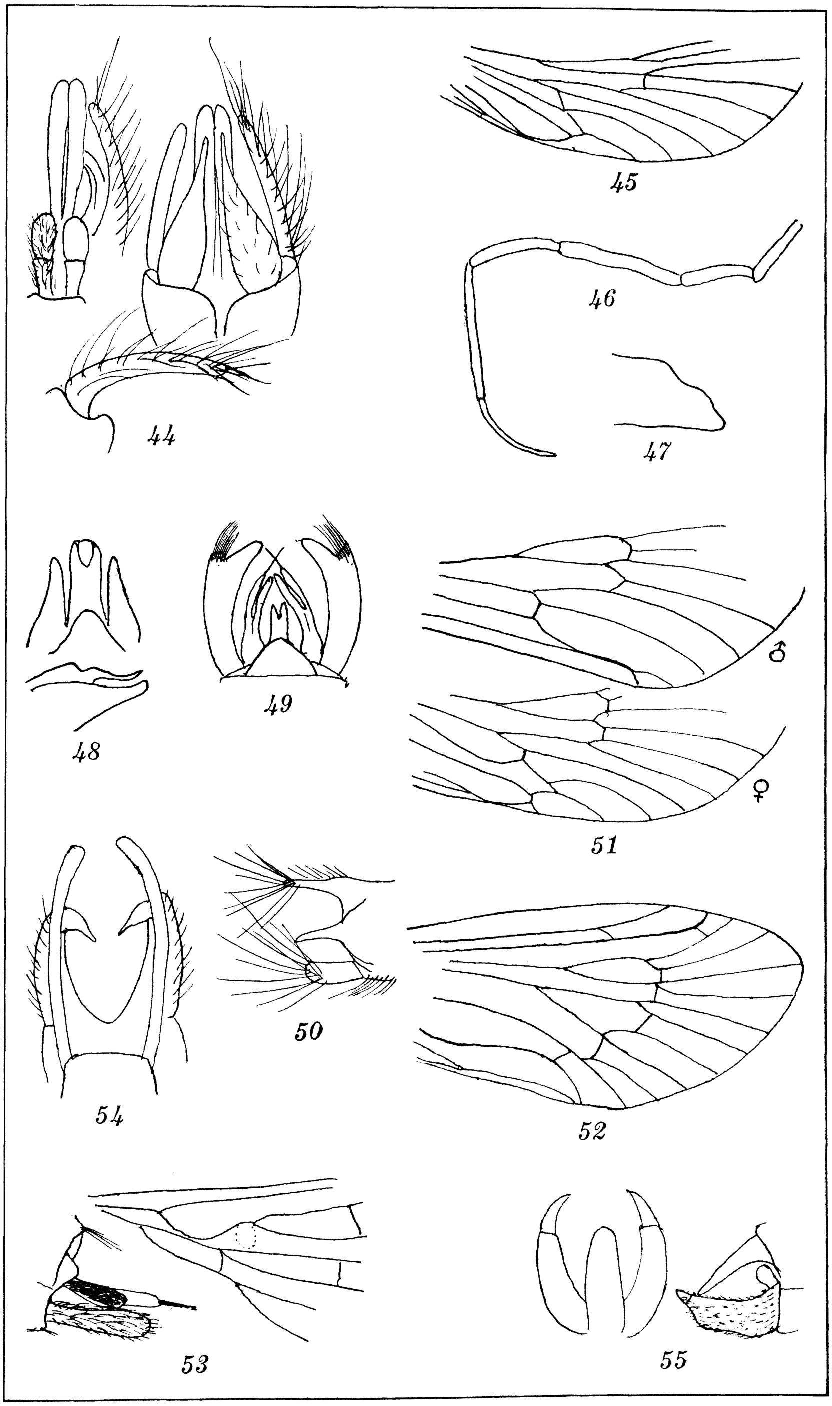

PLATE 5.

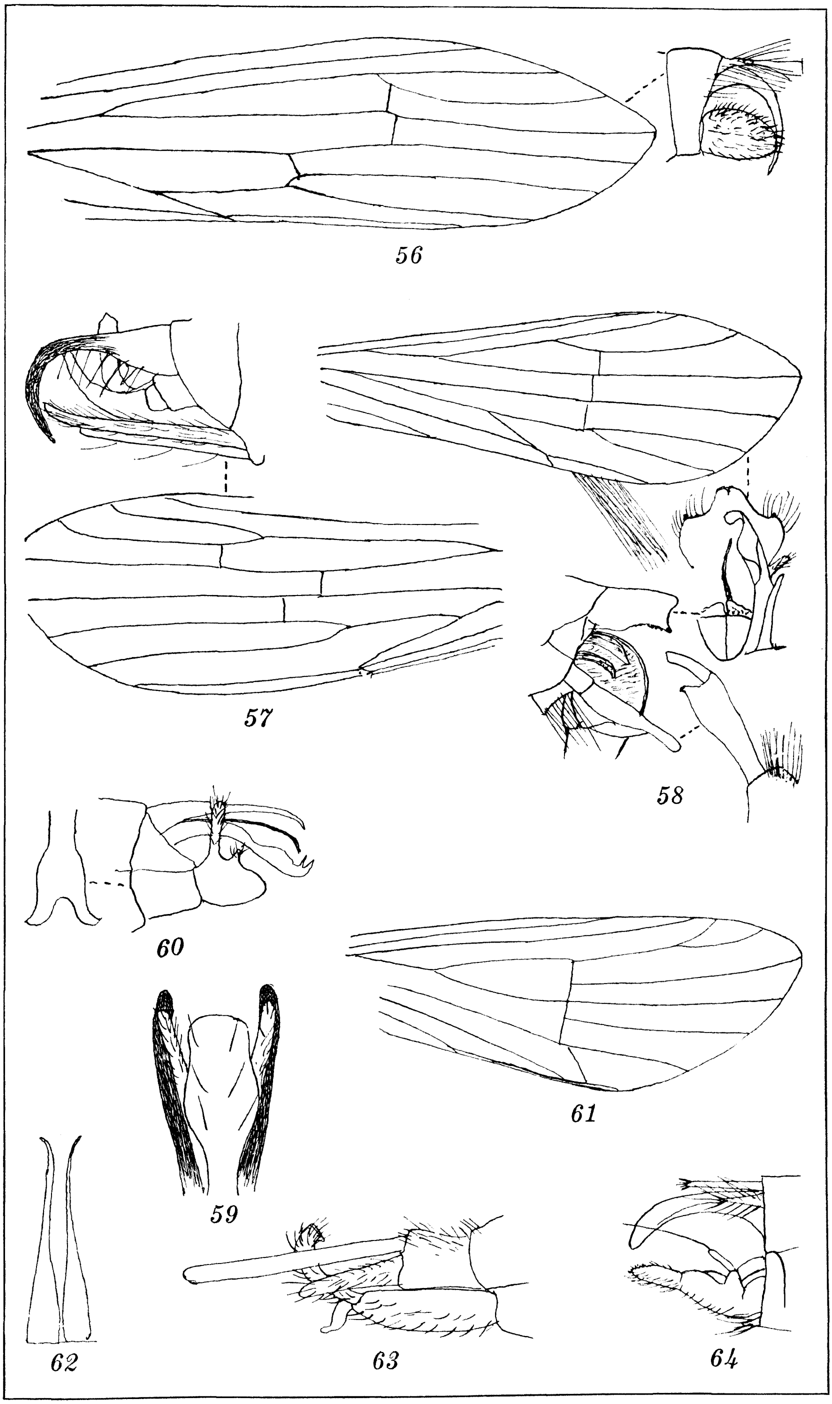

PLATE 6.

A REVIEW OF PHILIPPINE PIGEONS, V

SUBFAMILIES COLUMBINÆ, GEOPELIINÆ, PHABINÆ AND CALŒNADINÆ

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This paper is the continuation of a series the first four parts of which appeared in earlier issues of the Philippine Journal of Science.[1] For convenience, the subfamilies Columbinæ, Geopeliinæ, Phabinæ, and Calœnadinæ are all treated in this paper. Specimens of *Macropygia phasianella borneensis* were loaned by the Raffles Museum at Singapore, and Silliman University at Dumaguete, Oriental Negros, furnished specimens of *M. p. tenuirostris* from the island of Negros. I am indebted to these institutions for their coöperation. I am also under obligation to Mr. Graciano Castañeda, who placed his small collection of doves and pigeons from several islands at my disposal.

COLUMBINÆ

The subfamily Columbinæ includes pigeons with 12 tail feathers of various lengths; the tarsus and bill slender, the latter with a small gape; nostril covering conspicuously swollen; toes with or without broad soles.

Key to the Philippine genera of Columbinæ.

a^1. Tail even or slightly graduated.
  b^1. Tarsus feathered at base .... *Columba.*
  b^2. Tarsus not feathered at base.
    c^1. Tail more than 100 mm .... *Streptopelia.*
    c^2. Tail less than 100 mm .... *Œnopopelia.*
a^2. Tail greatly graduated .... *Macropygia.*

Genus COLUMBA Linnæus, 1758

Bill slender; nostril covering greatly swollen, tail even, shorter than wing; tarsus feathered at base.

[1] Philip. Journ. Sci. 59 (1936) 289–305, 327–336; 60 (1936) 157–163, 407–419.

COLUMBA VITIENSIS GRISEOGULARIS (Walden and Layard).

Carpophaga metallica (part.) SCHLEGEL, Ned. Tijds. Dierk. 3 (1866) 202.

Ianthœnas griseogularis WALDEN and LAYARD, Ibis (1872) 104, pl. 6.

Columba griseigularis SALVADORI, Cat. Birds Brit. Mus. 21 (1893) 313.

Janthœnas vitiensis griseogularis HACHISUKA, Birds Philippine Islands 1 pt. 2 (1932) 205.

Basilan, Batan, Cagayan Sulu, Calayan, Guimaras, Lubang, Luzon, Mindanao, Mindoro, Negros, Pula Tiga, Romblon, Sibutu, Sibuyan, Sulu, West Bolod.

Specimens from Batan, Biliran, Cagayan Sulu, Comiran, Lubang, Lumbucan, Luzon, Mindoro, Negros, Panay, and Romblon were examined.

Large pigeons; sexes similar; barbules of inner web of first primary largely decomposed near end; general color slate black with metallic purple or metallic green on head, neck, back, rump, upper tail coverts, breast, abdomen, and under tail coverts. The sheen is due to the iridescent color in the fringes of the feathers in the parts mentioned. Thus the material examined is variable with regards to the sheen. The only specimen examined from the island of Biliran, for example, exhibits a distinctly different sheen, with the head, neck, upper back, breast, and abdomen Deep Livid Brown.[2]

Measurements of Columba vitiensis griseogularis (Layard and Walden) based on thirteen males and six females.

	Extremes. mm.	Mean. mm.
Wing	230–244	235.30
Tail	148–158	153.84
Culmen	21– 23	22.15
Tarsus	28– 29	28.61
Middle toe and claw	41– 45	42.21

Recent studies by Riley (1930) and Rensch (1931) have shown that the Philippine form is subspecifically identical with the one from North Borneo. Moreover, this form, as far as known, represents the northern race of the grey-throated pigeon, *Columba vitiensis* Quoy and Gaimard.

Genus STREPTOPELIA Bonaparte, 1854

Comparatively small with correspondingly small head and small weak bill; neck slender; wing longer than tail; tail longer than 100 mm; feet adapted for walking.

[2] Colors with initial capitals are from R. Ridgway, Color Standards and Color Nomenclature. Washington (1912).

Key to the Philippine species of Streptopelia.

a[1]. Feathers of dark band on neck entire; color uniform............ *dussumieri.*
a[2]. Feathers of dark band on neck bifurcated; their tips each with a white spot .... *chinensis.*

STREPTOPELIA DUSSUMIERI (Temminck).

Columba dussumieri TEMMINCK, Pl. Col. livr. 32 (1823) 188.
Turtur dussumieri GRAY, Gen. Birds 2 (1844) 472.
Streptopelia dussumieri BONAPARTE, Compt. Rend. (1855) 219.
Streptopelia dussumieri gutierrezi HACHISUKA, Cont. Birds Philip. No. 2 (1930) 152.

Agutaya, Bantayan, Banton, Basilan, Bohol, Cagayancillo, Calamianes, Calayan, Caluya, Catanduanes, Cebu, Cuyo, Fuga, Guimaras, Leyte, Libagao, Lubang, Luzon, Maestre de Campo, Marinduque, Masbate, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Romblon, Samar, Semirara, Siasi, Sibaya, Sibutu, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi, Ticao, Verde.

Specimens from Alabat, Banton, Bohol, Cagayancillo, Calayan, Catanduanes, Cebu, Cuyo, Culion, Fuga, Hermana Mayor, Jintotolo, Lubang, Luzon, Maracañao, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Samar, Siasi, Sibuyan, Siquijor and Tablas were examined.

Medium-sized doves; sexes similar; general color of upper parts brown with a light wash of vinous; collar bluish black with a gray wash; chin white, gradually changing into vinous of throat, sides and hind neck and breast; abdomen and under tail coverts white; edges of distal half and outer web of outermost pair of rectrix white.

Measurements of Streptopelia dussumieri (Temminck) based on twenty-nine males and twenty-six females.

	Extremes. mm.	Mean. mm.
Wing	153–164	158.68
Tail	125–145	129.21
Culmen	15– 16	15.85
Tarsus	26– 29	27.71
Middle toe and claw	28– 32	30.00

The large series of specimens studied from different islands confirms the contention of many previous workers that only one race exists in the Philippines.

STREPTOPELIA CHINENSIS PALAWANA Hachisuka.

Turtur tigrina SHARPE, Ibis (1888) 203.
Spilopelia tigrina MCGREGOR and WORCESTER, Hand-list Bds. Philip. Is. (1906) 14.
Streptopelia chinensis palawana HACHISUKA, Birds Philippine Is. 1 pt. 2 (1932) 212.

Balabac, Palawan.

Specimens from Busuanga and Palawan were examined.

Medium-sized dove; sexes similar. The gray, vinous-washed head is separated from the brown, black-striped, fulvous-tipped back and the rest of the upper parts by a black collar, the feathers of which are bifurcate with white tips. Under parts largely vinaceous-pink, gradually changing into buffish white of abdomen, vent, and under tail coverts.

Measurements of Streptopelia chinensis palawana Hachisuka based on seven males and seven females.

	Extremes. mm.	Mean. mm.
Wing	135–141	137.87
Tail	136–143	139.33
Culmen	15– 16	15.56
Tarsus	24– 25	24.8
Middle toe and claw	27– 28	27.3

For a long time this bird had been referred to *Spilopelia tigrina,* a species peculiar to the Malay Peninsula, Java, Sumatra, Borneo, and adjoining islands. Hachisuka (1932) in separating the present form indicated its smaller size than that of *Spilopelia chinensis tigrina.* In the present study the Palawan form was not compared with those from other places, but the writer is inclined to accept the separation of *Streptopelia chinensis palawana* from *Streptopelia chinensis tigrina,* as according to Stuart Baker (1928) the wing of *S. chinensis tigrina* measures 137 to 155 mm while Robinson and Chasen (1936) give 5.75 inches (146 mm).

Genus ŒNOPOPELIA Blanford, 1898

Comparatively small dove; sexes dissimilar, first primary almost equal to the second; tail short, less than 100 mm long.

ŒNOPOPELIA TRANQUEBARICA HUMILIS (Temminck).

Columba humilis TEMMINCK, Pl. Col. livr. 44 (1824) 259.
Streptopelia humilis BONAPARTE, Comp. Rend. 40 (1855) 18, 219.
Turtur humilis WALDEN, Trans. Zoöl. Soc. London 9 pt. 2 (1875) 219.
Onopopelia humilis SHARPE, Hand-list Birds Brit. Mus. 1 (1899) 79.
Œnopopelia tranquebarica humilis HACHISUKA, Contrib. Bds. Philip. No. 2 (1930) 152.

Calayan, Lubang, Luzon, Mindoro.

Specimens from Luzon were examined.

Male.—Upper parts darker vinaceous red than under parts; head, lower back, rump and upper tail coverts gray; narrow nuchal band black.

Female.—General color much lighter than male.

Measurements of Œnopopelia tranquebarica humilis (Temminck) based on ten males and three females.

	Extremes. mm.	Mean. mm.
Wing	130–141	134.8
Tail	85– 89	86.36
Culmen	14– 15	14.16
Tarsus	....	21.0
Middle toe and claw	23– 25	23.83

The present race is identical with that of southern Asia. This subspecies is abundant in certain parts of Luzon and has been recorded in a few neighboring islands.

Genus MACROPYGIA Swainson, 1837

Tail greatly graduated, longer than wing; tarsus feathered at base, toes long and slender with broad soles.

McGregor (1909) recorded two species in the Philippines. Hachisuka (1932) listed three subspecies of only one species. It appears, however, that *Macropygia phasianella septentrionalis* Hachisuka (1930) should not, if valid, be included in the Philippine list. Batan and Botel Tobago were given as localities for this subspecies. The present study shows that specimens of the cuckoo dove from Batan are identical with those from Calayan described earlier by McGregor as *M. phasianella phæa.* Botel Tobago is not politically a part of the Philippine Archipelago. No specimen from this locality has been examined.

In view of their close resemblance the two Philippine races have been relegated to one species.

MACROPYGIA PHASIANELLA TENUIROSTRIS Bonaparte.

Columba phasianella TEMMINCK, Trans. Linn. Soc. 13 (1821) 129.
Macropygia tenuirostris BONAPARTE, Consp. Gen. Avium 2 (1854) 57.
Macropygia eurycerca TWEEDDALE, Proc. Zool. Soc. London (1875) 218.
Macropygia tenuirostris tenuirostris HACHISUKA, Cont. Bds. Philip. No. 2 (1930) 151.
Macropygia phasianella tenuirostris HACHISUKA, Bds. Philip. Is. 1 pt. 2 (1932) 207.

Balabac, Basilan, Bohol, Bungau, Leyte, Luzon, Marinduque, Masbate, Mindanao, Mindoro, Negros, Palawan, Polillo, Romblon, Sibutu, Sibuyan, Sulu, and Tawitawi.

Specimens from Basilan, Bohol, Busuanga, Leyte, Luzon, Mindanao, Mindoro, Negros, Palawan, Polillo, and Samar were examined.

Male.—Upper parts dark brown with a shade of rufous, tips of feathers dotted with cinnamon rufous appearing in the form of vermiculation; head and underparts cinnamon rufous; neck and sides with amethystine and green gloss.

Female.—Similar to the male, but neck and its sides dark brown barred with buff; throat and breast barred with dark brown.

Measurements of Macropygia phasianella tenuirostris Bonaparte based on fifteen males and seventeen females.

	Extremes. mm.	Mean. mm.
Wing	165–186	172.9
Tail	180–208	185.06
Culmen	15– 17	15.25
Tarsus	21– 22	22.38
Middle toe and claw	31– 35	33.05

Walden (1878) gave *Macropygia eurycerca* as a new name for the cuckoo dove from Negros, after verifying the distinction between the birds of Negros and those from Luzon which he first noted in an earlier publication (1875). Sharpe (1877), using the characters mentioned by Tweeddale (1875),[3] found no difference between the birds from Basilan, Negros, and Luzon. In a later paper Sharpe (1879) concurred with the view of Professor Schlegel in that *M. tenuirostris* "is found all over the Philippines and occurs even in Borneo." He thus reiterated his view that *M. eurycerca* is not a valid species. While the Bornean form has been given a subspecific status by Robinson and Kloss (1921), who regarded it as conspecific with the Philippine form, the Negros, Mindanao, and Basilan cuckoo dove seems to have remained identical with the Luzon form, according to subsequent authors. In the present study all cuckoo doves studied from the different islands except those from northern Luzon (*M. p. phæa*) are regarded as belonging to *M. p. tenuirostris*.

MACROPYGIA PHASIANELLA PHÆA McGregor.

Macropygia phæa McGREGOR, Bull. Philip. Mus. 4 (1904) 9.

Macropygia tenuirostris phæa HACHISUKA, Cont. Bds. Philip. No. 2 (1930) 151.

Macropygia phasianella phæa HACHISUKA, Bds. Philip. Is. 1 pt. 2 (1932) 208.

Batan, Calayan.

Specimens from these islands were examined.

Similar to *M. phasianella tenuirostris* but larger and darker.

[3] Marquis of Tweeddale; same as Viscount Walden.

Measurements of Macropygia phasianella phæa McGregor based on two males and three females.

	Extremes. mm.	Mean. mm.
Wing	196–202	199.0
Tail	192–201	197.0
Culmen	....	17.0
Tarsus	25–26	25.6
Middle toe and claw	36–37	36.4

The birds from Batan and Calayan are identical. The Batan birds should, therefore, retain the name *M. phasianella phæa* McGregor (1904) and not be included in *M. phasianella septentrionalis* Hachisuka (1930). If the latter name is valid it should not be included in the Philippine list.

GEOPELIINÆ

This subfamily is represented in the Philippines by only one race.

GEOPELIA STRIATA STRIATA (Linnæus).

Columba striata LINNÆUS, Syst. Nat. 12th ed. (1766) 282.
Geopelia striata WALDEN, Trans. Zoöl. Soc. London 9 pt. 2 (1875) 223.

Lubang, Luzon, Mindoro, Verde.

Specimens from Lubang, Luzon, and Mindoro were examined.

Comparatively small dove. Sexes similar; tail with 14 feathers graduated, longer than wing. Upper parts largely brown, feathers with dark fringe forming distinct bars; chin and throat pearl gray; middle of breast vinaceous pink gradually changing to white of under tail coverts, dark bars on white feathers of sides and flanks very conspicuous.

Measurements of Geopelia striata striata Linnæus based on thirty-seven males and thirty-three females.

	Extremes. mm.	Mean. mm.
Wing	96–103	98.52
Tail	97–117	106.14
Culmen	12– 13	12.78
Tarsus	17– 19	17.64
Middle toe and claw	21– 24	21.93

The distribution of this dove is very interesting. It is abundant in north and central Luzon, but rare in the southern part of the island. In Verde, Lubang, and Mindoro it is rare and it has not been recorded in Catanduanes. It is recorded in Borneo, Sumatra, Java, and Malay Peninsula, according to Chasen

(1935), but has not been reported in the islands intervening between Luzon and Borneo, where it would be expected to occur.

PHABINÆ

One race is recorded in the Philippines.

CHALCOPHAPS INDICA INDICA Linnæus.

Columba indica LINNÆUS, Syst. Nat. 10th ed. 1 (1758) 164.

Columba pileata SCOPOLI, "Del. Flor. et Faun. Insular." pt. 2 (1786) 94 (Ex Sonnerat).

Columba albicapilla GMELIN, "Syst. Nat." 1 (1788) 775 (Ex Sonnerat).

Chalcophaps indica WALDEN, Trans. Zoöl. Soc. London 9 pt. 2 (1875) 221.

Banton, Basilan, Batan, Bohol, Cagayancillo, Calamianes, Calayan, Camiguin Norte, Cebu, Cuyo, Fuga, Guimaras, Lubang, Luzon, Marinduque, Masbate, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Romblon, Samar, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi, Ticao, Verde.

Specimens from Alabat, Banton, Basilan, Batan, Bohol, Cagayancillo, Cagayan Sulu, Cebu, Cuyo, Divinubo, Fuga, Luzon, Masbate, Mindanao, Negros, Palawan, Polillo, Romblon, Samar, and Siquijor were examined.

Medium-sized pigeons; sexes dissimilar; tail with 12 feathers, rounded, shorter than wing.

General color, metallic emerald-green and brown above; brown below.

Male.—Forehead to superciliary stripe white, changing to bluish gray of crown and nape; neck and shoulders Carob Brown, this color extending below through sides of head and neck to the breast; back scapulars, wing coverts, and inner secondaries metallic emerald-green with metallic gloss; rump dark brown with metallic green gloss; tail coverts slate gray, similar to upper tail coverts; lower breast, abdomen, and flanks Hair Brown.

Female.—White of forehead and superciliary less distinct. Crown, nape, and neck Hair Brown like underparts; upper tail coverts and upper surface of tail brown with slight tinge of olivaceous gloss. In other parts similar to the male.

Measurements of Chalcophaps indica indica (Linnæus) based on eighteen males and twenty females.

	Extremes. mm.	Mean. mm.
Wing	141–151	143.52
Tail	80– 93	89.97
Culmen	16– 17	16.61
Tarsus	26– 28	26.87
Middle toe and claw	26– 30	28.81

A bird of the woods. Widely distributed over the Archipelago though not very common.

CALŒNADINÆ

One race is known in the Philippines.

CALŒNAS NICOBARICA NICOBARICA (Linnæus).

Calœnas nicobarica CASSIN, U. S. Explor. Exped. (1858) 276.

Balabac, Mindanao, Mindoro, Negros, Palawan, Sibutu, Siquijor, Sulu, Talaran (off Basilan), Tawitawi, Ursula.

Specimens from Cavilli, Lumbucan, Mindanao, Siquijor, and Ursula were examined.

Comparatively large-sized terrestrial pigeons; sexes similar in general appearance, tail rounded with 12 feathers less than half length of wing; neck feathers much more slender than others, loosely set, and forming an ornamentlike hackle.

General color of male deep metallic bluish black with sheen of various bluish green shades; tail largely white. Females have duller colors.

Measurements of Calœnas nicobarica nicobarica (Linnæus) based on five males and five females.

	Extremes. mm.	Mean. mm.
Wing	241–257	246.66
Tail	87– 93	88.50
Culmen from nostril	15– 16	15.16
Tarsus	39– 45	42.83
Middle toe and claw	43–48	45.83

The race appears to be commoner in the southern islands than in the more northern limits of its distribution.

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THE AVIFAUNA OF CATANDUANES

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John Whitehead visited Catanduanes in September, 1894. The results of his ornithological collection and observations there were published by Grant (1895). Collecting on this island for about one month, Whitehead obtained forty-eight species of birds. No further collecting had been done when this paucity of information about the avifauna of this island caused the writer to undertake the study reported in this paper.

According to the United States Coast Pilot (1927) Catanduanes Island is about 35 miles (56.3 kilometers) long, from north to south, and about 23 miles (37 kilometers) wide. It is mountainous and lies within 124° 10′ and 124° 25′ east longitude and 13° 30′ and 14° 10′ north latitude. Faustino (1927) states that it has an area of 1,461 square kilometers. This island is separated from the mainland of Luzon through Caramoan Peninsula, by the Maqueda Channel. The southern entrance of the channel, which is its narrowest part, is, according to U. S. Coast Pilot (1927), about four miles (6.4 kilometers) wide and about 44 fathoms deep.

From existing geological evidence Dickerson and others (1928) believe that Catanduanes, together with some other islands, was possibly connected with southern Luzon during the Pleistocene period. Faunistic studies like the present should help greatly in tracing the island's geologic history.

The data here presented were obtained by the writer, accompanied by Francisco S. Rivera, in a field trip to the island of Catanduanes, from December 3 to December 12, 1936.

The 140 birds, belonging to 60 forms, collected on this trip are listed in a later paragraph.

The terrific typhoon of December 2, 1936, which caused the destruction and denudation of considerable amounts of forest land, perhaps caused the apparent scarcity of bird life in the island at the time of collecting. Collecting was done principally in the vicinity of Bato and Virac in the southern part of the island.

The nomenclature adapted in this paper is taken from the following sources: Peters, J. L., "Birds of the World" 2 volumes; Hachisuka, M., "Birds of the Philippine Islands" 4 parts; Kuroda, N., "Birds of the Island of Java" 2 volumes; Chasen, F. N., "A Handlist of Malaysian Birds"; McGregor, R. C., "A Manual of Philippine Birds."

BIRDS COLLECTED IN CATANDUANES [1]

Scientific name.	Common name.
Excalfactoria chinensis lineata (Scopoli).	Island painted quail.
Streptopelia dussumieri (Temminck).*	Dussumier's turtle dove.
Rallus torquatus torquatus Linnæus.*	Philippine rail.
Pluvialis dominica fulva (Gmelin).	Asiatic golden plover.
Charadrius dubius dubius Scopoli.*	Little ringed plover.
Capella megala (Swinhoe).	Swinhoe's snipe.
Egretta garzetta nigripes (Temminck).	Little white egret.
Butorides striatus javanicus (Horsfield).	Javan green heron.
Accipiter virgatus gularis (Temminck and Schlegel).	Japanese sparrow hawk.
Spilornis holospilus holospilus (Vigors).*	Philippine serpent eagle.
Butastur indicus (Gmelin).	Tic-wee buzzard.
Pernis apivorus ptilorhyncus (Temminck).	Crested honey buzzard.
Prioniturus discurus discurus (Vieillot).*	Philippine racket-tailed parakeet.
Loriculus philippinensis philippensis (P. L. S. Müller).*	Luzon hanging parakeet.
Eurystomus orientalis orientalis (Linnæus).	Broad-billed roller.
Halcyon smyrnensis gularis (Kuhl).	White-throated kingfisher.
Penelopides panini manillæ (Boddaert).	Luzon tarictic.
Collocalia whiteheadi whiteheadi Grant.	Whitehead's swiflet.
Collocalia troglodytes Gray.	Pygmy swiflet.
Hierococcyx fugax hyperythrus (Gould).	Sino-Malayan hawk cuckoo.
Lepidogrammus cumingi (Fraser).	Scale-feathered cuckoo.
Centropus viridis (Scopoli).*	Red-winged coucal.
Dasylophus superciliosus (Cuvier).*	Rough-crested cuckoo.

[1]An asterisk * after the name of a bird indicates a previous record by Whitehead.

BIRDS COLLECTED IN CATANDUANES—continued

Scientific name.	Common name.
Hirundo tahitica javanica Sparrman.*	Asiatic swallow.
Hemichelidon griseisticta griseisticta Swinhoe.	Gray-spotted flycatcher.
Hypothymis azurea azurea Grant and Whitehead.	Black-naped flycatcher.
Xeocephus rufus rufus (Gray).	Long-tailed flycatcher.
Coracina striata striata (Boddaert).	Luzon cuckoo-shrike.
Lalage nigra chilensis (Meyen).*	Pied lalage.
Iole philippensis philippensis (Gmelin).	Philippine bulbul.
Euptilosus urostictus urostictus (Salvadori).*	Wattled bulbul.
Pycnonotus goiavier goiavier (Scopoli).	Guava bulbul.
Calliope calliope calliope (Pallas).	Siberian rubythroat.
Locustella ochotensis ochotensis (Middendorf).	Yellow grasshopper warbler.
Orthotomus derbianus Moore.*	Derby's tailorbird.
Cisticola cisticola cisticola (Temminck).	Rufus grass warbler.
Megalurus palustris forbesi Bangs.*	Striated marsh warbler.
Phylloscopus borealis borealis (Blasius).	Northern willow warbler.
Artamus leucorynchus leucorynchus (Linnæus).*	White-bellied swallow shrike.
Lanius cristatus lucionensis (Linnæus).*	Red-tailed shrike.
Parus elegans Lesson.	Elegant titmouse.
Zosterops aureiloris Grant.	Golden-lored silvereye.
Dicæum papuense (Gmelin).	Philippine flowerpecker.
Dicæum obscurum Grant.	Dusky flowerpecker.
Prionochilus inexpectatus Hartert.	Hartert's flowerpecker.
Prionochilus parsonsi McGregor.	Parson's flowerpecker.
Piprisoma æruginosum (Bourns and Worcester).	Rusty flowerpecker.
Leptocoma braziliana sperata (Linn.).	Red-breasted sunbird.
Leptocoma flagrans (Oustalet).*	Flaming sunbird.
Leptocoma jugularis jugularis (Linn.).*	Yellow-breasted sunbird.
Anthreptes malacensis griseigularis Tweeddale.	Gray-throated sunbird.
Motacilla flava simillana Hartert.*	Siberian yellow wagtail.
Anthus hodgsoni Richmond.	Spotted tree pipit.
Anthus richardi lugubris Walden.	Indian pipit.
Munia atricapilla minuta (Meyen).*	Philippine weaver.

BIRDS COLLECTED IN CATANDUANES—continued

Scientific name.	Common name.
Uroloncha leucogastra everetti (Tweeddale).*	Everett's weaver.
Oriolus chinensis chinensis Linnæus.*	Philippine oriole.
Dicrurus hottentottus balicassius (Linn.).	Northern drongo.
Sarcops calvus (Linn.).*	Gray-backed bald starling.
Corvus coronoides philippinus Bonaparte.*	Philippine crow.

The following birds were noted but not collected:

Macropygia phasianella tenuirostris Bonaparte.	Slender-billed cuckoo dove.
Haliastur indus intermedius Blyth.*	Malayan brahminy kite.
Kokatoe hæmaturopygius hæmaturopygius (P. L. S. Müller).	Philippine cockatoo.
Alcedo atthis bengalensis Gmelin.*	Asiatic kingfisher.
Pitta erythrogastra Temminck.	Red-breasted ant thrush.
Rhipidura javanica nigritorquis Vigors.*	Black and white fantail-flycatcher.
Rhipidura cyaniceps cyaniceps (Cassin).	Rufus-bellied fantail-flycatcher.
Passer montanus saturatus Stejneger.	Oriental tree sparrow.

Of the 60 forms of birds we obtained from Catanduanes 23 were recorded previously by Whitehead. Considering Whitehead's and our collection together, 85 forms will have been recorded from the avifauna of Catanduanes, including 14 migratory species. The 85 forms collected by Whitehead and by us are also found in Luzon. The 8 forms that were noted but not collected have also been recorded in Luzon. Moreover, 12 of those collected and one of those merely seen are distinctly Luzon forms. The writer was informed of the presence of a bleeding-heart pigeon, *Gallicolumba* sp., in Catanduanes, and according to description it is *G. luzonica.*

This similarity of the avifauna of the two islands is attributed primarily to their closeness; only an area of approximately 6.4 kilometers separates them. The possibility, however, of the species having been isolated in times too recent for any modification can be conjectured. The depth of the channel (44 fathoms) positively indicates a recent separation of Catanduanes from Luzon.

CONCLUSION

The avifauna of the island of Catanduanes, according to the results so far obtained, is distinctly similar to that of Luzon. This similarity is accounted for primarily by the fact that they are separated by a very narrow channel.

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THE FISHERIES OF LAKE TAAL, PANSIPIT RIVER, AND BALAYAN BAY, BATANGAS PROVINCE, LUZON

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FOUR PLATES AND TWO TEXT FIGURES

LAKE TAAL

Lake Taal, or Lake Bombon, Batangas Province, Luzon, has an area of approximately 267 square kilometers. Its depth varies from that of shallow water to 200 meters. Apart from its beautiful surroundings and the presence at its center of one of the lowest volcanoes in the world, it is famous also for its fisheries, which are known to contain the choicest food fishes in sufficient abundance to be of commercial significance.

In this paper the fishery industries of Lake Taal and Pansipit River are discussed primarily from the point of view of their conservation and the means of protecting the larvæ, fry, and young of the migratory species that constitute the bulk of these fisheries. Suggestions and recommendations to attain this end are given and discussed at some length. The fisheries of Balayan Bay are discussed with special consideration of their relation to the conservation of the fisheries of Lake Taal and Pansipit River. The seasonal occurrence of the commercial fishes of Balayan Bay and methods of fishing are also discussed.

Small streams enter Lake Taal, but its outlet is Pansipit River, which empties into Balayan Bay of the China Sea. This river has a flow of considerable volume, although it is approximately only 8 kilometers long, and not sufficiently deep to be navigated by boats with draft of more than 7 feet.

BALAYAN BAY

Balayan Bay is formed by the extension of Calatagan and Bauan Peninsulas from the mainland of Batangas into the China Sea. It is partly protected from high winds by the islands of Mindoro and the Lubang group. Between Balayan Bay and the mainland of Mindoro is the Verde Island Passage which permits the rich marine fauna of the China Sea to enter Balayan Bay.

Commercial value.—On the basis of figures of catch and sale over many years compiled from the records of the various lease holders, the value of the fisheries of Lake Taal and Pansipit River may be easily placed at no less than 500,000 pesos a year.

Kinds of fish composing the fisheries of Lake Taal.—Various investigators, collectors, and students of fishes have so far recorded the existence of forty-seven species of fish in Lake Taal and Pansipit River. Only eight of these are of commercial value. They are here listed somewhat in the order of their importance: (1) *Muslo, Caranx marginatus* Gill; (2) *maliputo, Caranx ignobilis* (Forskål); (3) *manipis, Caranx* sp.; (4) *lumulukso, Chanos chanos* (Forskål); (5) *alsó, Lutianus argentimaculatus* (Forskål); (6) *tawilis, Harengula tawilis* Herre; (7) *buan-buan, Megalops cyprinoides* (Broussonet); (8) *banak, Mugil* spp. These eight species of fishes constitute the bulk of commercial catches in Lake Taal and Pansipit River. The ten species constituting the less important food fishes in Lake Taal and Pansipit River are: (1) *Igat* or *palos, Anguilla mauritiana* Bennett; (2) *biyá, Glossogobius giurus* (Buchanan-Hamilton); (3) *dalag, Ophicephalus striatus* Bloch; (4) *kitang, Scatophagus argus* (Boddaert); (5) *asohos, Sillago sihama* (Forskål); (6) *baculihan* or *dalagan, bañgayñgay* or *palauan, Ophiocara aporos* Bleeker; (7) *bagaong, Therapon jarbua* (Forskål); (8) *damagan, Kuhlia rupestris* Lacépède or *Kuhlia marginata* Cuvier and Valenciennes; (9) *katabá, Toxotes jaculator* (Pallas); (10) *dañgat* or *lañgaray, Ambassis* spp.

Other species found in Lake Taal and Pansipit River are small fishes not utilized for food and therefore not economically important, except as the primary source of food for large, economic species.

Two kinds of crustaceans enter in the commercial fisheries of Lake Taal and Pansipit River, the *katang* or *talangka,* small fresh-water crabs belonging to the family Grapsidæ, and the *apta,* small prawns or fresh-water shrimps of the family Atyidæ. The katang or talanka are boiled and eaten or triturated with salt and made into *patis.* The apta are boiled fresh and eaten, or sun-dried and prepared for both human and poultry consumption. They are also preserved in salt and subsequently fermented into a native preparation, called *alamang.*

Pansipit River, from its mouth to about 2 kilometers above it, harbors in abundance a species of bivalves, locally called *parros, Solotellina elongata* (Lamarck). These mussels are gathered almost every day and sold in the local markets. It is estimated that no less than 50 pesos' worth of these bivalves are gathered every day during at least three months a year from Pansipit River. They are especially in demand during inclement weather when fishing is not possible in the open waters.

Methods of fishing and the migratory habits of fishes.—The methods of fishing and the migratory habits of fishes have an important bearing on the problems of conservation and depletion of fisheries. Most of the valuable and commercial fishes constituting the bulk of these fisheries are migratory. The larvæ or fry and the fingerlings ascend Pansipit River from Balayan Bay to enter Lake Taal, where they stay until they attain sexual maturity or marketable size. When about ready to live in the salt water the fish descend the river. In this way wholesale capture of both the young and the adults is rendered very easy, as catching devices are set in Pansipit River through which the fish migrating in compact groups or shoals must pass on their seaward and lakeward movements. Thus the famous muslo, maliputo, manipis (Carangidæ), the large lumulukso (bañgos, *Chanos chanos*), the banak (mullets, Mugilidæ), the buan-buan (tarpons, Megalopidæ), the kitang (butter or spade fish, Scatophagidæ), the igat or palos (eels, Anguillidæ), the alsó (gray snappers, Lutjanidæ), the maya-maya (red snapper, Lutjanidæ), and other fishes of similar migratory habits, are caught in large numbers now and then in the Baklad-Pansipit (fish corrals placed across Pansipit River), the Baklad Bokana (fish corrals placed in Lake Taal not far from the source of Pansipit River), and the Baklad Wawa (fish corrals placed in Balayan Bay not far from the mouth of Pansipit River). Similarly, these fishes are caught in large numbers in nets (salambao, sakag, etc.) operated in the waters mentioned. Even the talanká or katang (freshwater crabs) which have similar migratory habits are captured in large numbers in Pansipit River when they make the seaward migration to spawn in the salt water.

From the point of view of conservation of the supply, this habit of the fish and of the katang is unfortunate, since the continuous destruction in large numbers of the breeders and the young prevents the replacement of individuals necessary to keep the species at normal numbers.

The destruction of larvæ, fry, and young of these migratory fishes of Lake Taal and Pansipit River is aggravated by two circumstances: (1) The use of very fine-meshed nets from March to June in and in the vicinity of the mouth of Pansipit River for the primary purpose of catching bañgos fry, and (2) the eruption of Taal Volcano in 1911. Unfortunately, with regard to the former, during this time of year fry of other migratory fishes are also found in abundance in Balayan Bay and at the mouth of Pansipit River. These are, therefore, taken also in nets used in the catching of bañgos fry. Moreover, only the bañgos fry are taken, while the fry of other species are wantonly thrown on the beach to die. One of the consequences of the eruption of Taal Volcano was the sinking of land and the subsequent formation of tidal streams and swamps in the vicinity of Lemery, Batangas, covering an area of about 50 hectares.

These tidal streams provided a connection between a portion of Pansipit River and of Balayan Bay at Sukol, Lemery. In this way the larvæ and fry of migratory fishes are enabled to reach Pansipit River, whence they pass into Lake Taal, as well as by way of the tidal streams (now known as the Palanas of Lemery). The latter route of the larval fishes in their lakeward migration has several advantages over the former; namely, the larvæ and fry have a better chance to develop into larger and hardier individuals before they reach the fresh and swift-flowing stream of Pansipit River. From Balayan Bay to Pansipit River the tidal waters change gradually in salinity and pH, hence the delicate fry undergo gradual changes, from a salt- to a fresh-water habitat. The tidal streams are sheltered from untoward weather changes, and the characteristic food of the fry and larvæ of fishes is more abundant in these waters. Predatory fishes that devour fry and larval fishes are found in smaller numbers and fewer species in the tidal waters than at the mouth of Pansipit River. Unfortunately not many years after the formation of the Palanas tidal streams a small portion of the connecting stream between these tidal waters and Pansipit River was cut off by the construction of a provincial road, and consequently the larval fishes have been prevented from migrating freely from Balayan Bay into Pansipit River by way of these streams. The larval fishes therefore remain in these streams to grow into fingerlings or yearlings, and the people residing in the vicinity discovered in due time that they could catch countless numbers of them. As a result, the propagation stock of the important fisheries of Lake Taal and Pansipit River has been greatly diminished.

Another factor in the depletion of the fisheries of Lake Taal and Pansipit River is the unnecessary destruction of the breeding stock, brought about by the time-honored practice of awarding to the highest bidder the rights to fish in the waters. The municipalities of Taal and Lemery derive a large sum of money from the lease of fishing rights, and as this sum is paid in advance, the lease holders are obliged to catch and sell as much fish as possible to make good their investment. To this end the so-called "Baklad Pansipit," which blocks the entire width of the river, has been constructed. Practically all fish migrating seaward are caught in the Baklad Pansipit. Moreover, lease holders of the Pansipit fisheries also devise means to drive the fish from Lake Taal to the river in order to make the catching of the fish more complete, and therefore more exhaustive.

Thus the development of the migratory fishes that constitute the greatest volume of the commercial fisheries of Lake Taal and Pansipit River is seriously interfered with on two occasions: (1) During their larval stage upon their lakeward migration and (2) during their breeding stage when they travel seaward.

The records of catch of the "Baklad Pansipit" (Table 1), during three periods, 1888–1890, 1926–1927, and 1933–1934, show that the five species which compose the bulk of these fisheries, namely, the muslo, *Caranx marginatus;* the maliputo, *C. ignobilis;* the manipis, *Caranx* sp.; the lumulukso, *Chanos chanos;* and the banak, Mugilidæ, have been undergoing depletion. The average number of muslo taken in Baklad Pansipit during the three-year period from 1888 to 1890 was 14,352; from 1926 to 1927 it was 8,163; and from 1933 to 1934, 6,328. The catch of the third period was less than 50 per cent of that of the first period. The maliputo, manipis, lumulukso, and the banak likewise decreased markedly in number during these periods.

The depletion of these fisheries is also shown in the actual money value of the fishing rights. The lease for the period from 1928 to 1932 was 161,000 pesos, or 32,200 pesos annually. The lease for the period from 1933 to 1936 however, amounts to only 81,500 pesos, or 16,300 pesos a year, a decrease of about 50 per cent.

TABLE 1.—*Average number of fish caught in the Baklad Pansipit per annum.*

Year.	Muslo, *Caranx marginatus.*	Maliputo, *Caranx ignobilis.*	Manipis, *Caranx* sp.	Lumulukso *Chanos chanos.*	Banak, Mugilidæ.
1888	16,283	928	8,844	786	1,888
1889	12,369	1,474	10,630	1,520	4,200
1890	14,405	611	4,225	1,601	1,057
Average	14,352	1,004	7,899	1,302	2,381
1926	9,082	342	428	353	200
1927	7,244	372	2,886	334	311
Average	8,163	357	1,657	344	255
1933	5,969	207	1,107	420	527
1934	6,688	416	999	530	117
Average	6,328	311	1,053	475	322

MIGRATORY HABITS

Muslo, Caranx marginatus.—This pampano or talakitok breeds in salt water. The young, locally called pepikat, enter sloughs, mouths of rivers, and other sheltered bodies of water, and eventually ascend streams to enter a fresh-water lake, if such is available. My own observations in Balayan Bay in the vicinity of Lemery and Taal, the Palanas tidal streams at Lemery, and at the mouth of the Pansipit River in 1934, indicate that the young muslo make their lakeward migration almost the year round, but migration in greatest abundance of the pepikat (fingerlings of muslo) occurs during the period from January to April.

Under ordinary circumstances it is the general habit of this group of migratory fishes to remain in fresh water until sexual maturity, and to make the seaward migration when they are about ready to spawn. The muslo, however, is an exception to this general rule. Records of catch in the Baklad Pansipit show that the muslo return to the sea prior to maturity. Hundreds of muslo caught in Baklad Pansipit have been examined, and not a single specimen showed developed gonads. The seaward migration of the muslo has also been found to occur during all months of the year, as shown by the records of catches of the Baklad Pansipit for 1927 and 1934 (Table 2).

TABLE 2.—*Number of muslo taken by the month in Baklad Pansipit for 1927 and 1934.*

Month.	1927.	1934.
January	2,212	4,590
February	2,387	3,682
March	3,467	1,545
April	5,594	8,230
May	12,405	8,444
June	9,097	6,413
July	10,453	8,735
August	10,754	15,731
September	10,038	7,893
October	9,846	8,094
November	8,625	4,658
December	2,049	2,240
Total	86,927	80,256
Average	7,241	6,688

It is also apparent that more muslo migrate seaward from either April to October or May to November, the period from July to October being the height of the seaward migration.

The records of catch for 1934, where the number and weight of the muslo were recorded (Table 3), show that small and young muslo migrate seaward during August, September, and October. These months, especially August, are well known as the "pepikat-season" because of the abundance of small muslo in the catch. On the other hand, the so-called "muslong-laot" (large and old muslo) are caught in the Baklad Pansipit during April, May, June, and July.

TABLE 3.—*Number and average weight of muslo caught in Baklad Pansipit during 1934.*

Month.	Number.	Average weight.
		g.
January	4,590	168
February	3,682	172
March	1,545	196
April	8,230	203
May	8,444	213
June	6,413	238
July	8,735	304
August	15,731	149
September	7,893	152
October	8,094	166
November	4,658	172
December	2,240	177

Maliputo, Caranx ignobilis.—This species is the largest pampano in Philippine waters. It is also the largest among the fishes known to occur in Lake Taal, with the exception of a shark, *Carcharhinus* sp. Maliputo as heavy as 30 kilos have been caught in Baklad Pansipit. Such maliputo are locally called "sumañga." These are, however, quite rare.

Like the muslo, the maliputo is catadromous. It breeds in the sea, usually in deep water, while its young migrate to shallow water, even ascending rivers and eventually entering lakes where they stay for some time. In some cases the fish does not leave the lake on its seaward journey until after it has attained sexual maturity, or when it is ready to spawn in the sea. An example of this is the maliputo, *Caranx ignobilis.* Some migratory species, however, leave the fresh-water habitat to return to salt water when they are only a year old, or at least prior to sexual maturity. An example of this group of catadromous fishes is the muslo, *Caranx marginatus.*

Although it is generally known that the maliputo does not leave Lake Taal until it attains sexual maturity, my own observations at Baklad Pansipit give sufficient indication that such is not always the case. Small, immature maliputo, locally called "bulubuktok" are taken in Baklad Pansipit. These bulubuktok weigh on the average less than a kilo each. Records of catch at Baklad Pansipit for 1934 show that the bulubuktok make the seaward migration during August (Table 4).

TABLE 4.—*The number of maliputo taken from Baklad Pansipit in 1927 and 1934.*

Month.	1927.	1934.
January	0	0
February	0	0
March	503	0
April	1,075	0
May	73	407
June	139	413
July	568	533
August	205	1,716
September	0	32
October	0	42
November	42	47
December	0	143
Total	2,605	3,333
Average per month	372	416

Unlike the muslo which makes its seaward migration the year round, the maliputo makes its appearance in the Baklad Pansipit as early as March or as late as May of each year. From September to December it is not as abundant as during June, July, and August (Table 5).

TABLE 5.—*The number of adult and young maliputo together with their total and average weight in kilograms taken from the Baklad Pansipit in 1934.*

Month.	Adult.			Young.		
	Number.	Weight.		Number.	Weight.	
		Total.	Average.		Total.	Average.
		kg.	*kg.*		*kg.*	*kg.*
January						
February						
March						
April				3	25	0.833
May	407	866.1	2.128			
June	413	822.1	2.136			
July	533	1,230.5	2.309			
August	1,716	4,525.0	2.643	2,365	1,894.7	0.801
September	32	168.3	5.259			
October	42	106.7	2.541			
November	47	110.3	2.347			
December	143	411.6	3.571			

The lakeward migration of the young maliputo, which locally are also called "pepikat," occurs in greatest abundance from January to April.

Lumulukso, Chanos chanos.—Lumulukso are the large bañgos, generally sexually mature. The lumulukso (literally jumping) gets its name from its habit of making high leaps whenever surprised or disturbed.

This fish is another truly catadromous species, spawning in salt water and the fry or larvæ migrating into brackish waters or ascending streams and entering fresh-water lakes where they grow to sexual maturity.

Bañgos fry begin to appear in Balayan Bay and its contiguous waters in March and disappear in July, but occur in greatest abundance during April, May, and June.

The season of abundance of bañgos fry in the coastal waters from Nasugbu to Calatagan, Batangas, is similar to that of Balayan Bay, as shown in Table 8.

Bañgos fry drift towards the shores soon after they are hatched. They then enter quiet waters, such as sloughs, tidal streams, and mouths of rivers. After they have grown into strong individuals (probably a month old, and provided with

TABLE 6.—*Partial count of the bañgos fry collected from Balayan Bay within the Municipality of Lemery during 1935.*

Date of capture.	Number of fry.	Value at 10 centavos per 100.
		Pesos.
April 10, 11, 12	22,335	
April 18, 19, 20	66,470	
April 24, 25, 26	139,800	
April 27, 30	511,710	
Total for April	740,315	740.32
May 1, 2, 3, 4, 5	381,000	
May 6, 7	301,160	
May 8, 9	55,970	
May 10, 11	32,980	
May 13, 14, 15	346,550	
May 16, 17	403,150	
May 20, 21, 22	683,170	
May 26, 27, 28	84,350	
Total for May	2,288,320	2,288.32
June 7, 8, 9	77,940	
June 10, 11	104,630	
June 12, 13	308,140	
June 14, 15	22,140	
June 16, 17	440,640	
Total for June	953,490	
Total for the season	3,982,035	3,982.04

TABLE 7.—*Partial count of the bañgos fry collected from Palanas tidal waters of Lemery, Batangas.*

Date of capture.	Number of fry.	Value at 10 centavos per 100.
		Pesos.
April 10, 11, 12	2,500	
April 24, 25, 26	5,100	
April 29, 30	20,000	
Total for April	27,700	27.70
May 1, 4, 5, 6	11,400	
May 14, 15, 16	10,500	
May 20, 21, 22	20,000	
Total for May	41,900	41.90
June 11, 12, 13	12,000	
June 14, 15	11,500	
Total for June	23,500	23.50
Total for the season	93,100	93.10

TABLE 8.—*Bañgos fry in coastal waters from Nasugbu to Calatagan, Batangas.*

Date of capture.	Number of bañgos fry.	Value at 10 centavos per 100.
		Pesos.
April, 1930	----------	
May, 1930	1,598.000	
June, 1930	212,000	
July, 1930	212,000	
Total for 1930	2,022,000	2,022.00
April, 1931	676,000	
May, 1931	2,020,000	
June, 1931	656,000	
Total for 1931	4,352,000	4,352.00
April, 1932	376,000	
May, 1932	1,102,000	
June, 1932	1,730,000	
Total for 1932	3,208,000	3,208.00
April, 1933	----------	
May, 1933	2,474,000	
June, 1933	3,222,000	
Total for 1933	5,696,000	5,696.00
April, 1934	50,000	
May, 1934	1,402,000	
June, 1934	552,000	
July, 1934	378,000	
Total for 1934	2,382,000	2,382.00
April, 1935	318,000	
May, 1935	5,684,000	
June, 1935	500,000	
Total for 1935	6,502,000	6,502.00
Average per year	4,197,000	4,197.00

scales) they move more freely into brackish water. Those that have the chance to ascend rivers even enter fresh-water lakes, where they remain for a number of years (most likely two to four years) until they become sexually mature and are ready to make the seaward migration. At this age bañgos generally attain a length of 50 centimeters and are locally called lumulukso.

It is commonly believed in Batangas Province that the lumulukso breeds or spawns in deep portions of the sea. The waters around Maricaban Island, and Calatagan and Bauan Peninsulas of Balayan Bay, are believed by many fishermen to be the breeding grounds of the lumulukso.

The time of the seaward migration of the lumulukso is shown by the records of catch in the Baklad Pansipit (Table 9).

Table 9 shows that the lumulukso make the seaward migration at any time of the year. Examination of the seaward-migrating lumulukso showed that those passing through Pansipit River and caught in the Baklad Pansipit during November, December, and January have somewhat developed and enlarged gonads. Those caught during February, March, April, and May have very much enlarged gonads and show sign of approaching spawning activity.

Table 9 also shows that during about 36 years, from the period of 1888–1890 to that of 1926–1934, the number of lumulukso

TABLE 9.—*Number of lumulukso taken in Baklad Pansipit.*

Year.	January.	February.	March.	April.	May.	June.
1888	----------	----------	110	110	17	250
1889	----------	374	4,096	873	----------	----------
1890	----------	1,831	3,595	784	----------	----------

Year.	July.	August.	September.	October.	November.	December.
1888	1,706	2,080	1,723	53	----------	1,030
1889	----------	1,000	----------	970	1,882	1,555
1890	124	807	411	5,664	1,132	58

Average a year for the period 1888–1890 1,374

Year.	January.	February.	March.	April.	May.	June.
1926	----------	----------	----------	----------	----------	46
1927	----------	29	29	107	243	263

Year.	July.	August.	September.	October.	November.	December.
1926	8	201	490	130	81	6
1927	765	657	11	1	----------	----------

Average a year for the period 1926–1927 185

Year.	January.	February.	March.	April.	May.	June.
1933	----------	----------	----------	----------	----------	4
1934	125	24	25	20	118	-------

Year.	July.	August.	September.	October.	November.	December.
1933	11	665	484	1,168	397	217
1934	564	557	1,747	1,170	868	623

Average a year for the period 1933–1934 476

taken from the Baklad Pansipit had markedly decreased, the difference being 1,374 and 185 (1926–1927 period) or 476 (1933–1934 period).

Banak (mullets, Mugilidæ).—Two species of banak or mullets, *Mugil melinopterus* (Cuvier and Valenciennes) and *Mugil macrolepis* (A. Smith), are definitely known to occur in Lake Taal. However, many species of mullets are known to occur in Pansipit River. Among them are *Mugil cæruleomaculatus* Lacépède, *M. ceramensis* Bleeker, *M. ogilby* Fowler, *M. vaigiensis* Quoy and Gaimard, *M. amarulus* Cuvier and Valenciennes, and *M. lepidopterus* Fowler.

The seaward migration of the banak of Lake Taal, principally *Mugil melinopterus* and *M. macrolepis*, lasts from July or August to January, as shown in Table 10.

Table 10 also shows that the number of migratory banak in Lake Taal has markedly decreased within the 36 years from the 1888–1890 to the 1926–1934 period.

The lakeward migration of the fry and fingerlings of the banak lasts from January to May, but is most marked during February, March, and April. During these months in 1934 I collected plenty of fingerlings of banak in the mouth of Pansipit River and in the tidal waters of the Palanas regions of Lemery. Fingerlings of these fish were also collected by me during April, 1934, in Pansipit River, at the place where the Baklad Pansipit is located. During May, 1934, I collected numerous fingerlings of mullets along the shallow edge of Lake Taal. During February, 1934, I collected fry and fingerlings of *Mugil ceramensis, M. macrolepis, M. lepidopterus, M. amarulus, M. ogilby,* and *M. melinopterus.*

The result of my observations further showed that the common *aligasin, Mugil ceramensis,* breeds almost the year round, its fry and fingerlings having been encountered during every month of the year.

Igat or palos, Anguilla mauritiana.—This eel is one of the largest in the Philippines and is the largest among the so-called fresh-water eels. Specimens as long as 2 meters, with a body circumference of 460 millimeters, are not uncommon. The igat is also one of the choicest food fishes among the Philippine eels.

The Mauritian eel is migratory and is truly a catadromous species. The females are about three or four times larger than the males. *Anguilla mauritiana* is reported to breed or spawn in very deep portions of the open sea. After spawning, the parent eels are said to die. The newly hatched larvæ are ex-

TABLE 10.—*The number of banak (mullets) taken by the month.*

Year.	Number of banak (mullets) taken in—					
	January.	February.	March.	April.	May.	June.
1888						
1889	1,500					
1890	274					

Year.	Number of banak (mullets) taken in—					
	July.	August.	September.	October.	November.	December.
1888		288	2,800			700
1889		100		1,300	5,400	700
1890				2,467	900	

Average for a year for the period 1888–1890 2,550

Year.	Number of banak (mullets) taken in—					
	January.	February.	March.	April.	May.	June.
1926						
1927	27					

Year.	Number of banak (mullets) taken in—					
	July.	August.	September.	October.	November.	December.
1926	207	4	29	222	2	12
1927	818	78				

Average for a year for the period 1926–1927 200

Year.	Number of banak (mullets) taken in—					
	January.	February.	March.	April.	May.	June.
1933						
1934	258	4			6	

Year.	Number of banak (mullets) taken in—					
	July.	August.	September.	October.	November.	December.
1933	319	1,121	392	164	471	889
1934	341		31	60	33	1

Average for a year for the period 1933–1934 325

tremely transparent and pelagic. They drift towards the mainland, and, upon reaching shallow shores, enter estuaries and river mouths where they undergo metamorphic changes from transparent, laterally flattened larvæ into the form of pigmented young, similar in appearance and shape to the adults. At this juncture, the females segregate themselves from the males and continue their migration, ascending rivers, entering lakes or climbing mountain streams, where they develop into sexually mature individuals 1 to 2 meters long.

It is reported that it takes one or two years for this eel to complete the lakeward or mountain-streamward journey. It is known to ascend mountain streams as high as 1,530 meters above sea level.

When about ready to spawn the females begin to undertake the seaward trip. Upon reaching the mouths of rivers, estuaries and bays, they again join the males, with whom they make the journey to the continental shelves of the sea.

It is said that upon reaching the continental shelf the sexually mature and ripe eels let themselves fall to the depth of the sea, and the pressure thus produced causes the eggs and sperm to ooze out. Fertilization, therefore, takes place in the water.

The time of seaward migration of *Anguilla mauritiana* is shown in Table 11.

TABLE 11.—*The number of Anguilla mauritiana taken from Baklad Pansipit by the month from 1926 to 1934.*

Year.	Number of *Anguilla mauritiana* taken in—											
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1926							1		4	1	1	1
1927	2		1			1	3					
1933						1	1	14	29	68	86	78
1934	38	30		1	3	1	3	4	9	53	126	15

Table 11 shows that the seaward migration of *Anguilla mauritiana* occurs during any month of the year, but is most marked between September and November.

Other migratory fishes.—Among migratory fishes of little economic importance entering the fisheries of Lake Taal and Pansipit River are buan-buan, *Megalops cyprinoides;* kitang, *Scatophagus argus;* maya-maya, *Lutianus malabaricus;* bakoko, *Pomadasys hasta;* lañgaray, *Ambassis* spp. These fishes are also catadromous and breed only in salt water.

Fishes that are permanent residents of Lake Taal.—The only species of commercial significance that resides permanently in Lake Taal is the tawilis, *Harengula tawilis* Herre. This herring is believed to have immigrated into Lake Taal from Balayan Bay or the China Sea. In order to assure the conservation of this important food fish of Lake Taal, immediate attention should be given to the problem of the regulation of the methods by which the tawilis are caught. The bayakus, now in use, is a fine-meshed drag-seine that catches even the smallest fry of this species in large numbers.

Other permanent residents of Lake Taal of little commercial importance are the biyá, *Glossogobius giurus,* and the dalag, *Ophicephalus striatus.* Even these two species are now overfished, as sexually immature individuals are caught in large quantities.

PROBLEMS OF CONSERVATION OF THE FISHERIES OF LAKE TAAL AND PANSIPIT RIVER

Condition of the fisheries and causes of depletion.—From the discussions and data presented in the early part of this paper certain conclusions suggest themselves with regard to the conservation of the valuable fishery resources of Lake Taal and Pansipit River.

(1) The fisheries of Lake Taal and Pansipit River have apparently decreased markedly, both in the volume of catch and in their actual value in pesos and centavos during a period of about 36 years.

(2) Such depletion may be traced to the following causes:

(*a*) The unnecessary destruction of larvæ, fry, and fingerlings of fishes migrating from Balayan Bay to Lake Taal by way of Pansipit River. These migratory fishes furnish Lake Taal with the necessary stock for the propagation of the important commercial species of fish in that body of water. Destruction of such propagation stock takes place at the following places: (1) In the mouth of Pansipit River and its contiguous waters in Balayan Bay. During March, April, May, and June, the fry of bañgos and of many migratory fishes are abundant there. Bañgos fry are caught in abundance by means of the *salap,* fine-meshed sinamay nets that are very effective for catching the fry not only of bañgos but of all kinds of fishes. During other months of the year fry and fingerlings of such migratory fishes as the banak, kitang, alsó, talakitok, lañgaray, and others are also caught by salap and sakag. *Pukot* (drag seines), which are capable of catching small and young fishes, are operated in Balayan Bay near the mouth of Pansipit River. (2) In the Palanas tidal streams at Lemery, bañgos fry as well as fry of other migratory fishes are also effectively caught in abundance. Furthermore, the closing of the connection between these Palanas tidal streams and Pansipit River prevents the free migration of countless numbers of fry and fingerlings of migratory fishes from Balayan Bay into Lake Taal.

(*b*) Almost wholesale capture of adults and breeders which migrate seaward, either to develop into spawners or to breed in the sea, takes place at the following points: (1) In the open waters of Lake Taal where *pante* (gill nets) are extensively used to capture large fish. (2) Along the edge of Lake Taal, especially in the vicinity of the source of Pansipit River, where *baklad-bokana* (fish corrals) are constructed. Large fish on their way to Pansipit River preparatory to their seaward migration are caught in these fish corrals. (3) In Pansipit River, about a kilometer from the junction between Pansipit River and Lake Taal, a huge fish corral (Baklad Pansipit), blocking the entire width of the river, is constructed. In this baklad the greatest catches of Lake Taal fishes are made, and almost all the migratory fishes that leave Lake Taal to undertake the seaward journey are caught there. (4) In the lower portions of Pansipit River *salambao* (nets) are operated to catch fishes that escape the Baklad Pansipit from Lake Taal and those that are returning to the sea from the river itself. (5) In Balayan Bay, near the mouth of Pansipit River, baklad-bokana (fish corrals) and pukot (drag seines) are also operated to catch migratory fishes and fishes moving to and fro between the Bay and the River.

Measures for improving and conserving the fishery resources of Lake Taal and Pansipit River.—As the data of this study show, the fisheries of Lake Taal have undergone some depletion. The problem, therefore, is one of rehabilitation rather than one of conservation. Since the main cause of depletion is the unnecessary destruction of the larvæ, fry, and fingerlings of migratory fishes that compose the bulk of the fisheries, the catching of these must be regulated and restricted. To this end the following measures are suggested:

(1) The waters at the mouth of Pansipit River and its contiguous waters of Balayan Bay, for at least 200 meters from the general coastline, and 200 meters on each side of the mouth of Pansipit River, in the jurisdiction of Lemery and Taal, Batangas,

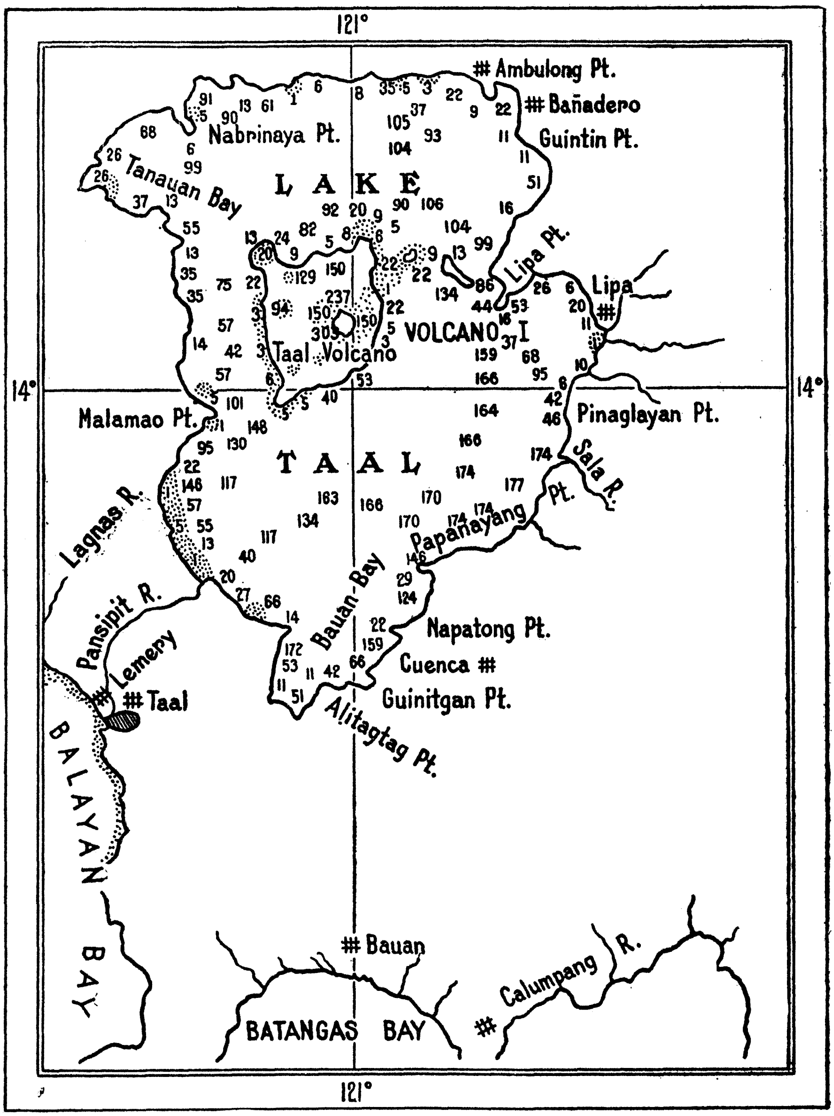

FIG. 1. Lake Taal and Pansipit River, including a portion of Balayan Bay. Pansipit River, connecting Lake Taal and Balayan Bay, is the only passage permitting the migration of fishes between these two bodies of water.

should be established as a fish sanctuary. This measure would have the effect of permitting undisturbed upstream and lakeward migration of a large volume of larval fishes, which eventually will reach Lake Taal to develop into individuals of marketable size or sexual maturity.

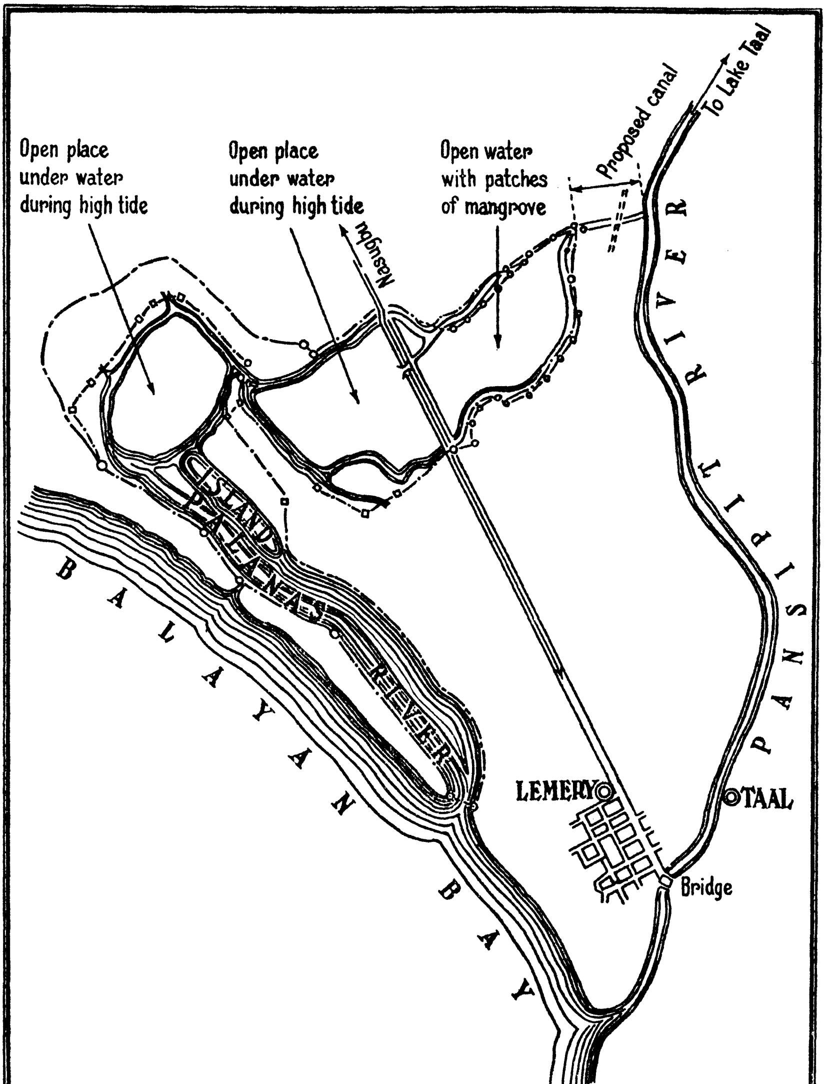

FIG. 2. Palanas River and its contiguous tidal streams at Lemery, including a portion of Balayan Bay. A portion of the tidal stream was closed when a provincial road was constructed through that point. The proposed canal to connect these tidal streams with Pansipit River will make possible the free migration of larval fishes from Balayan Bay into Pansipit River, and thence into Lake Taal.

(2) To further increase the volume of the larval migration from Balayan Bay into Pansipit River, and thence into Lake Taal, the following waters should also be converted into a fish sanctuary: The portion of Balayan Bay extending for 200 meters from the general coastline and 100 meters on each side of the

mouth of Palanas creek, including the entire tidal water of that creek and its tributaries, to its junction with Pansipit River in the jurisdiction of Lemery, Batangas. This Palanas area of Lemery is shown in text fig. 2. It is most important, however, that a canal be constructed to connect the Palanas tidal streams with Pansipit River. This canal would only be a few meters long and should cost the Municipalities of Taal and Lemery about 600 pesos to construct. The writer has repeatedly called the attention of the Municipal officials of Lemery and Taal, as well as that of the Provincial Officials of Batangas, to the urgent need for such a canal, and the Municipality of Lemery responded favorably by appropriating the sum of 200 pesos for the purpose. The Municipality of Taal has so far failed to give its share.[1] Through the efforts of the Provincial governor an item was included in the Appropriation Act for 1935, in which the sum of 5,000 pesos was to be set aside for the construction of the proposed canal, but unfortunately that item was among the many public works projects that came under the executive veto of the Governor General.

In line with the proposed protection of fry and larvæ of migratory fishes in Pansipit River, Balayan Bay, and elsewhere in the Philippines, the Bureau of Science has recommended the promulgation of Fish and Game Administrative Order No. 12, as follows:

Pursuant to the provisions of section 79 (B) of the Revised Administrative Code and of sections 4, 7, 8, 9, and 19 of Act No. 4003, entitled "An Act to amend and compile the laws relating to fish and other aquatic resources of the Philippine Islands, and for other purposes," and for the protection and conservation of banak and bañgos and certain fisheries in Batangas and Mindoro, the following rules and regulations are hereby promulgated for the information and guidance of all concerned:

1. *Five years close season.*—There is hereby established for five years from the date this Administrative Order takes effect a close season for the taking of all species of banak and bañgos and aquatic animals and plants or their parts or portions from all the waters described below:

(*a*) All the waters at the mouth of Pansipit River, 200 meters wide from the general coastline, and extending 200 meters on each side of the mouth thereof, in the jurisdiction of Lemery and Taal, Batangas.

(*b*) That portion of Balayan Bay, 200 meters wide from the general coastline and extending 100 meters on each side of the entrance or mouth of the Palanas creek, including the entire tidal water of the said creek

[1] June 11, 1937, the municipal council of Taal was reported to have appropriated the sum of 300 pesos as its share for the construction of the proposed canal. However, no negotiations have as yet been made with the owners of the land through which the canal in question would be constructed.

and its tributaries, to its junction with the Pansipit River, in the jurisdiction of Lemery, Batangas.

(*c*) All the waters at the mouth of Butas River, 200 meters wide from the general coastline and extending 200 meters on each side of the mouth thereof, in the jurisdiction of Naujan, Mindoro.

(*d*) All the waters around Paniquian Island, 200 meters wide from the general coastline in the jurisdiction of Puerto Galera, Mindoro.

2. *Prohibitions.*—It shall be unlawful at all times during the close season for any person, association or corporation to disturb or drive away from the areas described in the preceding section or in any manner take, kill or catch or cause to be killed, caught, or taken from these waters, purchase, sell, offer or expose for sale any aquatic animals or plants taken therefrom, dead or alive, or have in possession any part of same, except as provided in Section 3 of this Administrative Order.

3. *Exemptions.*—(*a*) For scientific, educational, personal or propagation purposes any person, association, institution or corporation of good repute may be granted by the Secretary of Agriculture and Commerce, free of charge, a permit to catch or take or cause to be caught or taken fishes of all sizes or aquatic animals and plants otherwise prohibited in this Administrative Order, subject to such conditions as the Secretary of Agriculture and Commerce may deem wise to impose for the proper conservation of the fisheries.

(*b*) Fish caught under these licenses but used for purposes other than those mentioned herein above shall subject the violators to the same penalty as if no permit had been granted.

4. *Enforcement.*—For the purpose of enforcing the provisions of this Administrative Order and of such regulations as may hereafter be promulgated, game wardens; members of the Philippine Constabulary; members of municipal and municipal district police; members of the secret service force; inspectors, guards, wharfingers of the Customs Service; internal-revenue officers and agents; officers of coast guard cutters and lighthouse keepers; and such other competent officials, employees or persons as may be designated in writing by the Secretary of Agriculture and Commerce, are hereby made deputies of said Department Head and empowered: (*a*) to arrest any person found committing or attempting to commit an offense against the provisions of Act No. 4003, and of this Administrative Order; (*b*) to seize, when deemed necessary, for evidence or for such purposes as the Secretary of Agriculture and Commerce or his duly authorized representative may consider advisable, any fishing gear or apparatus used or which may be used to catch, kill or take any protected fish or other aquatic animals or plants and fish caught or killed or aquatic animals taken or found in possession of any person, in violation of the laws and regulations; and (*c*) to file the necessary complaint in Court and report such violations to the Secretary of Agriculture and Commerce or to the Director of Science, for appropriate action (Sec. 5, Act No. 4003).

5. *Penalty.*—Any violations of the provisions of this Administrative Order shall subject the offender to prosecution and, upon conviction, he shall suffer the penalty provided in Section 83 of Act No. 4003, which is a fine of not more than two hundred pesos, or imprisonment of not more than six months, or both, in the discretion of the Court.

6. *Repealing provisions.*—All administrative orders and regulations or parts thereof inconsistent with the provisions of this Administrative Order are hereby revoked.

7. *Effectivity.*—This Administrative Order shall take effect on May 1, 1936.

(3) Another important cause of depletion of the fisheries under consideration is the almost wholesale capture of the breeders or spawners in Pansipit River. As has already been said, the migratory (catadromous) fishes must reach the salt water in order that they may develop their gonads or spawn. Since Lake Taal has but one outlet, Pansipit River, all fishes, in order to breed, must pass through Pansipit River, where almost all are caught in the Baklad Pansipit, a huge, permanent fish corral that blocks the entire width of the river. The baklad-bokana, baklad-wawa, and the salambao are also operated, with the same effect.

From the point of view of conservation and propagation, the most appropriate measure is the removal of the Baklad Pansipit. From the point of view of economics, however, this is hardly feasible, since by so doing the Municipalities of Taal and Lemery would lose the yearly income of 20,000 to 30,000 pesos derived from the lease of the rights to these fisheries. Most practicable, therefore, is the establishment of a short close season for seaward-migrating fish, so that a sufficient number of breeders may be allowed to reach the sea. It is also recommended that larvæ, fry, and fingerlings of migratory fishes be transplanted yearly from the mouth of Pansipit River or Palanas tidal streams to Lake Taal for purposes of propagation.

The best way to establish the close season is as follows:

The company holding the franchise to the fisheries of Lake Taal and Pansipit River should be required to provide a runway at least 5 meters wide in either wing of the Baklad Pansipit. This runway is to be opened only during the night, from 6 P. M. to 6 A. M., during the months designated hereunder for the following species:

(*a*) For the benefit of the muslo, *Caranx marginatus*, the month of August, when the greatest number of small muslo leave the lake for the sea. The average weight of the muslo of the 15,731 recorded in 1934 to have been caught in Baklad Pansipit is 149 grams (Table 3). This fish leaves the lake for the sea without first attaining sexual maturity. Therefore, those that should be protected are the young and small individuals that do not command a good price on the markets, and not the fish that are of marketable size.

(*b*) For the benefit of the maliputo, *Caranx ignobilis*, the runway should be opened during August also, as then the greatest number of adult and young maliputo migrate seaward (Table 5).

(*c*) For the benefit of the lumulukso fishery of Lake Taal and Pansipit River the runway should be opened during the last half of August and the first half of September, when the lumulukso appear to be migrating seaward and are ready to develop their gonads. The ideal period for the close season for lumulukso in Pansipit River is from November to January, when their gonads are well developed, but to this the lease holders of the fisheries would object, as they must recover the large amount paid to the Municipalities of Taal and Lemery. By allowing the seaward-migrating lumulukso a close season during the August–September period, the number of bañgos allowed to spawn would be sufficient to produce enough fry during the April–May bañgos-fry season in Balayan Bay in the neighborhood of the mouth of Pansipit River. A close season during the August–September period is also believed to be better than during the November–January period, because Pansipit River is deeper during the former than during the latter period, and hence the migrating lumulukso would have a better chance to reach the spawning ground. Other things being equal, the deeper the water, the more chance the fish have to escape during their journey in the River.

(*d*) For the benefit of the mullet or banak fishery, the runway should be opened during August. To protect further the spawning mullets (banak), the salambao (lever nets) should be prohibited in the Pansipit River during July, August, and September of each year.

(4) Another measure that can materially help in improving the productivity of the fisheries of Lake Taal and Pansipit River is the rescue and subsequent transplanting of larvæ, fry, and fingerlings of migratory fishes that become stranded in shallow portions of Balayan Bay, the Palanas tidal streams, sloughs, and other places in the vicinity of the mouth of Pansipit River. Among the fishes that have reacted favorably to the changes involved in transplanting fry from the brackish water to fresh water of the Pansipit River and Lake Taal are mullets (banak), bañgos, talakitok (Carangidæ), alsó (snappers), and kitang (spade or butterfishes). These larval fishes may be collected from time to time and transported in bancas or boats in which the water may be replaced with water at different portions of the Pansipit River during the trip from its mouth to Lake Taal.

Pansipit River is only 8 kilometers long, so that the transporting of the larval fishes is not difficult.

THE FISHERIES OF BALAYAN BAY

Commercial value.—An accurate estimate of the value of the fisheries of Balayan Bay is not available. However, taking into consideration the fact that the value of the fisheries of Lake Taal and the Pansipit River is conservatively estimated at 500,000 pesos annually, that of Balayan Bay should be more than twice that much. Balayan Bay is more than twice as large as Lake Taal, and undoubtedly has more species of commercial food fishes in large quantities than Lake Taal. (See page 192 and Table 12 for commercial food fishes.) The annual commercial value of the fisheries of Balayan Bay could therefore be conservatively estimated at 1,000,000 pesos. The yearly catches alone of the pelagic fishes, such as tunnies, mackerels, scads, sardines, herrings, and anchovies, would in all likelihood approach the estimated value. The value of the yearly catch of bañgos is placed at no less than 20,000 pesos.

Kinds of fish composing the fisheries of Balayan Bay.—The important species of fish found in Balayan Bay are listed in Table 12.

The seasonal occurrence of the commercial species of fish in Balayan Bay.—The fishing season for each of the commercial species of fish in Balayan Bay is shown in Table 13.

As shown by the catch in Lemery, Calaca, and Balayan, fish in Balayan Bay are abundant in the period from February to April, although they are not scarce during January, May, and June. Fish from Balayan Bay begin to appear in the markets in December. Certain species are caught in small numbers during July, and rarely and scarcely during August and September when fishing in Balayan Bay is possible only during calm weather.

Fishes of Balayan Bay that migrate into Pansipit River and Lake Taal.—Fry and fingerlings of the following species migrate from Balayan Bay into Pansipit River, and thence into Lake Taal. They supply the propagating stock of the most important fisheries of Lake Taal: Muslo, *Caranx marginatus;* maliputo, *Caranx ignobilis;* bañgos or lumulukso, *Chanos chanos;* banak, *Mugil* spp.; buan-buan, *Megalops cyprinoides;* palos or igat, *Anguilla mauritiana;* kitang, *Scatophagus argus;* bugin, *Hemiramphus quoyi;* bagaong, *Therapon* spp.; bakoko, *Pomadasys hasta;*

TABLE 12.—*Fishes entering the fisheries of Balayan Bay.*

Local name (Batangas).	English name.	Scientific name.	Family.
Tuliñgan	Oceanic bonito	*Euthynnus yaito* Kishinouye.	Thunnidæ,
Do	Frigate mackerel	*Auxis thynnoides* Bleeker	Do.
Tambakol	Yellowfin tuna	*Neothynnus macropterus* Schlegel.	Do.
Do	Albacore	*Thunnus germo* (Lacép.)	Do
Guliasan	Striped albacore	*Katwonus pelamis* (Linn.)	Do.
Tanigé	Spanish mackerel	*Cybium commerson* (Lacépède).	Scombridæ.
Lumahan	do	*Rastrelliger chrysozoma* (Ruppell).	Do.
Hasá-hasá	Short-bodied mackerel	*R. brachysomus* Bleeker	Do.
Galonggong	Round scad	*Decapterus macrosomus* Bleeker.	Carangidæ.
Do	do	*D. kurra* Bleeker	Do.
Matang-baka	Large-eyed scad	*Selar crumenophthalmus* (Bloch).	Do.
Salay-salay	Deep-bellied crevalle	*Caranx kallas* (Cuv. and Val.).	Do.
Do	do	*C. djedaba* (Forskål)	Do.
Do	do	*C. leptolepis* (Cuv. and Val.).	Do.
Oriles	Hardtail	*Megalaspis cordyla* (Linn.)	Do.
Muslong-laot	Pampano	*Caranx marginatus* Gill	Do.
Maliputong-laot	do	*C. ignobilis* (Forskål)	Do.
Talupak or dorado	Yellow leatherjacket	*Chorinemus lysan* (Forskål).	Do.
Talakitok	Pampano	*Caranx armatus* (Forskål).	Do.
Do	do	*C. malabaricus* (Bloch and Schneider).	Do.
Damis	Jack	*Hynnis momsa* Herre	Do.
Tawilis, tamban, tunsoy, manansi.	Herrings	*Harengula* spp.	Clupeidæ.
Manansing-laot, karis-karis.	Sardines	*Sardinella* spp.	Do.
Tambang-lapad	do	*Sardinella perforata* (Cantor).	Do.
Siliñasi	Fry of sardines and herrings.		Do.
Dumpilas	Herrings	*Ilisha hoevenii* Bleeker	Do.
Dilis, dulis, pilipitin	Anchovies		Engraulidæ.
Tuakang	Anchovy	*Stolephorus commersonii* (Lacépède).	Do.
Bolinao	do	*S. indicus* (Van Hasselt)	Do.
Dulong	Fry of anchovies, gobies, etc.		Engraulidæ, Gobiidæ, etc.
Asogon, torcilio	Barracuda	*Sphyræna jello* Cuv. and Val.	Sphyrænidæ.
Bicuda, babayo, rompe-candado.	Lockbreakers	*S. obtusata* Cuv. and Val.	Do.
Bañgos (small), lumulukso (large), kawag-kawag (fry).	Milkfish	*Chanos chanos* (Forskål)	Chanidæ.
Miralla	Slipmouth	*Leiognathus leuciscus* (Gunther).	Leiognathidæ.
Malauay	do	*L. equulus* (Forskål)	Do.
Sap-sap	do	*Leiognathus* spp.	Do.

TABLE 12.—*Fishes entering the fisheries of Balayan Bay*—Continued.

Local name (Batangas).	English name.	Scientific name.	Family.
Hiwas	Moonfish	*Mene maculata* (Bloch)	Menidæ.
Enles	Whitinglike inermiid	*Dipterygonotus leucogrammicus* Bleeker.	Inermiidæ.
Bisugo	Nemipterid	*Nemipterus japonicus* (Bloch).	Nemipteridæ.
Do	do	*N. tæniopterus* (Cuv. and Val.).	Do.
Kuyog	Siganid	*Teuthis* sp.	Teuthidæ.
Samaral	do	*Siganus* spp.	Do.
Aligasin	Mullet	*Mugil ceramensis* Bleeker	Mugilidæ.
Aguas	do	*M. macrolepsis* A. Smith	Do.
Do	do	*M. dussumieri* (Cuv. and Val.).	Do.
Banak	do	*M. melinopterus* (Cuv. and Val.).	Do.
Do	do	*M. cæruleomaculatus* Lacépède.	Do.
Do	do	*M. amarulus* Cuv. and Val.	Do.
Do	do	*M. vaigensis* Quoy and Gaimard.	Do.
Do	do	*M. ogilby* Fowler	Do.
Do	do	*M. lepidopterus* Fowler	Do.
Batalay	Garfish, needlefish, billifish, houndfish.	*Tylosurus giganteus* (Schlegel).	Belonidæ.
Kambabalo	do	*T. melanotus* (Bleeker)	Do.
Boguin siliw	Halfbeak	*Hemiramphus quoyi* (Cuv. and Val.).	Hemiramphidæ.
Sarmullete	Surmullet, goatfish	*Upencides vittatus* Bleeker	Mullidæ.
Do	do	*U. mollucensis* Bleeker	Do.
Do	do	*Upeneus indicus* (Shaw)	Do.
Do	do	*U. moana* (Jordan and Seale).	Do.
Lapu-lapu, kulapu, kaltang.	Groupers, sea bass	*Epenephelus* spp.	Epenephelidæ.
Apahap	White sea bass	*Lates calcarifer* (Bloch)	Latidæ.
Buan-buan	Tarpon	*Megalops cyprinoides* (Broussonet).	Megalopidæ.
Bidbid	Tenpounder	*Elops hawaiiensis* (Regan).	Elopidæ.
Bagaong	Grunt	*Therapon* spp.	Theraponidæ.
Bakoko	do	*Pomadasys hasta* (Bloch)	Pomadasysidæ.
Asohos	Whiting	*Sillago sihama* (Forskål)	Sillagonidæ.
Bolador	Flying fish	*Cypselurus oligolepis* (Bleeker).	Exocœtidæ.
Kitang	Spade or butterfish	*Scatophagus argus* (Bodaert).	Scatophagidæ.
Kabasi	Gizzard shad	*Nematolosa nasus* (Bloch)	Dorosomidæ.
Do	do	*Anodontostoma chacunda* (Hamilton-Buchanan).	Do.
Palos, igat	Fresh-water eel	*Anguilla mauritiana* Bennett.	Anguillidæ.
Guno	Silversides	*Atherina* spp.	Atherinidæ.
Mamali	Threadfins	*Polynemus* spp.	Polynemidæ.
Buñguan	Sea catfish	*Arius* spp.	Ariidæ.

alsó, *Lutjanus argentimaculatus;* malaway, *Leiognathus equulus;* lan͠garay, *Ambassis* spp. The following species move back and forth between Balayan Bay and Pansipit River: Samaral, *Siganus* spp.; aligasin, *Mugil ceramensis;* banak, *Mugil amaralus* and *Mugil ogilby;* kambabalo, *Tylosurus melanotus;* lapu-lapu, *Epenephelus* spp.; apahap, *Lates calcarifer;* asohos, *Sillago sihama;* mamali, *Polynemus* spp.

Fishing methods and gear used in Balayan Bay.—The following is a list of fishing methods and gear employed in Balayan Bay. They are not described in detail in this paper because they are generally the same as those used in other parts of the Philippines, and have, as a rule, already been repeatedly treated in the Philippine Journal of Science and other Philippine publications. However, the most important ones are illustrated to show certain peculiar differences from their kind as used in other parts of the Philippines.

I. Nets.
  1. Pukot (drag seines).
    a. Pukot-pang-gabi (seines used during night fishing).
    b. Pukot-pang-araw (seines used during day fishing).
    c. Bayakus (very fine-meshed seines used in shallow waters).
  2. Pante (Gill nets).
    a. Panteng-pang-manansi (gill nets for sardines, herrings).
    b. Panteng-pang-banak (gill nets for mullets).
    c. Panteng-pang-lumahan (gill nets for mackerels and scads).
    d. Panteng-pang-tenigé (gill nets for Spanish mackerels).
    e. Panteng-pang-dan͠gat (gill nets for catching slipmouths, ambassids, and other small shore and river fishes).
    f. Sapiao (gill nets operated in conjunction with luminous lights to attract and catch fishes traveling in schools, such as anchovies and young sardines and herrings).
  3. Sakag (scissors nets).
    a. Sakag or sulong (scissors nets for catching shrimps, crabs, and small shore and river fishes).
    b. Daplis or kurukutok (scissors nets operated in conjunction with a rope feathered with pieces of coconut husk used for driving the fish towards the nets, used principally to catch banak and other shore and river fishes).
    c. Sagap or salap (nets used for catching ban͠gos fry).
  4. Salambao (lever nets used for catching river fish, especially the banak).
  5. Dala (cast nets).

II. Fish corrals.
  1. Baklad.
    a. Baklad-pang-malalim (deep-sea fish corrals, principally for catching thunnies, mackerels, carangoids, etc.).

TABLE 13.—*Seasonal occurrence of commercial fishes in Balayan Bay in 1935.*

[a, Abundant; f, few; s, scarce.]

Common name (Batangas).	Scientific name.	January.				February.				March.				April.				May.				June.			
		Week.				Week.				Week.				Week.				Week.				Week.			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Tulingan	*Euthynnus yaito* Kishinouye. *Auxis thynnoides* Bleeker	f	a	f	f	----	a	a	----	a	s	a	a	a	a	a	f	f	----	----	----	----		f	----
Tambakol	*Neothunnus macropterus* (Schlegel). *Thunnus germo* (Lacépède).[a]	----	----	----	----	a	a	f	----	f	f	a	----	f	a	a	a	----	f	f	----	a	f	f	a
Guliasan	*Katwonus pelamis* (Linnæus).	----	----	----	----	a	a	f	----	f	f	a	----	f	a	a	a	----	f	f	----	a	f	f	a
Tanigé	*Cybium commerson* (Lacèpéde).	----	----	----	s	----	s	----	----	a	a	a	a	f	a	a	f	----	s	s	----	s	----	s	----
Lumahan	*Rastrelliger chrysozoma* (Ruppell).	----	----	----	----	f	a	f	a	----	a	a	f	a	a	f	a	----	f	----	----	----	----	f	----
Hasá-hasá	*Rastrelliger brachysomus* Bleeker.	----	----	----	----	f	a	f	a	----	a	a	f	a	a	f	a	----	f	----	----	----	----	f	----
Galonggong	*Decapterus macrosomus* Bleeker. *Decapterus kurra* Bleeker	a	a	a	a	a	f	a	f	----	f	f	----	----	s	----	s	----	----	----	----	----	----	----	----
Matang-baka	*Selar crumenophthalmus* (Bloch).	----	----	----	f	a	a	f	a	f	s	a	a	f	s	a	a	----	f	----	----	----	f	s	----
Hiwas	*Mene maculata* (Bloch)	----	s	f	f	----	f	f	f	a	f	a	a	s	f	f	s	----	s	----	f	----	s	f	----
Dilis	Engraulidæ (anchovies)	f	f	f	f	a	a	a	a	----	a	a	----	----	f	f	----	----	f	f	----	s	f	s	----
Salai-salai	*Caranx kallas* (Cuv. and Val.). *Caranx djedaba* (Forskål). *Caranx leptolepis*	----	----	s	f	----	a	a	f	f	a	a	f	a	f	a	a	----	f	s	----	s	f	s	s

Enles	*Dipterygonotus leucogrammicus* Bleeker.	----	----	----	----	----	----	----	----	a	a	a	a	f	a	a	a	----	f	a	----	f	s	----	----
Miralia	*Leiognathus leuciscus* (Günther).	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Manansi	Clupeidæ (sardines and herrings).	f	a	f	f	a	f	f	f	f	f	f	----	----	f	f	----	f	f	f	----	a	f	f	----
Dulong	Engraulidæ, Gobiidæ, etc., fry.	f	f	f	f	a	f	a	a	f	a	f	a	f	s	f	s	f	s	f	s	----	----	----	----
Laguidlid	Carangidæ and Scombridæ, young.	----	----	----	----	f	s	f	s	f	a	a	s	s	f	a	----	f	s	a	s	f	f	s	----
Bisugo	Nemipteridæ	s	f	f	f	----	f	a	a	f	f	a	----	----	s	s	----	----	----	----	----	----	----	----	----
Pulang-buntot	Red-tailed Carangidæ	f	f	f	f	----	a	f	f	f	----	----	----	----	f	f	----	----	----	----	----	----	----	----	----
Sapsap	Leiognathidæ (slipmouths).	----	----	----	----	----	f	f	f	----	f	a	s	f	s	f	s	f		s	f	----	----	----	----
Sarmullete	Mullidæ (goatfishes)	----	----	----	----	s	s	s	s	f	f	a	a	f	s	s	f	s	s	----	s	----	----	----	----
Lapulapu	Epenephelidæ (groupers and sea bass).	----	----	----	----	----	f	f	----	f	f	f	----	----	f	s	f	----	s	f	s	----	----	----	----
Kawag-kawag	*Chanos chanos*, fry	----	----	----	----	----	----	----	----	s	f	f	f	a	a	a	a	a	a	a	a	a	a	a	a

[a] *Thunnus germo* (Lacépède) is rarely taken in Balayan Bay; *Neothunnus macropterus* (Schlegel) is the common tambakol of that locality.

TABLE 13.—*Seasonal occurrence of commercial fishes in Balayan Bay in 1935*—Continued.

Common name (Batangas).	Scientific name.	July. Week.				August. Week.				September. Week.				October. Week.				November. Week.				December. Week.			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Tuliñgan	{*Euthynnus yaito* Kishinouye. *Auxis thynnoides* Bleeker}	s	f	f																					
Tambakol	{*Neothunnus macropterus* (Schlegel). *Thunnus germo* (Lacépède). [a]}		f	f	f	s					f	a													
Guliasan	*Katwonus pelamis* (Linnæus).		f	f	f	s					f	a													
Tanigé	*Cybium commerson* (Lacépède).																								
Lumahan	*Rastrelliger chrysozoma* (Ruppell).																								
Hasá-hasá	*Rastrelliger brachysomus* Bleeker.																								
Galonggong	{*Decapterus macrosomus* Bleeker. *Decapterus kurra* Bleeker}																	s	f	f	f	f	a	a	a
Matang-baka	*Selar crumenophthalmus* (Bloch).																								
Hiwas	*Mene maculata* (Bloch)		s	f	s																s	f	f	f	f
Dilis	Engraulidæ (anchovies)		s	f		s	f																		
Salai-salai	{*Caranx kallas* (Cuv. and Val.). *Caranx djedaba* (Forskål) *Caranx leptolepis*}																								

Enles	*Dipterygonotus leucogrammicus* Bleeker.																								
Miralla	*Leiognathus leuciscus* (Günther).																								
Manansi	Clupeidæ (sardines and herrings).	s				a	a	f			f											s	f	f	f
Dulong	Engraulidæ, Gobiidæ, etc., fry.																								
Laguidlid	Carangidæ and Scombridæ, young.																								
Bisugo	Nemipteridæ.																								
Pulang-buntot	Red-tailed Carangidæ																						s	f	f
Sapsap	Leiognathidæ (slipmouths).																								
Sarmullete, barak	Mullidæ (goatfishes)																								
Lapulapu	Epenephelidæ (groupers and sea bass).																								
Kawag-kawag	*Chanos chanos*, fry	f	s	s	s																				

[a] *Thunnus germo* (Lacépède) is rarely taken in Balayan Bay; *Neothunnus macropterus* (Schlegel) is the common tambakol of that locality.

b. Baklad-pandak (shallow-water fish corrals for catching sardines, herrings, anchovies, mackerels, scads, round scads, and other species that travel in schools in fairly shallow waters).

c. Baklad-pang-ilog (river fish corals used principally to trap migratory fishes).

d. Baklad-pang-bukana (fish corrals placed in the lake near source of river to catch principally migratory fishes).

e. Baklad-pang-wawa (fish corrals placed in Bay near mouth of river to catch principally migratory fishes).

III. Hook-and-line.

1. Pahila (trollings).
   - *a.* Trolling with live bait.
   - *b.* Trolling with artificial bait.
   - *c.* Trolling with dead fish and other animals as bait.
2. Kitang or haihai (set lines baited with shrimps, squids, crabs, pieces of fish, and other kinds of suitable bait).
3. Tubog (long lines with sinkers). This is known as still-line fishing.
4. Baliuasnan (hook-and-line tied to an end of bamboo or wooden pole).
5. Kawil-pang-pusit (hook-and-line for catching squids).

IV. Other gear and fish traps.

1. Bobó (basket fish traps with bait).
2. Bombon (bunches of twigs or branches of trees submerged in water to serve as traps).

Comparative statements as to the effect of some fishing gear upon certain fisheries of Balayan Bay.—On the basis of observations made for nearly one year (1934) on the composition of catch, the following may be regarded as affecting, one way or another, certain fisheries of Balayan Bay.

(1) All kinds of drag seines used in Balayan Bay catch large quantities of fry of sardines and herrings (siliñiasi) during February, March, and April. The bayakus catches the greatest number of siliñiasi. During these months these young fish are abundant, and are taken in appreciable numbers even in nets of the fish corrals.

(2) From February to April siliñiasi are also taken in large quantities by a fine-meshed gill net, called sapiao, and operated in conjunction with powerful luminous lights to attract schools of fishes, principally the clupeids and engraulids. The sapiao is of only recent introduction in Balayan Bay.

(3) The bayakus catches not only fry of sardines and herrings, but also anchovies and many other fishes occurring in the comparatively shallow waters of Balayan Bay.

(4) The sakag (scissors nets) are quite destructive to the larval fishes and crustaceans of Balayan Bay and its contiguous waters in the mouth of Pansipit River, resulting in the depletion of the fry and fingerlings of the migratory fishes.

(5) Fish corrals, especially the deep-sea baklad, should be given encouragement in Balayan Bay, as they do not catch immature fish but principally capture the large migratory fishes of the open waters, such as the tunnies, mackerels, and scads. Large-meshed gill nets should also be encouraged as they tend to catch only large and mature fishes.

RECOMMENDATIONS

For the purpose of following up the study of the fisheries of Balayan Bay, especially with regards to the proper conservation and utilization of its natural resources, the following recommendations are made:

(1) The distribution, seasonal occurrence, and migration of the important pelagic fishes such as Thunnidæ, Clupeidæ, Engraulidæ, and Scombridæ should be studied thoroughly. The Clupeidæ and Engraulidæ are already reported to have decreased markedly in recent years. The use of the sapiao, which is of recent introduction in Balayan Bay, should be looked into carefully in view of its effectiveness in catching young clupeids and anchovies. The bagoong industry of Balayan which requires large quantities of anchovies is now almost ruined, due to the scarcity of these fish.

(2) The use of fishing gear that are used solely in shallow waters and catch mostly larval and young (immature) fishes of commercial value should be regulated, after thorough study of the composition of their catch.

(3) The advisability and practicability of establishing refrigeration units in certain points in Balayan Bay, preferably in Lemery and Balayan, should be looked into. In these two towns large and oftentimes excessive catches are landed periodically, so that fresh fish have to be disposed of at a very poor price; yet, one or two days thereafter, the price rises up to a point where the average consumer cannot afford to buy.

(4) A more vigorous campaign should be waged in the enforcement of the dynamite law in the regions of Balayan Bay. The use of this explosive has been largely responsible for the destruction of fish and the prevention of the entrance into Balayan Bay from the open sea of schools of pelagic fishes.

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ILLUSTRATIONS

Plate 1

Schematic drawing of the deep-sea fish-corral (baklad), called "madalang" in Batangas Province. Heavy stones are attached to the ends of bamboo poles holding them in place, as it is impossible to set the poles in a bottom that is rocky or covered with corals.

Plate 2

Schematic drawing of shallow-water fish corral (baklad), called "malimit" or "pandak" in Batangas Province.

Plate 3

Schematic drawing of very shallow fish corral (baklad), called "panak" in Batangas Province.

Plate 4

Schematic drawing of drag seine used in Batangas Province, where it is called "pukot-pang-gabi."

TEXT FIGURES

[Drawn by Francisco Rafael.]

FIG. 1. Lake Taal and Pansipit River, including a portion of Balayan Bay. Pansipit River, connecting Lake Taal and Balayan Bay, is the only passage permitting the migration of fishes between these two bodies of water.

2. Palanas River and its contiguous tidal streams at Lemery, including a portion of Balayan Bay. A portion of the tidal stream was closed when a provincial road was constructed through that point. The proposed canal to connect these tidal streams with Pansipit River will make possible the free migration of larval fishes from Balayan Bay into Pansipit River, and thence into Lake Taal.

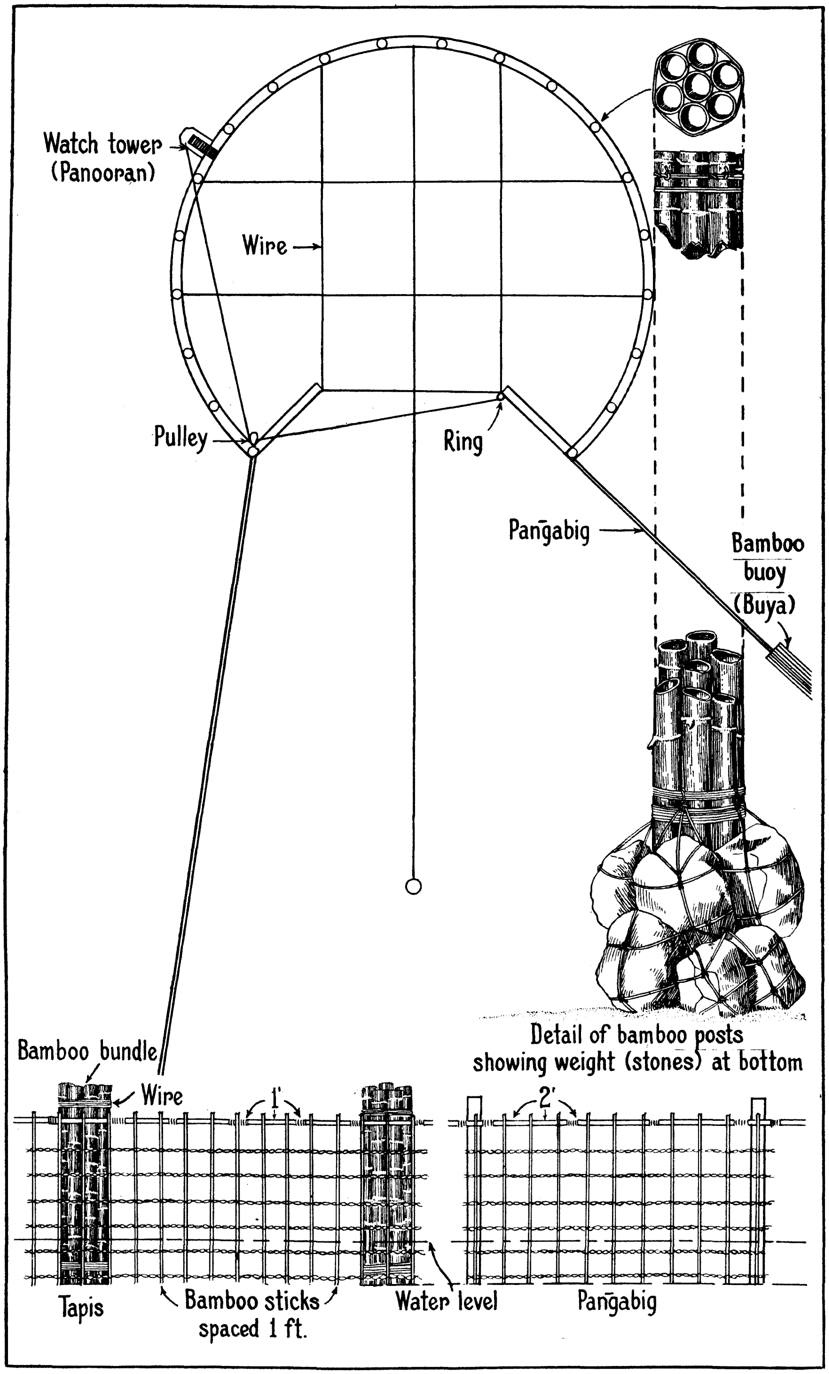
Watch tower
(Panooran)
Wire
Pulley
Ring
Pangabig
Bamboo
buoy
(Buya)
Detail of bamboo posts
showing weight (stones) at bottom
Bamboo bundle
Wire
1'
2'
Tapis
Bamboo sticks
spaced 1 ft.
Water level
Pangabig

PLATE 1.

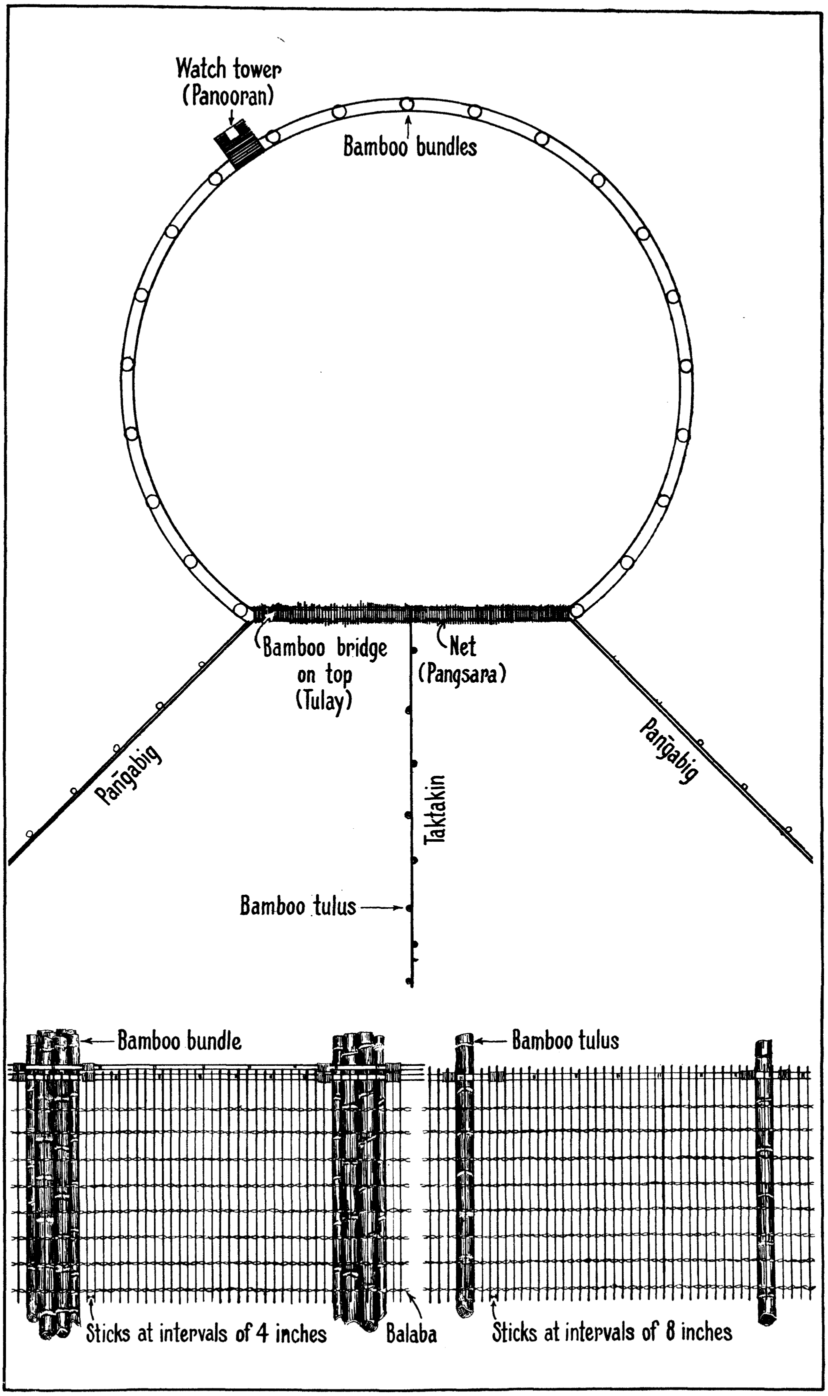
Watch tower
(Panooran)
Bamboo bundles
Bamboo bridge
on top
(Tulay)
Net
(Pangsara)
Pañgabig
Taktakin
Pañgabig
Bamboo tulus
Bamboo bundle
Bamboo tulus
Sticks at intervals of 4 inches
Balaba
Sticks at intervals of 8 inches

PLATE 2.

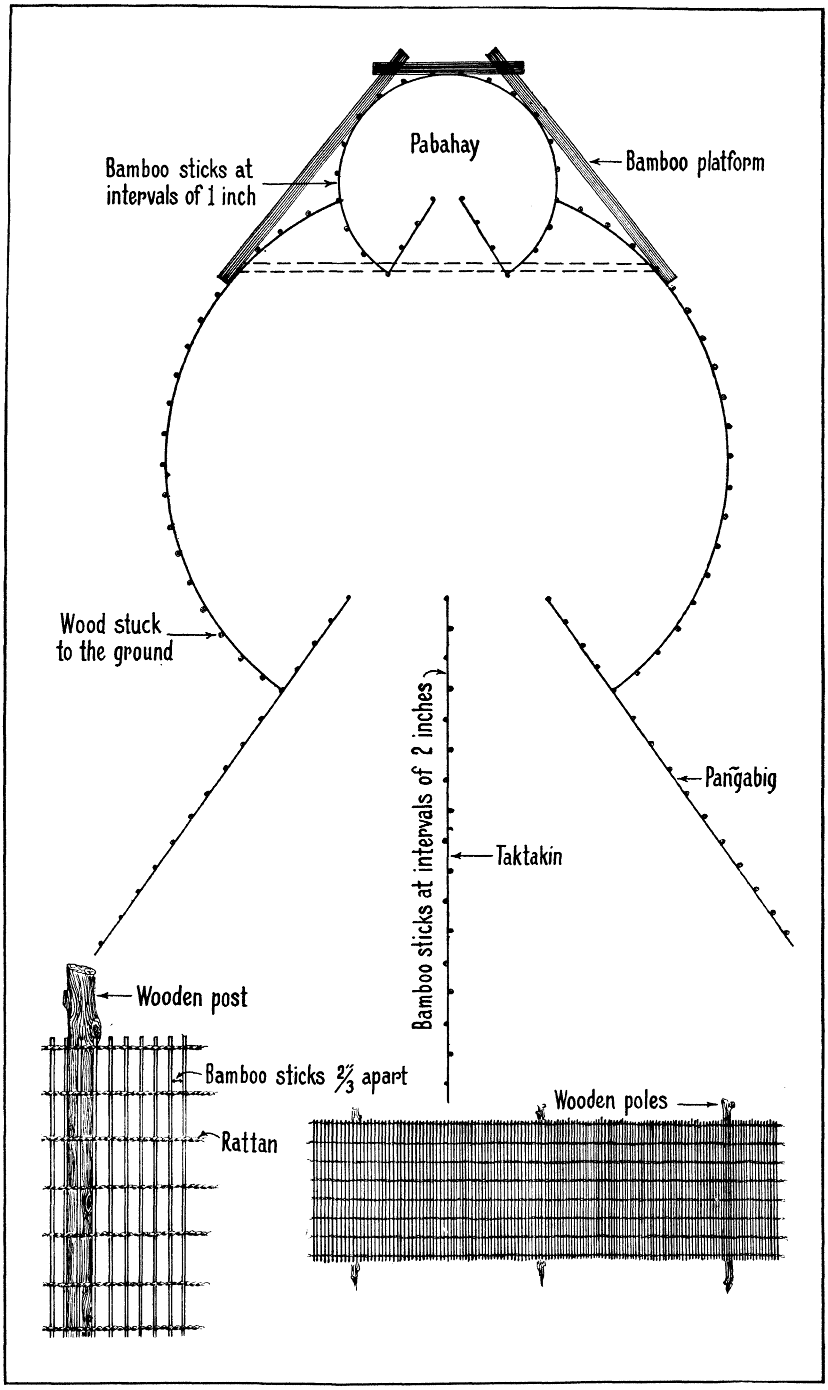
Pabahay
Bamboo sticks at intervals of 1 inch
Bamboo platform
Wood stuck to the ground
Bamboo sticks at intervals of 2 inches
Pangabig
Taktakin
Wooden post
Bamboo sticks 2/3 apart
Rattan
Wooden poles

PLATE 3.

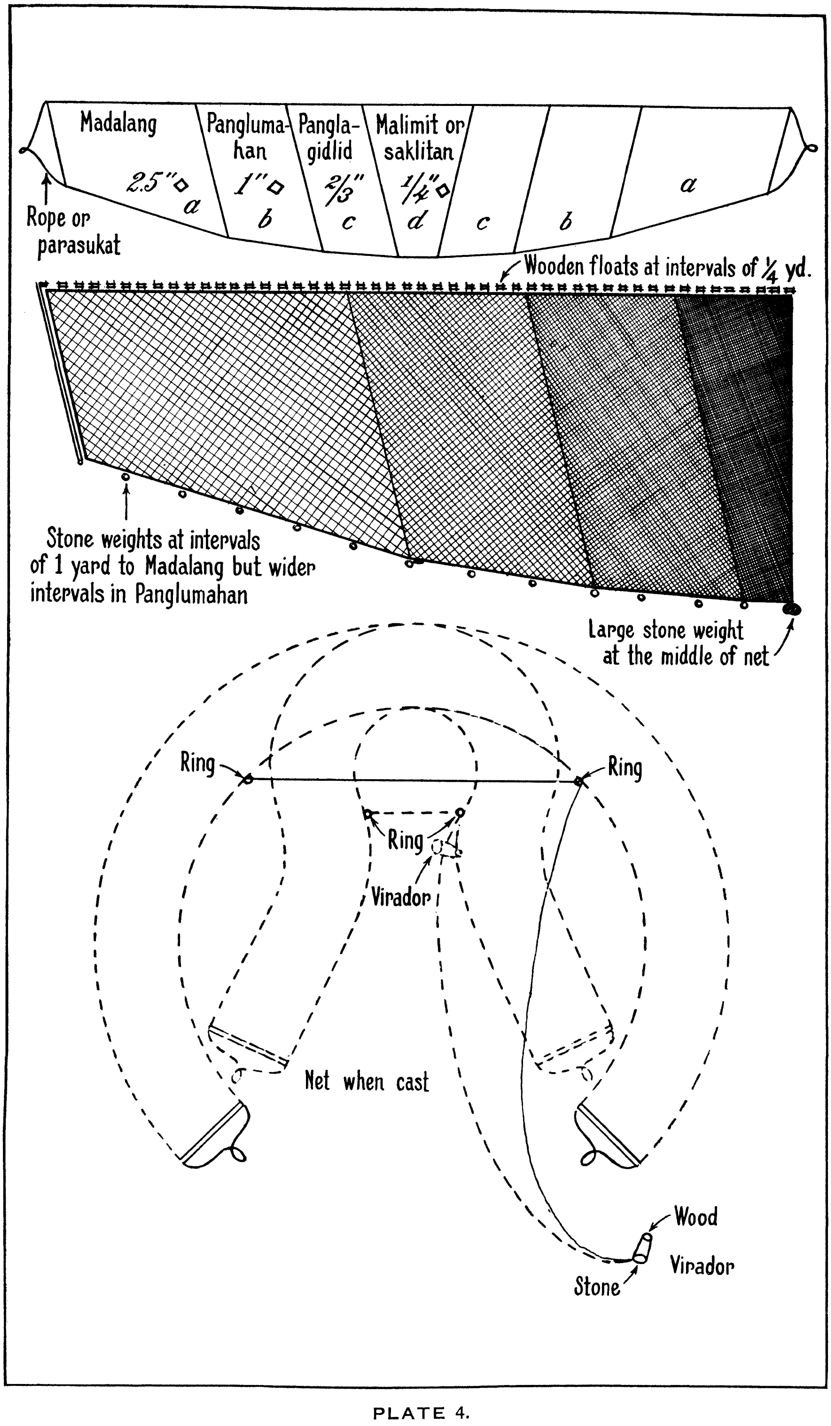
Madalang
Pangluma-han
Pangla-gidlid
Malimit or saklitan
2.5"
1"
2/3"
1/4"
a
b
c
d
c
b
a
Rope or parasukat
Wooden floats at intervals of 1/4 yd.
Stone weights at intervals of 1 yard to Madalang but wider intervals in Panglumahan
Large stone weight at the middle of net
Ring
Ring
Ring
Virador
Net when cast
Wood
Virador
Stone

PLATE 4.

THE FISHERY INDUSTRIES OF SAN MIGUEL BAY

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Of the Fish and Game Administration, Bureau of Science, Manila

SEVEN PLATES AND NINE TEXT FIGURES

INTRODUCTION

San Miguel Bay is one of the few rich fishing areas in the Philippines that are convenient and profitable during the southwest monsoon. It is rich because of its enormous supply of aquatic resources, convenient because it is least exposed to the prevailing monsoon, and profitable because the produce reaches the market when the supply of fresh fish is at its minimum, the majority of the fishing grounds in the Islands being exposed and thus unproductive during this most stormy part of the year.

The bay is somewhat pear-shaped in general outline, extending 18 miles southward from the entrance between Caringo and Siruma Islands and varying in width from 5.5 miles at this narrow entrance to 16 miles at its greatest width, the latter being about 4 miles distant from the head. Plate 1, adapted from Chart No. 4223 of the U. S. Coast and Geodetic Survey, shows the fishing grounds in this region and the extent of the available areas, the nature of the bottom, and the 5-fathom (dotted) line at mean low water.

Although a considerable part of the waters of the bay on the western coast falls under the jurisdiction of two towns in Camarines Norte Province, the major portion is under the control of five towns of Camarines Sur Province, from Siruma on the eastern coast to Sipocot on the western. The inhabitants of the towns of Cabusao, Calabanga, Tinambac, and Siruma are principally, if not solely, dependent upon the fishery resources of the bay for their livelihood. The bulk of the revenue of the local governments of these municipalities is derived from the fees collected for the privilege of fishing. Thus the state of the fishery will serve to indicate the living condition of the populace and the financial status of the local governments. Even a superficial glance at the economic conditions prevailing in these regions will not fail to reveal the importance of fisheries. However, because of injudicious exploitation of these valuable resources, the fishermen being interested merely in gathering all they can without giving the least thought to the prevention of depletion, it is imperative that regulatory measures based on intensive researches be formulated and enforced, not only by control on the part of the municipal authorities concerned, but also through the more desirable medium of education. The inhabitants should be acquainted with the necessity for such precautions in order that the richness of these grounds may yet be handed to posterity.

Table 1 shows the income from fishery of the different municipalities situated on San Miguel Bay, as compiled from the trial balance records of the Bureau of Audits, Manila. Most of this fishery income is derived from San Miguel Bay.

TABLE 1.—*Income in pesos from fisheries on San Miguel Bay for the period of 1931 to 1935 inclusive.*

Municipality.	1931	1932	1933	1934	1935
Daet [a]	264.78	416.00	393.50	261.75	296.75
Basud	21.00		36.50	30.00	28.50
Sipocot [a]	218.75	265.00	33.75	46.76	111.25
Cabusao	1,507.45	1,298.50	821.50	617.00	475.00
Calabanga	1,310.00	1,790.25	858.75	970.25	1,101.00
Tinambac	721.50	537.50	227.50	536.75	467.00
Siruma	994.50	825.70	559.00	511.50	583.80
Total	5,037.98	5,132.95	2,930.50	2,974.01	3,063.80

[a] Incomes only partly derived from the San Miguel Bay fisheries.

Table 1 shows that Calabanga leads in the fishing activities around the bay, and receives the greatest income from fishery from year to year. In the following paragraphs the status and importance of the fishery in each of the municipalities bordering on the bay, from Siruma on the extreme eastern end to Daet on the western, is graphically presented.

Siruma.—The new town of Siruma is situated on the northern shore of Siruma Bay, about 1.8 miles east of Siruma Point. The old townsite, about 1 mile east of Quelon Point, is now the barrio of Matandang Siruma.

Of the different municipalities around the bay, Siruma has the coastline that is most indented with smaller bays, foremost among which are Siruma Bay, Sapenitan Bay, and Butauanan Bay. The nature of its coastline makes Siruma a very rich fishing ground. Although the peak of the season is during the northeast monsoon, fishing is pursued in some parts almost the year round. The sea bottom in this vicinity is also the most rocky portion of the bay, the water being clear, deep, and steep-to. Thus a very profitable industry is being carried on in the catching of reef dwellers by hook and line with or without the use of light. Not only is the ground rich in coral reef species, but the shore is also frequented by pelagic game fishes seeking shelter; these species, also, are frequently caught by hook-and-line fishermen. The area is a good hiding place for these pelagic game fishes because portions of it are protected from both monsoons. The grounds in the neighborhood of the barrio of Tandoc in Butauanan Bay are an example. However, the two most important fishing barrios in the municipality are Bito and Sulpa.

Although the lumber industry is also very important in this region, especially in Tandoc where the largest sawmill in the Bicol region is situated, fishing is an important occupation, if not the most important, of the people, because of the presence of these rich fishing areas. Fish-corral and hook-and-line fishing are the most important methods employed. *Aboy bating, kub-kub, chinchorro, palubog, pamalao, laya,* and *bobo* are frequently employed during the northeast monsoon. Icing of the large-sized species and preservation by drying and salting are engaged in, especially in Bito where the corral fishery of this municipality is located.

Tinambac.—Although its waters are not as rich a fishing ground as the waters of Siruma, Tinambac has jurisdiction over favorable areas for the construction of fish corrals and the operation of the beam trawl during the northeast monsoon, the grounds being least exposed during this time of the year.

Tinambac is situated at the mouth of Himoragat River, towards its northern bank. Fishing and lumbering are the two important occupations of the inhabitants, especially since the collapse of the abaca and coconut industries. Bagacay, Buenavista, and Cagliliog are fishing barrios where enormous quantities of *balao* (tiny shrimps) are caught. The waters of the latter two barrios are especially favorable during the northeast monsoon and are usually frequented at this time of the year by net fishers from Calabanga.

Fish corrals, hook and line, palubog, *sakag, sapiao,* pamalao, *patalang sa tamban* or *panglambang,* and *bintol,* are the important appliances employed.

The preservation of the catch by drying and salting and the making of *bagoong* and *dinailan* are actively engaged in during the period of abundant catch.

Calabanga.—Although a somewhat interior town, Calabanga is the most important fishing center in San Miguel Bay, having jurisdiction over a long section of the southern coast. Its fishing areas are very profitable during the southwest monsoon, where fish corrals literally dot the shore, although they are somewhat barren during the northeast monsoon.

Baloñgay and Punta Calabanga are fishing barrios of Calabanga that are located at the mouth of Bicol River—the former having been the base of the Japanese trawlers at the start of their operations in San Miguel Bay. Sabang Calabanga is purely a fishing locality, thickly populated and all humming with fishing activity from February to September of each year. It is, in fact, the landing center of the major catch from San Miguel Bay during this part of the year. Fish dealers call at this place during the early hours of the morning to make their purchases for marketing of fish either in the fresh state at the town market in Naga or for curing for market on some future date either in the smaller towns of the Camarines Provinces or in Manila. The larger fishes are sent to Manila by rail. Fishermen from Manila Bay have settled here and are introducing their devices of fishing and their methods of preserving the catch. Fish-preservation plants for drying and salting are located in this barrio. Fish-corral, hook-and-line, kubkub, palubog, panglambang, aboy bating, and sakag are the most important methods of fishing.

Another important fishing barrio of Calabanga is Sibobo, the base of the three Japanese trawlers operating in the bay. Every morning, including Sundays, the fish dealers make their call at this place for the trawler's catch. Small salting and drying establishments are located there. Fish corrals dot the shores during the southwest monsoon.

Besides the purely fish-catching industry carried on in Sibobo, the barrio is a very rich collecting ground for window shell, where these shells are picked with the bare hands and sold to a Chinese dealer.

Cabusao.—The town of Cabusao is located on the western bank at the mouth of Bicol River. During the southwest monsoon it ranks second in importance as a fishing center. All its important barrios are fishing villages, foremost among which are Castillo and Barceloneta. Because of the extremely muddy bottom and the shallow water with abundant accumulations of sediment carried by Bicol River, the fishery is especially rich in shrimps. Fishing for *balao* (very tiny shrimps) is actively engaged in during the entire fishing season, but especially during June and July.

In this town the fish corral is also the most important fishing gear. Other gear employed are palubog, *sabay,* sakag, laya, *sarap,* and *largarete.*

Curing is engaged in to some extent—drying and salting of fish and the making of *hibe* and dinailan for the preservation of shrimps.

Sipocot.—This municipality is located in the interior, but it has jurisdiction over a portion of the western coast of the bay. It derives its fishery income from both San Miguel Bay and Ragay Gulf, exercizing control over Caima Bay in the latter.

Towards San Miguel Bay its fishing grounds and fishing conditions are not very different from those of Cabusao, its neighbor on the coastline of San Miguel Bay. The barrio of Cotmo is the only important fishing community under its jurisdiction.

Daet.—With the exception of a small strip of water under the municipality of Basud, Camarines Norte Province, the waters of San Miguel Bay after Sipocot and on the opposite western shore of Siruma are under the municipality of Daet, the capital of Camarines Norte Province. Daet itself is situated toward the interior, but it has control over a considerable portion of the western coast of the bay. Lalawigan, Matoogtoog, and Mercedes are the important fishing barrios, the last-named being the landing center of the catch for marketing in Daet, Paracale, and Mambulao, all rich markets for fish.

The coast is well indented, especially in the vicinity of Mercedes where there are several smaller islands. Considerable areas have rocky bottoms, so that reef dwellers are not infrequently caught by hook and line and in fish corrals. The well-protected grounds between the smaller islands southeast of Mercedes are favorable sites for the construction of fish corrals the year round. In effect, the corral fishery of Daet is almost wholly confined to this locality where the current is not so swift.

Basud.—As has been stated above, a portion of the western shore of San Miguel Bay falls under the jurisdiction of Basud, another interior town south of Daet. Añgas is the important fishing barrio where fish corrals and hook and line are the important devices employed.

FISHING CONDITIONS

Although fishing is carried on in different portions of San Miguel Bay the year round, the peak of the season is during the southwest monsoon, when the greater length of the coastline is least exposed to the two distinct monsoons prevailing in the Philippines. Such areas along the southern and western coasts under the jurisdiction of the municipalities of Calabanga, Cabusao, and Sipocot are all rich and favorable grounds during this part of the year. During the northeast monsoon, fishing becomes more active along the eastern coast, the waters under the jurisdiction of the municipalities of Tinambac and Siruma. In baylets and coves protected from the monsoons, fishing is carried on throughout the year, the condition obtaining, for instance, in the barrio of Tandoc, Siruma Municipality, where there are good fishing grounds for hook-and-line fishing for the larger species of game fishes. In view of the prevailing conditions, fish corrals along the eastern coast are set during September and removed before the end of May; on the western coast they are set in February or in March and removed during the latter part of September before the northeast monsoon.

Although scattered patches of rocky bottom are in different portions of the bay, especially in the neighborhood of the entrance along the western, but more so on the eastern coast, the ground as a whole is smooth, sand bottom in some parts and soft mud in others, the latter being more noticeable near the mouth of Bicol river toward the southern and southwestern areas. For the most part the bay is very shallow, especially towards the southern coast where the depth of the water decreases very gradually until it becomes extremely shallow even at a great distance from the shore. Besides a number of smaller rivers, two large rivers (Bicol and Looc) empty into it, carrying enormous amounts of plankton which serve to enrich the area for the feeding of the various species of aquatic animals.

Although the greater portion of the bay is very shallow and is filled with the stumps of the posts of old and discarded fish corrals, especially the area within the five-fathom line, the middle portion is of moderate depth with smooth bottom, a condition favorable for trawling operations even if only to a limited extent. In effect, the middle portion of the bay is the operating ground of the trawlers. In view of its proximity to a vast body of water (the Pacific Ocean), the current is quite strong at all times of the year, and especially during the change of tide.

Added to the velocity of the tidal current is the effect of the current caused by the prevailing winds. In the absence of wind current the trawls, which are always dragged with the direction of the current, are towed towards the south or landward during flood, and towards the north or seaward during ebb. Otherwise operated, it has been found impossible to drag the net with the 40-horse-power engines used by the trawlers. Like the other important fishing gear employed in the bay, the trawls fish along the western coast during the southwest monsoon and along the eastern coast during the advent of the northeast monsoon. The prevalence of large numbers of various species of jellyfishes in these waters, especially during the southwest monsoon, has become a great handicap to proper trawling operations, so much so that the three Japanese trawlers were forced to stop fishing because of losses occasioned by the very much diminished catch. Apparently the sting of these jellyfishes has some effect upon the fishes, scaring them away by their nematocysts. It has been observed, however, that during the northeast monsoon there are not so many of these pests, and that trawling is profitable in this region at such times.

Unlike the practice in other fishing centers, fishing with light is not very actively done in San Miguel Bay, as there are only a few occasional runs of those pelagic migratory species that appear in vast schools and are the only fishes readily caught by this method. Some fish-corral owners, a few largarete outfits, and a few of line fishermen, employ light to a limited extent.

COMMERCIAL CATCHES

Although large-sized pelagic game fishes, like the tunas, Spanish mackerel, barracudas, and reef-dwellers like the groupers, are caught by hook-and-line fishermen operating in Tandoc and Mercedes, these fishes are, in general, not found in abundance or caught in quantities inside the bay. The major resources of the bay lie in the large quantities of shrimps (*Penæus* spp.) croakers (Sciænidæ), spotted pomadasids (*Pomadasys hasta*), sea catfishes (*Arius leiotetocephalus*), and crabs (*Neptunus pelagicus*). Window shells (*Placuna placenta*) abound in the vicinity of Barrio Sibobo.

Although limited quantities of herrings (*Sardinella perforata*), anchovies (Engraulidæ), mullets (*Mugil* spp.), and mackerels (*Rastrelliger brachysomus*), are occasionally caught, it can be deduced from the above that the richness of these fishing grounds

TABLE 2.—*Commercial species of fishes caught in San Miguel Bay.*

Bicol name (San Miguel Bay).	English common name.	Scientific name.
Abo	Large-mouthed croaker	*Otolithes argenteus* Cuvier.
Aliso	Silver-spotted gray snapper.	*Lutjanus argentimaculatus* (Forskål).
Arado	Guitar fish	*Rhynchobatus djiddensis* (Forskål).
Arakaak	Plain croaker	*Johnius aneus* (Bloch).
Araran	Mullet	Mugilidæ.
Atoloy	Crevalle	*Caranx* spp.
Awal	Hammerhead shark	*Sphyrna zygæna* (Linnæus).
Bagaong	Theraponid	*Therapon* spp.
Bakoko	Fresh-water porgy	*Sparus berda* (Forskål).
Balanak	Mullet (small size)	*Mugil* spp.
Balisokan	Sergeant fish	*Rachycentron canadus* (Linnæus).
Bangkolis	Tuna	Thunnidæ.
Banogon	Spotted eagle ray	*Aëtobatus narinari* (Euphrasen).
Barorog	Slipmouth	*Leiognathus equulus* (Forskål).
Barira	Silver-bar fish	*Chirocentrus dorab* (Forskål).
Bilong-bilong	Wily slipmouth	*Leiognathus insidiator* (Bloch).
Bolgan	Sea bass	*Lates calcarifer* (Bloch).
Bolinao	Transparent herring	*Clupeoides lile* (Cuvier and Valenciennes).
Boñgalonon	Sharp-nosed shark	*Scoliodon palassorah* (Cuvier).
Borirawan	Moray	Murænidæ.
Buca dulce	Threadfin	Polynemidæ.
Bugiw	Half-beak	Hemiramphidæ.
Bulan-bulan	Tarpon	*Megalops cyprinoides* (Broussonet).
Burao	Striped mackerel	*Rastrelliger chrysozonus* (Rüppell).
Buroy	Halfbeak	*Hemiramphus far* (Forskål).
Damos	Lactarid	*Lactarius lactarius* (Bloch and Schneider).
Dapak	Red snapper	*Lutjanus malabaricus* (Schneider).
Daragon	Blue-spotted sting ray	*Dasyatis kuhlii* (Müller and Henle).
Dilis	Anchovies	*Stolephorus commersonii* Lacépède.
Do-al	Garfish	Belonidæ.
I-ito	Sea catfish	Plotosidæ.
Itang	Flathead	*Platycephalus* spp.
Kabalyas	Short-bodied mackerel	*Rastrelliger brachysomus* (Bleeker).
Kabasi	Short-finned gizzard shad	*Anodontostoma chacunda* (Hamilton-Buchanan).
Kikiro	Spadefish	*Scatophagus argus* (Linnæus).
Kini	Remora	*Echeneis naucrates* (Linnæus).
Kiskisan	Spotted pomadasid	*Pomadasys hasta* (Bloch).
Koron-koron	Four-lined theraponid	*Pelates quadrilineatus* (Bloch).
Kowa-kowa	Small-mouthed threadfin	*Polynemus microstoma* (Bleeker).
Krosan	Hammer-head shark	Sphyrnidæ.
Langkoy	Cutlass fish	*Trichiurus haumela* (Forskål).
Laolao	Fimbriated herring	*Sardinella fimbriata* (Cuvier and Valenciennes).
Lapis	Leatherjacket	*Scomberoides lysan* (Forskål).
Lapo-lapo	Groupers	Serranidæ.
Lawihan	Threadfish	*Alectis* sp.
Lawi-lawi	do	*Alectis indicus* (Rüppell).
Lison	Banded cavalla	*Caranx sexfasciatus* (Quoy and Gaimard).
Lodlod	Black-finned shark	*Carcharinus melanopterus* (Quoy and Gaimard).
Malagapas	Spotted mojarras	*Gerres filamentosus* Cuvier.
Mamsa	Cavalla	*Caranx* spp.
Managat	Red snapper	*Lutjanus* sp.
Matang baka	Big-eyed scad	*Caranx crumenophthalmus* (Bloch).
Milipili	Theraponid	*Therapon* spp.

TABLE 2.—*Commercial species of fishes caught in San Miguel Bay*—Ctd.

Bicol name (San Miguel Bay).	English common name.	Scientific name.
Motomot	Banded slipmouth	*Leiognathus fasciatus* Lacépède.
Nabilan	Thick-lipped grunt	*Plectorhinchus* spp.
Obod	Piko eel	*Murænesox cinereus* (Forskål).
Ogaog	Cow-nosed ray	*Phinoptera javanica* Müller and Henle.
Osoos	Whiting	Sillaginidæ.
Pagi	Rays	Batoidei.
Pagotpot	Whiskered croaker	*Sciæna* spp.
Pakan	Hardtail	*Megalaspis cordyla* (Linnæus).
Palad	Flatfishes	Heterosomata.
Pampano	Pomfret	*Stromateus niger* (Bloch).
Paras	Leaffish	*Platax orbicularis* (Forskål).
Pating	Sharks	Elasmobranchii.
Pirak-pirak	Spotted slipmouth	*Leiognathus ruconius* (Hamilton-Buchanan).
Pogapo	Grouper	Serranidæ.
Ponicon	Sea catfish	*Arius* spp.
Rayado	Bonitos	*Auxis* spp.
Riring	Drepane	*Drepane punctata* (Linnæus).
Rompe	Barracuda (large)	*Sphyraena* spp.
Salay-salay	Deep-bodied crevalle	*Caranx kalla* Cuvier and Valenciennes.
Saminayon	Yellow-striped goatfish	*Upeneoides sulphureus* (Cuvier and Valenciennes).
Sarañgan	Devil ray	*Mobula* spp.
Siliw	Flying fish	*Cypselurus* spp.
Sorodan	Sawfish	*Pristis* spp.
Suagan	Long-finned gizzard shad	*Nematalosa nasus* (Bloch).
Tabal-tabal	Banded pomadasid	*Pomadasys maculatus* (Bloch).
Tabañgoñgo	Sea catfish	*Arius leiotetocephalus* Bleeker.
Tabaroyan	Yellow-striped crevalle	*Caranx leptolepis* Cuvier and Valenciennes.
Taligmanok	Spotted eagle ray	*Aëtobatus narinari* (Euphrasen).
Talotoon	Deep-bodied pristipomid	*Pristipomoides* sp.
Tamban kabasi-on	Deep-bodied herring	*Sardinella perforata* (Cantor).
Tangigi	Spanish mackerel	*Cybium commerson* (Lacépède).
Tarakitok	Cavalla (large)	*Caranx* spp.
Tayotos	Whiting	Sillaginidæ.
Tegui	Deep-bodied anchovy	*Scutengraulis* sp.
Tingarog	Flame-colored snapper	*Lutjanus fulvus* (Bloch and Schneider).
Titso	Barracuda (small size)	Sphyrænidæ.
Toros	Siganid	*Teuthis javus* Linnæus.
Turiñgan	Bonito and tuna	Thunnidæ.
	SHELLFISHES	
Balao	Tiny shrimp	*Palæmonetes.*
Kanoos	Squid	Decapoda.
Kapis	Window shell	*Placuna placenta* Linnæus.
Kasag	Crab	*Neptunus pelagicus* Linnæus.
Pasayan	Shrimps	*Penæus* spp.

consists in submerged resources rather than in abundance of the pelagic migratory species that appear in vast schools and are caught at definite seasons of the year. This region is an abode of "ground" species, which frequent muddy bottoms and derive most of their food from the enormous quantities of plankton life carried with the sediment of the large rivers that empty into the bay. Thus it has been observed that after heavy rains the fish corrals set nearer the shore make better and larger hauls than those constructed in the deeper waters. Even the trawls which always fish in the deeper waters of the bay are ineffective in the capture of such shore-feeding species as the shrimps and the sea catfishes. Evidently these fishes are nearer the shore during this time for feeding purposes.

Table 2 is an alphabetical list of the different species observed in varying quantities in the catches of the different gear in use in San Miguel Bay, together with their local names. Due to the influence of fishermen that came from Manila Bay, some fishes are known by two names—the San Miguel Bay Bicol and the Manila Bay Tagalog.

FISHING METHODS

As in other fishing centers in the Philippines, the methods of fishing employed in San Miguel Bay are varied and numerous, ranging from the simple way of catching fish by the use of hook and line with or without the use of banca and light, to the more modern beam trawling involving the use of a motor boat of more than three tons gross. Because of the nature of the sea bottom in this region and the fact that the major resources consist of submerged species, the fishing appliances used are designed and constructed largely for the catching of so-called "ground" fishes.

As many fishermen from Manila Bay, mostly from Rizal Province, are operating in San Miguel Bay, the majority of the fishing gear used more or less resemble or are identical with gear used in Manila Bay. The fishermen from Manila Bay have brought with them their methods of fishing, which, with the exception of the beam trawl, have been adopted by the Bicol fishermen, who are now employing them with skill and ease.

Japanese beam trawl.—From the point of view of volume of catch, the beam trawl is the most important fishing method in use. Having been operated here for barely a year's time, this gear has met with stiff opposition from the native fishermen and the local authorities. Two petitions were forwarded, one to the President of the Commonwealth of the Philippines and the other to the Secretary of Agriculture and Commerce. An investigation of this gear was conducted by the writer, the results of which are given below.

These beam trawlers are operated in the deeper waters of the bay, in the neighborhood of the mouth of Bicol river, in depths ranging from 6 to 17 fathoms, toward the western coast during the southwest monsoon and toward the eastern coast during the northeast monsoon.

The description of the make and the mode of operation were published in a previous paper.[1]

The three trawlers with Sibobo, Calabanga, as their home port start for the fishing ground between 7 and 8 A. M., after receiving their provision, fuel for the engine, and ice for the catch. They reach the fishing ground at about 11 A. M. when the trawl net is shot for the first time. It is then towed until about 2:30 P. M., when the first haul is made. If the conditions of the current do not change, the second shooting occurs about 3 P. M., after the catch of the first haul is sorted and stored, and when the approximate point of the start of the first towing is reached. The net is again towed until about 7 P. M. when it is hauled for the second time. The third shooting takes place at about 8 P. M., and the net towed until about 2 A. M., when the third and last haul is made. The trawlers (only three were operating in San Miguel Bay during the investigation in 1936,—"Lubang III," "Lubang V," and "Mabuhay A") then start on their homeward trip to Sibobo, where they arrive between 4 and 5 A. M.

Aboard the trawlers the Filipino middlemen purchase the catches and take them by truck to Naga. The large-sized specimens are packed in boxes with ice and shipped to Manila by rail, while the smaller fishes are sold to retailers for marketing in the local fresh-fish markets. The wholesale prices paid by these middlemen are definite for each of the major species that compose the catch. The unit measure used in these wholesale transactions is the kerosene box (case containing 2 kerosene cans of about 5 gallons each), which, when it is filled with fish, weighs approximately 25 kilograms on the average.

PRICES FOR EACH OF THE SPECIES MOST FREQUENTLY CAUGHT IN QUANTITIES BY THE TRAWLERS IN SAN MIGUEL BAY

Kind of fish.	Price per 25 kilograms. Pesos.
Kiskisan	3.00
Abo	2.00–2.20
Pagotpot	0.80–0.90
Pasayan	4.00–4.50

[1] Philip. Journ. Sci. 48 (1932) 389–410.

The grounds being extremely shallow and not far from the home port or base, a trawler with a Japanese engine of more than 40 h. p. is expensive and unnecessary. The trawlers operating in San Miguel Bay are all steered from a wheelhouse.

The following is an itemized list of expenses involved in the capitalization of one of the trawlers, the "Mabuhay A" (12.48 gross tons capacity), operating in San Miguel Bay, as furnished by Mr. Uehara:

	Pesos.
Vessel (Sampan type)	3,500
Engine (40 h. p. Japanese make at 70 pesos per h. p.)	2,800
Three trawl nets at 250 pesos per net	750
Winch	200
Warps (wire and hemp)	100
Iron chains (200 kg at 0.15 pesos per kg)	30
Glass floats (100 at 0.10 peso per float)	10
Stone weights (60 at 0.15 peso per weight)	9
Total	7,399

The catch of the trawlers in San Miguel Bay is very different from those of other trawling grounds—Manila Bay, Lingayen Gulf, and Ragay Gulf—in that the bulk consists of fewer species. The kiskisan are caught in moderate or large sizes and the abo, not found in other trawling grounds in the Islands so far exploited, is present in great quantities. The shrimps appear in small and moderate sizes, none of the large ones common in Ragay Gulf being included in the catch.

Fish corrals (*sagkad*).—Of the different native devices of fishing in use here, the fish corrals, locally known as *sagkad,* are the most important and numerous, literally dotting the shores along the western and southern coasts during the southwest monsoon and along the eastern coast during the northeast monsoon. Various sizes, styles, and shapes set in varying depths of water are seen in this region, some of them native or local styles and others introduced by the fishermen of Manila Bay.

For shallow waters, they have the *pamasayan,* and as the name signifies, is used for the catching of *pasayan* or shrimps. This device is either of the natural or of the *toris* type, set in depths up to 7 feet, and necessitates an investment of about 100 pesos. Text figs. 1 and 2 are the ground plans of the 2 types of pamasayan used in this region. As has been previously stated, the catch consists mostly of shrimps of different species and of various sizes, together with limited amounts of small-sized fishes found not far from the shore.

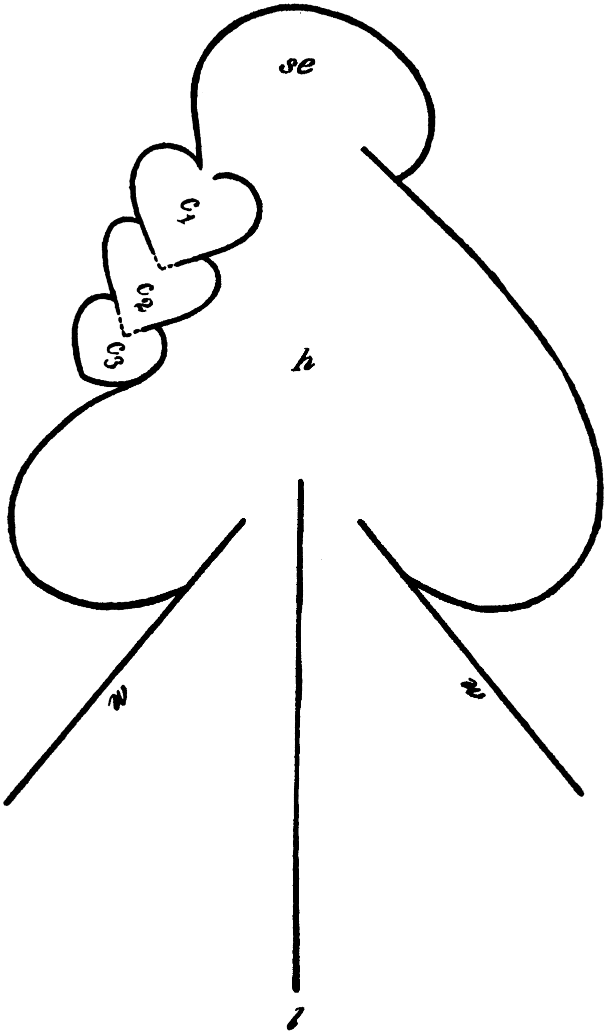


FIG. 1. Pamasayan (shallow-water fish corral) of the natural type; diagrammatic. *l*, Leader; *w*, wings; *h*, heart; *se*, semicircular enclosure; c_1, c_2, c_3, cribs or pounds.

Text fig. 3 is the ground plan of the *sabay*, a local movable shallow-water fish weir that is transferred from place to place as the conditions for good fishing demand. The gear consists of long, but low, split-bamboo mattings supported on poles and set parallel to the coastline just before ebbtide. It is about 800 feet long and about 4 feet deep.

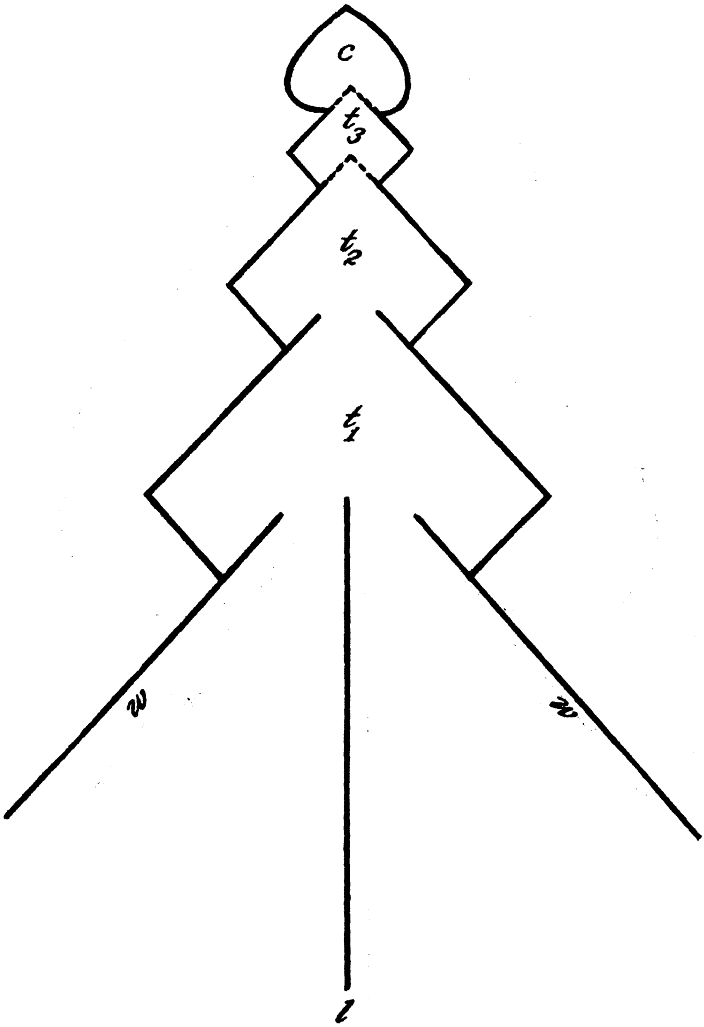


FIG. 2. Pamasayan of the toris type; diagrammatic. *l*, Leader; *w*, wings; t_1, t_2, t_3, triangular compartments; *c*, crib or pound.

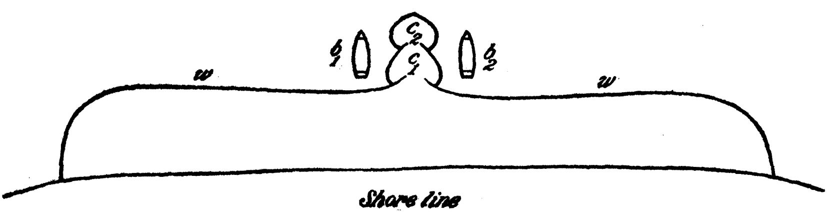


FIG. 3. Sabay, a transitory fish weir; diagrammatic. *w*, Wing; c_1, c_2, cribs or pounds; b_1, b_2, attending bancas.

With the ebbtide, small-sized mullets and shrimps brought by the flood are caught and impounded in the small terminal crib, c_2, as the water recedes. From here the catch is collected by means of dip nets into the bancas, b_1 and b_2.

After brailing out the catch, the whole apparatus is removed to be set in some convenient and profitable site before the next ebb, when the whole operation is repeated.

This fishing device necessitates the investment of about 200 pesos and requires 5 men to operate.

Text fig. 4 is the ground plan of the deep-water fish corral, known in the San Miguel Bay region as the *quinavite,* because Cavite fishermen are supposed to have introduced it there. In

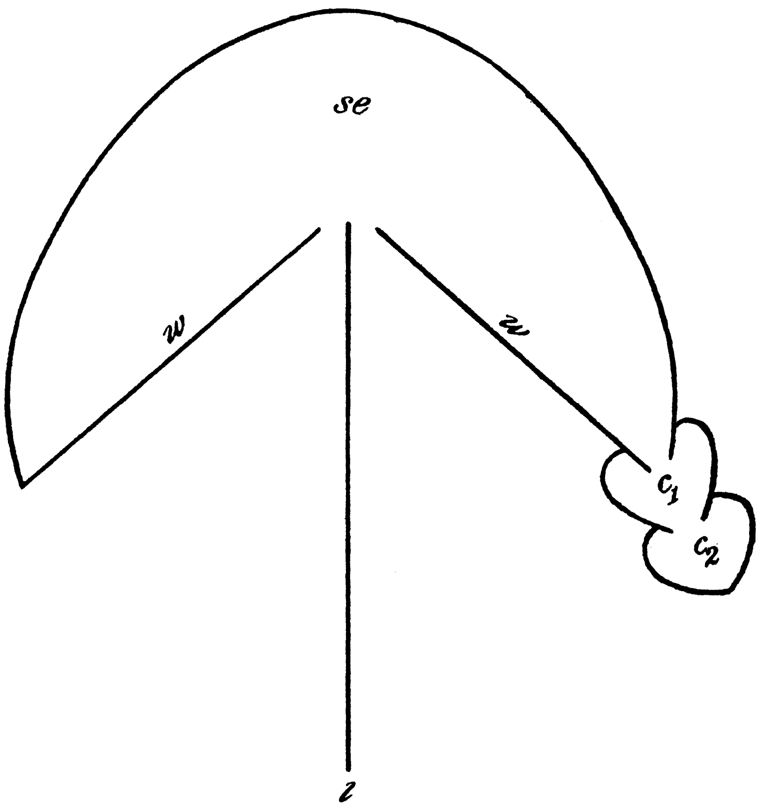


FIG. 4. Quinavite (deep-water fish corral); diagrammatic. *l*, Leader; *w*, wings; *se*, semicircular enclosure; c_1, c_2, cribs or pounds.

fact, as previously stated, many of the fish corral owners and operators in this region came from Manila Bay and have become permanent residents of this place.

This type of fish corral is generally set in waters ranging from 3 to 7 fathoms in depth, and necessitates the investment of from 400 to 600 pesos. The *siguin* (a drag net with purse rings) is usually employed in the collection of the catch. The catch consists of the large-sized pomadasids, cavallas, sea catfishes, and sharks, and the smaller pelagic species, like the mackerels and the deep-bodied herrings. During the period of investigation, (1936) with the southwestern monsoon prevailing, the fish weirs constructed in comparatively shallower waters were observed to have made greater and larger catches of sea catfishes and cavallas—a phenomenon which seems to signify that during the rainy season the vast quantities of nitrogenous matter and plankton carried by the rivers are responsible for the congregation of more fishes nearer the shore for feeding purposes.

Kubkub.—The kubkub in this region is different from the purse seine of the Tagalogs. In San Miguel Bay it is not exactly a purse seine. It is commonly employed in the catching of demersal species, such as the spotted pomadasids (kiskisan) and the sea catfishes (tabañgoñgo). Although used without light, it is operated only in the dark of the moon, apparently to prevent the fishes from being scared by the netting.

Text fig. 5 is a diagrammatic presentation of its operation. The gear itself consists of two sets of nets—an outer curtainlike impounding net of variable length and of any size of twine and width of mesh for surrounding or impounding the school, and an inner pursing net generally consisting of two pieces of siguin (fish-corral drag seine) joined together. The inner net is a brailing net operated in much the same way as in the deep-water fish corral, being dragged from one side of the pound to the other and the bottom line being pursed as the opposite side is reached, where the catch is brailed into the attending banca.

A submerged school of demersal fishes is first located by the luminescense of the water. It is then surrounded by the first or outer net which hangs to the bottom of the sea like a curtain. The pursing net is then paid out inside the first netting and dragged from one side to the other of the impounding net, as in seining a deep-water fish corral, and its bottom line pursed. Hence the second or inner net serves the purpose of an auxiliary pursing net which becomes a huge dip net when thus pursed for the brailing of the catch. The catch are generally only the large-sized kiskisan and tabañgoñgo.

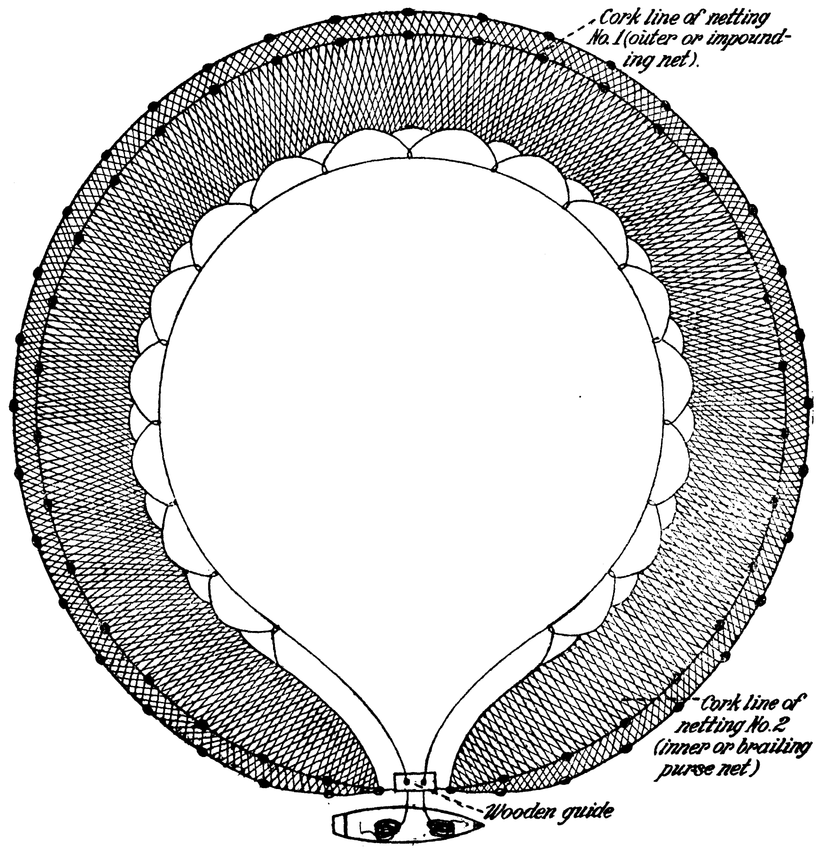


FIG. 5. Kubkub in operation; diagrammatic.

One outfit of this gear necessitates the employment of over 30 men in its operation and requires the investment of about 600 pesos.

Hook-and-line fishing.—Although quite an antiquated fishing gear, the hook and line used in various ways is of commercial importance in this region because of the great number of hand liners. They thus bring to the market a considerable quantity of fish when their catch is considered as an aggregate haul.

With neither banca nor light, fishing is done in wharves or in some convenient steep-to places where the lines can be easily played.

When a banca is employed and in daytime fishing, the lines are cast from a boat some distance from the shore, where fishes (usually abo and osoos) bite freely. As many as 50 handline fishing bancas in limited areas where fishes abound are not an uncommon sight off the barrios of Bito and Cagliliog.

When fishing is done at night during the dark of the moon, light is employed, not for actual fishing for the large-sized game fishes, but for attracting the smaller pelagic species upon which the former prey. The presence of these smaller fishes serves to attract the larger species sought after, and fishing is done in the manner of chumming. The kerosene lamps used are of several makes, among them Coleman, Petromax, and Standard, and of varying intensity. The aggregate catch of the great number of fishermen operating with hook and line and light is enormous, and certainly to be reckoned with in the fresh-fish supply. This type of hook-and-line fishing is especially common in Tandoc, the catch contributing considerably to the supply sent in ice from Naga to Manila by rail.

To some extent *quitang* (trawl line) and *sibid-sibid* (trolling) are employed for the catching of such pelagic game fishes as the tangigi (Spanish mackerel), the turiñgan (tuna), the rompe (barracauda), and the lison (cavallas).

Palubug or patalang.—This gear is also commonly employed by the native fishermen. It is a gill net similar to the *bating* of the Tagalog fishermen, both in make and in the mode of operation, save that the former is slightly smaller and made of different sizes of netting, depending upon the species sought after.

Table 3 is a comparative list of the different kinds of palubog employed in this region, the kinds of netting used, and the species of fish caught.

TABLE 3.—*Types of palubog used in San Miguel Bay and the fishes caught by them.*

Name of gear.	Netting used.		Species caught.
	Mesh.	Twine [a] No.	
	Inches.		
Palubog sa balanak	$1\frac{1}{3}$	40	Mullet.
Palubog sa tamban	$1\frac{1}{4}$	27	Deep-bodied herring.
Palubog sa lawihan	2	31	Long-finned gizzard shad.
Palubog sa kabasi	2	5	Short-finned gizzard shad.
Palubog sa kiskisan	4	2 or 5	Spotted pomadasid.
Palubog sa tabañgoñgo	4	30	Sea catfish.

[a] The sizes of the twines adopted are arbitrary numbers used in the catalog of L. R. Aguinaldo for 1935.

The net with wooden floats on the cork line and lead weights on the bottom line is composed of several separate rectangular pieces that are joined together in the actual fishing operation to produce a net of considerable length. Each piece is about 1,500 meshes long and about 10 feet deep.

It is carried on board a banca. When a school of fish is sighted, the net is paid out in such a way as to describe a circle enclosing and impounding the fishes. The banca then enters the inclosure and the fishermen scare the impounded fishes into the meshes of the net by beating the water and by making all sorts of disturbance. Once the fish are gilled, the net is hauled in, and the fishes are picked one by one from the meshes.

Sarap.—The sarap is a small shore seine of sinamay or abacá cloth. Its length and depth vary with the species for which it is designed. Two kinds of sarap are commonly used in this region. One is the *pamalao,* used in catching tiny shrimps (balao) and usually equipped with a bag of from 10 to 15 feet, and wings of about the same length and about 3 feet deep. The other, designed for the capture of balanak or mullet, is a slightly larger sarap, locally known as *sarap sa balanak.*

The cork and ground lines, together with the ends of the two wings, are selvaged with wider meshes of $\frac{1}{4}$-inch hand-knit abacá twines. The free ends of the wings are each provided with bamboo or wooden brails about 3 feet high, to each of which a short bridle is attached. The pull or hauling ropes are in turn attached to these wing bridles. Most often, however, these brails serve as handles by which the two men operating the net drag it along the shore.

Aboy bating.—This gear is not identical to the bating used by the fishermen of Manila Bay. Its name is rather a misnomer, for in reality it is more similar to what is known to the Tagalog fishermen as *pangtukos,* a trap net provided with two wings and a landing bag or bunt at the center.

The net itself, which is rectangular in shape, is made of either No. 25 or No. 28 cotton web at the wings and of No. 43 at the bunt. It is from about 80 to 100 feet long and from about 25 to 40 feet deep. It is carried in two large bancas escorted by several (from two to twenty) smaller bancas. Its operation is also confined to the dark of the moon, although it is sometimes operated in the daytime for the capture of balanak, in which case it resembles the *katigbi* of the Tagalog fishermen.

When a school of fish, usually herring fry, is sighted, the net is paid out by the two large bancas. Upon a given signal from these large bancas, the smaller bancas, manned by one or two men, align themselves into an arc some distance from where the net has been set. They then scare the fishes into the set net by creating all sorts of disturbance in the water, thus forming a cordon of escorts driving the fishes into the bunt of the net. By means of two ropes attached to the ends, the lead line is then hauled from the two large bancas. Text fig. 6 is a diagrammatic sketch of the arrangement of the net and the bancas during the fishing operation.

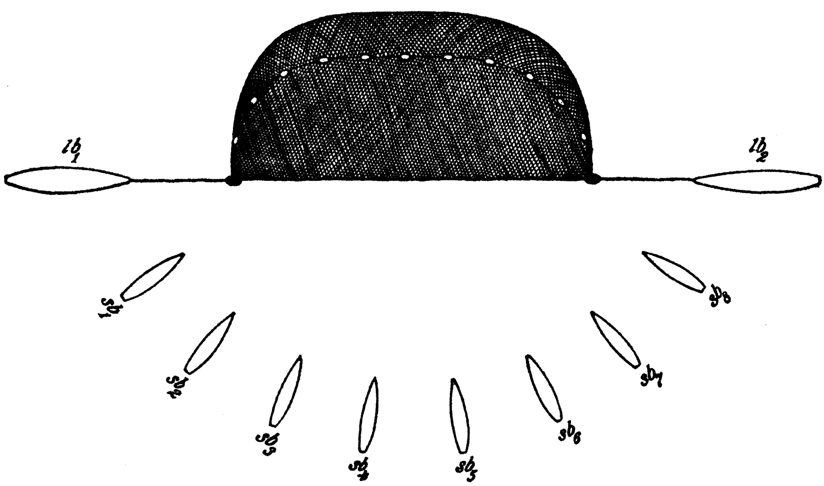


FIG. 6. Aboy bating in operation; diagrammatic. lb_1, lb_2, Large bancas; sb_1, sb_2, sb_3 sb_4, sb_5, sb_6, sb_7, sb_8, small bancas.

The catch consists exclusively of herring fry. The whole outfit is manned by about 50 men in actual fishing.

Panglambang.—This floating gill net for the catching of herring was only recently introduced in this region by the Navotas fishermen. Although the type used in San Miguel Bay is smaller than that used in Manila Bay, the make and mode of operation is the same. This gear resembles the true bating, except that the meshes are strung vertically in relation to the cork and bottom lines.

The net proper is composed of twelve pieces which are joined together during actual fishing. Each piece is 18 fathoms long and 13 fathoms deep. The body of the net is of No. 40 cotton twine webbed with a mesh of 1 inch stretched. The side selvage consists of 8 meshes of No. 18 twine webbed with a mesh of 1 inch stretched, while those of the cork and bottom lines are of 8 and 13 guarding meshes, respectively, made of No. 18 twine that is webbed with a mesh of 1 inch stretched. The wooden floats on the cork line and the lead weights on the bottom line are attached and strung at intervals of 1 foot.

This gear is usually operated during the daytime, in connection with one or more boats, generally with two. The fishing boats leave port for the fishing grounds early in the morning and return late in the afternoon. When they arrive in the fishing grounds, they begin to search for a school of herring (usually adults). Experienced fishermen detect a floating school by the flipping movements of the fish on the surface of the water, the ripples caused by such disturbances even enabling an expert to determine the size of the fishes. A submerged school can be detected by an expert fisherman by the sound caused by the activity of the fish, that is, by the "feel" of the water. The presence of gulls in the vicinity signifies the prevalence of herrings.

When a floating school is sighted, the two bancas with a net in each pay out their respective nets, describing a half circle in this laying process (text fig. 7*a*), each dropping their starting buoys, sb_1 and sb_2 and setting the first portion of the net seaward. The net is paid out in this manner in order to check the escape of the fishes in that direction, the natural course followed by them when frightened. Both bancas meet at a shoreward point, dropping their terminal buoys, tb_1 and tb_2, and thus enclosing the school. The two bancas are then rowed inside the inclosure and by the beating of bamboos on their holds and by making all sorts of noises in the air and commotions in the water with the aid of a wooden plunger (text fig. 8*c*) the fish are scared into the meshes. The course followed by the bancas is shown in text fig. 7 by dotted lines. The nets are then hauled in from the terminal buoys and the fish picked from the meshes. The nets are then piled carefully on board, and when another school is located the entire operation is repeated.

When a submerged school is observed by a boat operating singly, the net is first paid out at the starting buoy (text fig. 7*b*, *sb*), whence a sort of a crib is traced; then the boat proceeds in such a manner as to describe an arc parallel to the shore and seaward from the starting buoy. At the opposite end of the net another crib is formed, and a terminal buoy, *tb*, is lowered. The boat then cruises as indicated by the dotted line in text fig. 7, and by means of the same devices mentioned in the above discussion the fishes are driven into the meshes of the net. The net is then hauled in, the hauling process commencing at the terminal buoy and terminating at the starting buoy. The fishes are then picked from the meshes of the net.

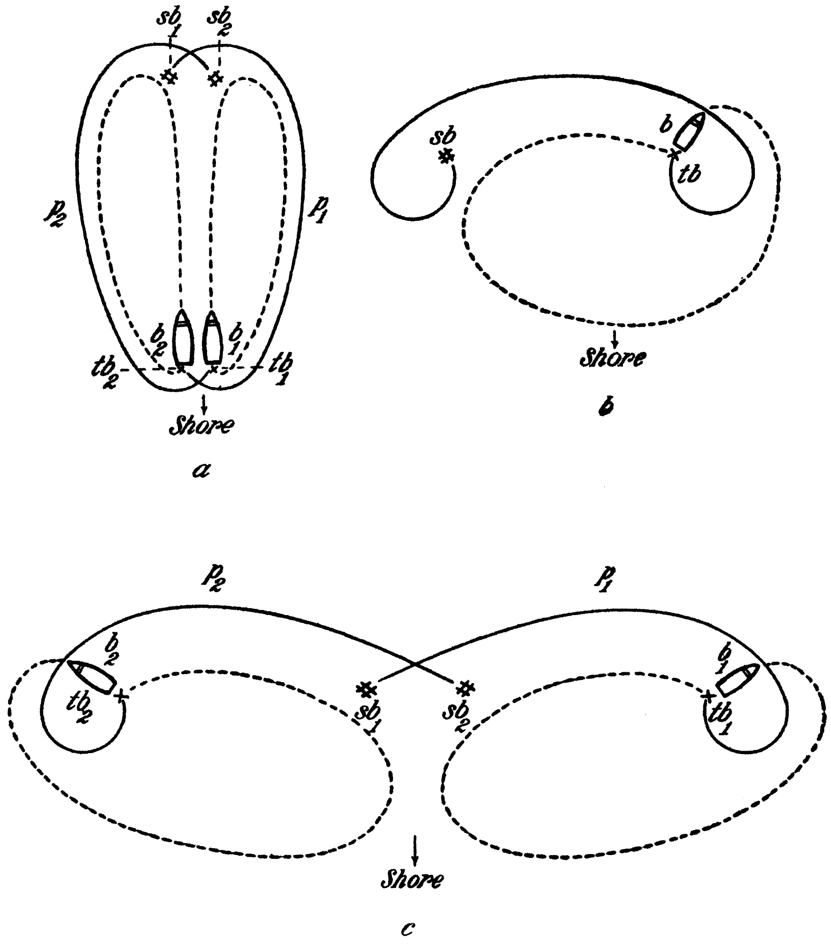


FIG. 7. Different ways of paying out the panglambang; diagrammatic. *a*, Operating in pairs and enclosing a floating school; *b*, operating individually; *c*, operating in pairs and enclosing a submerged school; sb_1, starting buoy of outfit No. 1; sb_2, starting buoy of outfit No. 2; p_1, panglambang of outfit No. 1; p_2, panglambang of outfit No. 2; tb_1, terminal buoy of outfit No. 1; tb_2, terminal buoy of outfit No. 2; b_1, banca of outfit No. 1; b_2, banca of outfit No. 2.

In operating in pairs and in fishing for a submerged school, the procedure in laying out the net is shown in text fig. 7*c*; the course followed by the boats in scaring the fishes is indicated by the dotted line.

A fishing crew operating a single boat consists of 12 men, while a crew operating a pair of boats consists of at least 24 men. The catch consists mostly of deep-bodied herring together with limited quantities of crabs, squids, gizzard shads, and halfbeaks accidentally gilled.

CAPITAL REQUIRED FOR THE EQUIPMENT OF A BOAT OPERATING SINGLY.

	Pesos.
Boat (banca)	500
Net	500
Total	1,000

Sapiao.—This gear is entirely different from the common sapiao used in the catching of pelagic species, such as anchovies and herring. As observed in the barrio of Bagacay, Tinambac, it consists of a triangular net mounted on two bamboo cross pieces; the whole appliance in turn is mounted on a banca. Text fig. 9 is a diagrammatic sketch of this gear.

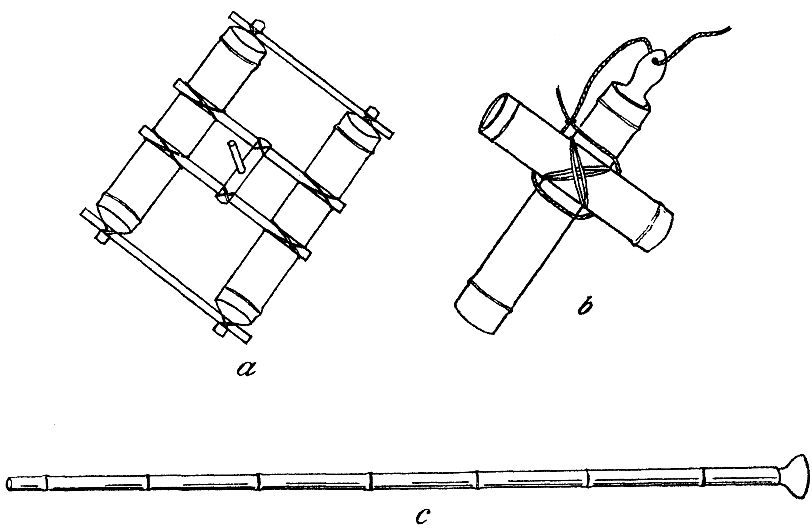


FIG. 8. Accessories of a panglambang outfit. *a*, Starting buoy; *b*, terminal buoy; *c*, panglurok, a wooden plunger.

The net itself is of Number 40 cotton thread with a square mesh of about $\frac{1}{2}$ inch. It is about 25 feet wide at the base of the supposedly triangular net and has an altitude corresponding to the full length of the two bamboo cross pieces.

The mounted net is towed parallel to the shoreline on a banca by two men who also lower and raise the net. When schools of mullet are seen, the net is lowered by tilting the banca to one side. From a distance of about 60 feet two other men begin to drag a scare line (abaca rope with pieces of coconut husk strung at regular intervals) about 60 feet long. The mullet, upon being scared, jump until they are driven into the submerged net, and the two men supporting it begin to raise it above the surface of the water where the catch is collected.

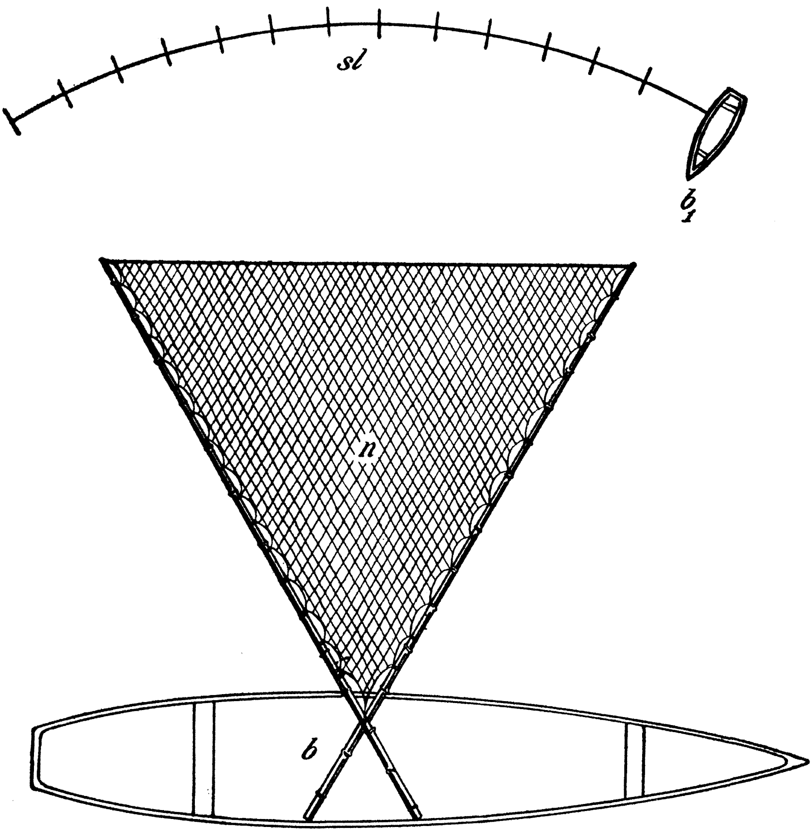


FIG. 9. The sapiao in operation; diagrammatic. *b*, Banca to which net is attached; *n*, net; *sl*, scareline; b_1, attending banca.

Other fishing gear of rather less importance, operated in almost the same manner as in Manila Bay and described in various papers on Philippine fishing methods, are the *pante* (gill net for crabs), the *largarete* (gill net for herring), the *hodhod* or *sakag* (collapsible triangular dip net), the *chinchorro* (beach seine), the *laya* (cast net), the *bobo* (bamboo fish basket or trap), and the *bintol* (trap net for crabs).

FISH-PRESERVATION METHODS

As more or less adequate icing facilities and fairly regular means of transportation in the form of railroads and trucks are available, a great volume of the catch is marketed in the fresh state in Manila. The curing of fish by salting, drying, and, to a limited extent, smoking is confined to the small and medium-sized species and to larger sizes that are left unsold in the fresh-fish market of Naga.

Refrigeration.—The refrigeration method employed is direct icing, a temporary method of preserving the catch so that it can be shipped to richer markets in cities where it is sold at much higher prices than those obtaining locally. During the height of the fishing season in San Miguel Bay, four icing establishments were observed in Naga, with a daily shipment of no less than from 1 to 2 tons of fish of the larger and first-class species.

The business consists in the wholesale buying of the catches of the fishermen, icing them, and shipping them to Manila. Ice is supplied by either the Camarines Sur Industry plant located at Magarao or by the Meralco Ice Plant situated in the town of Naga.

The catches of large and desirable species are bought by the middlemen from the individual fishermen. They are then resold to any of the four icing establishments. The following are the quotations for the various species with station or delivery at Naga:

Kind of fish.	Price per kg. Pesos.
Kiskisan	0.15 to 0.17
Lapu-lapu	0.30
Tin̄garog	0.20
Kanoos	0.20
Pasayan	0.22

These fishes are packed in fish boxes (one box has an approximate capacity of 100 kilograms) with alternate layers of crushed ice, the sides and the top being covered with several layers of banana leaves before the wooden cover is put in place. These boxes are then shipped to Manila by either the 11:00 A. M. or the 3:10 P. M. trip of the Manila Railroad.

Drying.—Drying is done especially when there is plenty of sunshine. The small fishes, such as the dilis, bolinao, and siliñasi, are dried without the preliminary brining process. The moderate-sized species, such as the pagotpot, abo, tamban kabasi-on, balanak, kabasi, and the small tabañgoñgo, are immersed in brining tanks in the round for about 12 hours, after which they are allowed to drain. They are then spread on platforms to dry thoroughly in the sun. During extremely rainy days, when the air becomes very moist, they are salted individually before being dried in the sun.

The larger-sized individuals, such as the large abo, tabañgoñgo, kiskisan, and kabalyas, are first split and eviscerated before they undergo the brining process. They are then dried thoroughly in the sun.

Salting.—*Bagoong* and *boro* making are the two genuine salting processes in vogue in this region.

In the making of *bagoong*, either the fry of herring (siliñasi) or the tiny shrimps (balao) are used. The process employed is identical with the method followed in other fishing centers, like Manila Bay, Carigara Bay, and Balayan Bay.

In the manufacture of *boro*, either the tamban, the dilis, or the bolinao is used. The fish are first immersed in concentrated brine solution for 12 hours, after which they are allowed to drain overnight. The following morning they are salted with coarse dry salt, and marketed dry in this state with crystals of the preserving material.

Smoking.—To some extent, large rays are cut into strips and smoked over elevated platforms in the manner of making coprax by the "tapahan" method.

Preservation of shrimps.—Because of the abundance of shrimps in this region, several methods of preserving them have been evolved and are being employed on a commercial scale, some of them observed only in this region. The resulting preserved products are *bagoong*, *hibe*, and *dinailan*.

The manufacture of bagoong has been discussed above. Hibe is made as follows: To 1 "kawa" of water, 6 liters of salt is added. The mixture is heated and the medium-sized shrimps are boiled until they turn red. They are then drained and dried, after which they are placed in sacks. By beating the sack containing the boiled shrimps against any hard object (a post for instance) the flesh is freed of the exoskeleton. By shifting, the finished product is separated from the waste material, and is then ready for the market.

The preparation of *dinailan* consists in the drying of the tiny shrimps on elevated platforms in the sun for about one day. These semidried products are then ground or pounded as fine as possible. Then the partially solidified product is dried for another day, after which it is ground or pounded for the second time with the resulting very fine and almost homogeneous product or paste, although still somewhat wet. This is dried for the third time after which it is finally shaped into cylindrical bars about 2 inches in diameter and about 1 foot long. In this shape and state, it is sold in the market.

The Bicolanos relish this preparation which they cook with various kinds of vegetables.

FISHERY LEGISLATION AND ITS ADMINISTRATION

As in most fishing centers in the Islands, local fishery legislation in this region has one purpose—the collection of as much revenue as possible in order to swell the municipal funds for the support of the local government without due consideration for the poor fishermen that have to shoulder the burden. More often than not, legislation has the sole or principal objective of imposing as high taxes and fees as possible, usually prohibitive, with no attention paid to the question of preservation and conservation of the fisheries for future generations. In some instances, provisions of the municipal ordinances relating to fishery are restrictions placed upon introduced, but legitimate, fishing appliances, with the aim of actually prohibiting and sometimes expressly outlawing them, with no scientific basis whatsoever for such action but merely for the purpose of protecting the interest of a group or groups of fishers.

Varied conflicts have been registered due to faulty legislation, containing provisions not in accordance with those of the Fisheries Act. These differences were not only between commercial or insular and municipal operators but also among the local fishers themselves—Tagalog versus Bicol and Bicol versus Bicol. One of the serious outrages committed by the native fishermen that came to the knowledge of the writer was the case of a fisherman from Manila Bay who suffered physical injuries at the hands of some notorious Bicol fishermen who took the law into their hands for the settlement of differences in their fishing interests.

A very recent conflict is evidenced in two petitions of fish-corral owners against the operation of the beam trawl. An investigation was personally conducted by the writer, the results of which are cited in the following paragraphs.

The petitions mentioned above were motivated by reasons similar to those that prompted the fishermen of Manila Bay to question the operation of the trawlers during the early days of the latter's activities there. The fishermen here, just like those of Manila Bay, object to the operation of this modern gear, not because it has been proven destructive to the fishery resources, but because it is far superior and more effective than the gear in vogue in this region. In the strict sense, the petitions do not concern the fishing appliance proper, but are directed towards the strong competition offered by the trawlers to the fish-corral owners, the latter being the most important device used by native fishermen here. Any new fishing device other than the beam trawl would have met the same opposition in this region.

As has been the case in Manila Bay, and in Lingayen Gulf, the beam trawl in San Miguel Bay has been subjected to unfounded suspicions and destructive criticism for no other reason than its novelty and its foreign origin. Such opposition is always encountered by any new method of fishing employed for the first time in a locality, not only in the Philippines but also in foreign countries. To quote J. B. Philips [2] "the introduction of any new form of fishing gear which profoundly affects a fishery is usually met with by opposition from fishermen who cannot successfully compete with their old-styled gear, and their opposition is always on the ground that the new gear is unduly destructive and will ruin the fishery."

A new gear is always considered destructive by those who have studied neither its construction nor its mode of operation, because it is more effective than the gear already in vogue. Due to the ease and the facility with which its operators capture fish, its operators are, more often than not, suspected of illegal methods. As time passes, however, and as the local fishermen become cognizant of the legitimacy and superiority of a new gear, their attitude of unreceptiveness and antagonism disappears automatically, and they emulate it rather than despise it. No better proof is worth presenting than the conditions now obtaining in Manila Bay and in Lingayen Gulf where once the same beam trawl was bitterly opposed and where it is now operating without molestation.

[2] California Fish and Game Quarterly Magazine 18 (1932) 209.

CONCLUSION AND RECOMMENDATION

1. Fishing in San Miguel Bay is profitable, for here the season is at its height during the stormy part of the year, when most of the fishing grounds in the Philippines are exposed and hence rendered barren. Consequently there is always a good market for the catch with good prices.

2. Although in some sections of the bay fishing is observed the year round, the peak of the season occurs during the southwest monsoon from May to September, when the greater portion of the coastline is least exposed.

3. Calabanga, and more specifically Barrio Sabang in the municipality of Calabanga, is the center of fishing activities around San Miguel Bay.

4. The resources of the grounds consist in enormous quantities of submerged, ground, or bottom species rather than in abundance of the pelagic migratory fishes that appear in vast schools during definite seasons of the year.

5. Although only a recently exploited trawling ground because of its limited area beam trawling operations in San Miguel Bay need to be regulated. However, such regulatory measures must be based on results of scientific investigation on the life histories of the different species that compose the bulk of the catch. On the basis of such studies and actual experimental trawling, the meshes of the cod ends or bags can be fixed in such a way that these said bags when towed will catch the maximum number of mature and marketable individuals and at the same time allow the escape of the greatest number of immature individuals. Legislation based on considerations other than technical studies will cause unnecessary waste in the utilization of these submerged resources and may finally lead to the collapse of this very profitable industry.

6. Since time immemorial various native fishing gear have been in operation in the bay with the sole aim of catching as much as possible, without thought of the conservation of the fishery. Even a superficial examination of the catch of the gear employed will reveal a very heterogenous composition, large individuals as well as small, and mature as well as immature. This indiscriminate catching of the different species has resulted in a decrease of the supply that is now beginning to be felt more acutely by the individual fishermen. The establishment of size limits for the most important species and the setting of minimum

widths of the meshes of the siguin or drag nets used in fish corrals and the bags of the seines and trawls is now of paramount importance.

7. A reform in the method of direct icing employed is essential in order that the frozen or iced fish shipped to distant markets will retain the original flavor of the freshly caught fish. This reform should involve proper care of the catch before icing, evisceration of specimens to be iced, especially the large-sized ones, and the avoidance of too much pressure on the flesh of the fishes during packing and in transit.

8. Supervision of the sanitary conditions prevailing in preservation sheds and plants, and hygienic procedure in the preparation of *tuyo, bagoong, hibe,* and *dinailan,* as well as proper care in storage, are imperative.

9. Coördination of the different local regulations relating to fisheries as provided in the different municipal ordinances is badly needed in order to avoid conflicts between the commercial or insular fishers and municipal operators, and among the local fishers themselves. Maximum limits for fees exacted of each fishing apparatus must be established in accordance with the richness of the ground and the amount of capital invested, with the insular rates as the basis. Class legislation resulting from political manipulation must be checked. All these improvements can be effected by making all such municipal ordinances subject to the approval of the Secretary of Agriculture and Commerce.

10. Since the sole interest of the local authorities is the collection of fees without regard to the conservation of fishery resources, it would be wise in the long run for the insular government to take over the control of the supervision over the municipal fisheries from the local authorities, with the provision that a certain percentage of the amount collected in fees for the privilege of fishing revert to the funds of the municipalities concerned.

ILLUSTRATIONS

FIG. 6. Aboy bating in operation; diagrammatic. lb_1, lb_2, Large bancas; sb_1, sb_2, sb_3, sb_4, sb_5, sb_6, sb_7, sb_8, small bancas.

7. Different ways of paying out the panglambang; diagrammatic. *a*, Operating in pairs and enclosing a floating school; *b*, operating individually, *c*, operating in pairs and enclosing a submerged school. sb_1, Starting buoy of outfit No. 1; sb_2, starting buoy of outfit No. 2; p_1, panglambang of outfit No. 1; p_2, panglambang of outfit No. 2; tb_1, terminal buoy of outfit No. 1; tb_2, terminal buoy of outfit No. 2; b_1, banca of outfit No. 1; b_2, banca of outfit No. 2.

8. Accessories of a panglambang outfit. *a*, Starting buoy; *b*, terminal buoy; *c*, panglurok, a wooden plunger.

9. The sapiao in operation; diagrammatic. *b*, Banca to which net is attached; *n*, net; *sl*, scareline; b_1, attending banca.

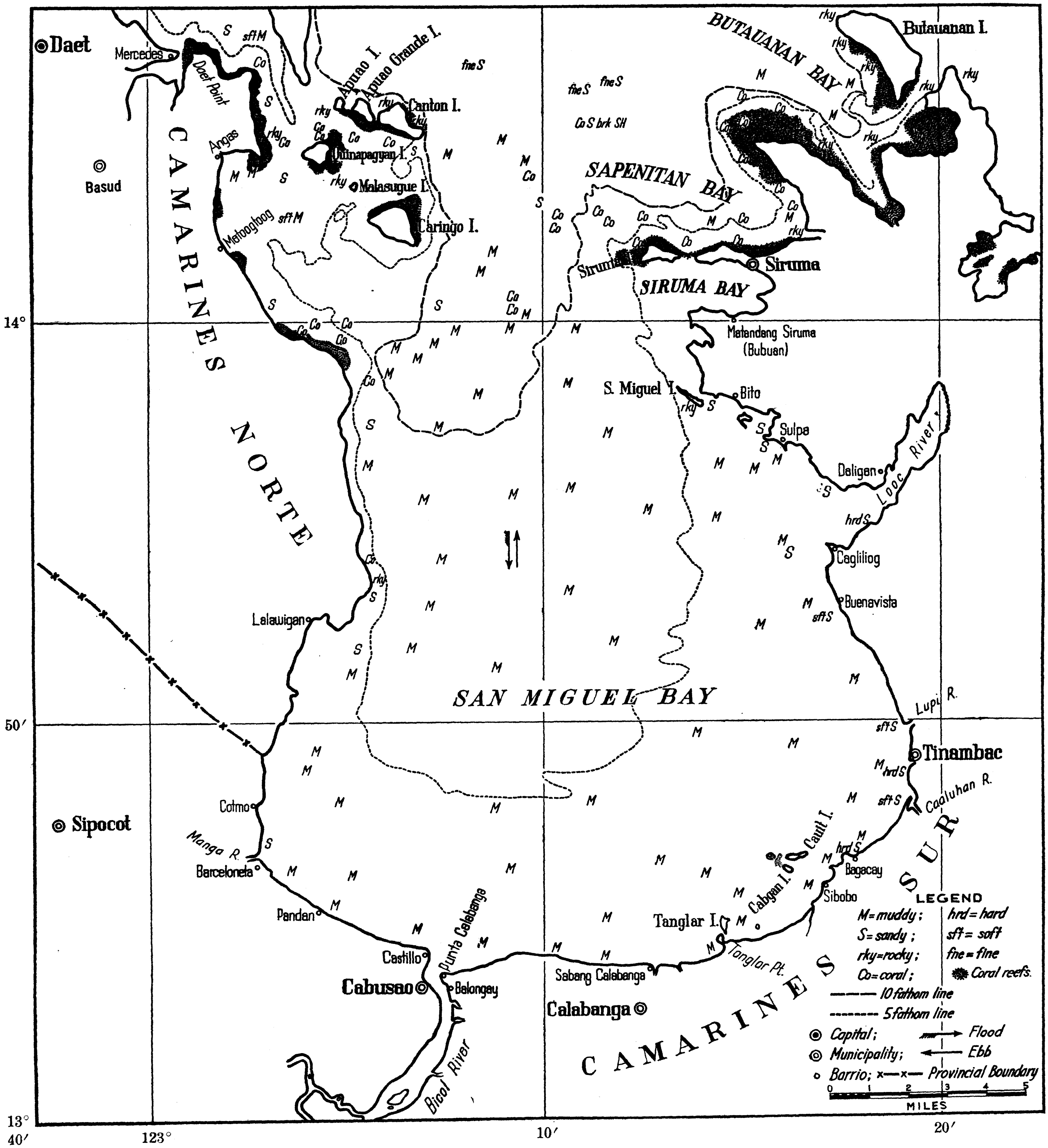
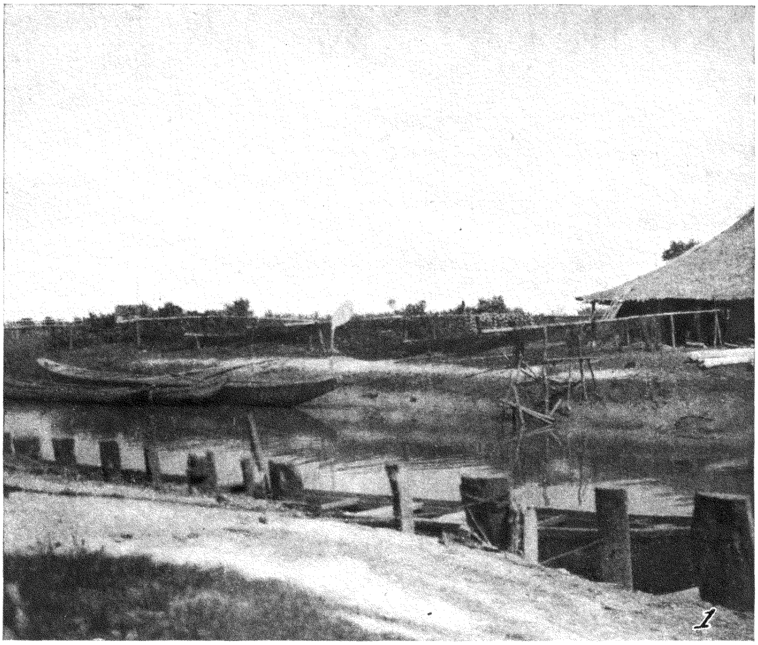

Daet
Mercedes
Daet Point
Basud
Angas
Apuao I.
Apuao Grande I.
Canton I.
Quinapagyan I.
Malasugue I.
Caringo I.
Metoogtoog
CAMARINES NORTE
Butauanan I.
BUTAUANAN BAY
SAPENITAN BAY
Siruma
Sirumta
SIRUMA BAY
Matandang Siruma
(Bubuan)
S. Miguel I.
Bito
Sulpa
Daligan
Looc River
Cagliliog
Buenavista
Lalawigan
SAN MIGUEL BAY
Lupi R.
Tinambac
Caaluhan R.
Sipocot
Cotmo
Manga R.
Barceloneta
Pandan
Castillo
Cabusao
Punta Calabanga
Balongay
Bicol River
Sabang Calabanga
Calabanga
Tanglar I.
Tanglar Pt.
Cabgan I.
Cauit I.
Bagacay
Sibobo
CAMARINES SUR
LEGEND
M=muddy; hrd=hard
S=sandy; sft=soft
rky=rocky; fne=fine
Co=coral; Coral reefs.
10 fathom line
5 fathom line
Capital; Flood
Municipality; Ebb
Barrio; x—x— Provincial Boundary
0 1 2 3 4 5
MILES
14°
50′
13°
40′
123°
10′
20′

PLATE 1.



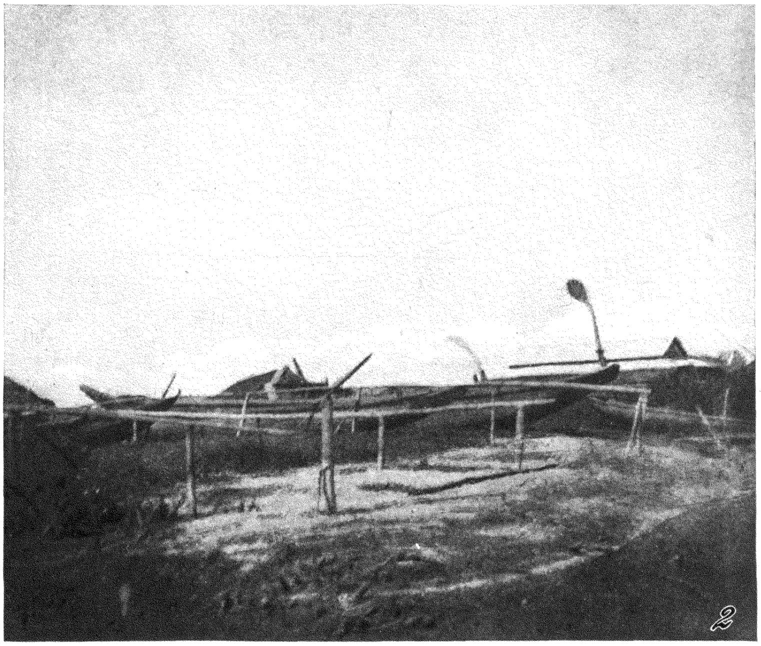


PLATE 2.

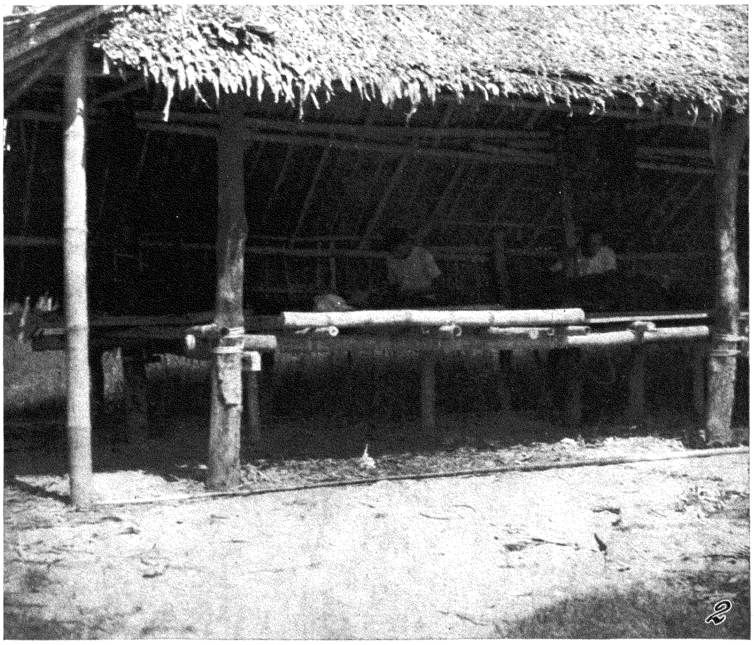


PLATE 3.

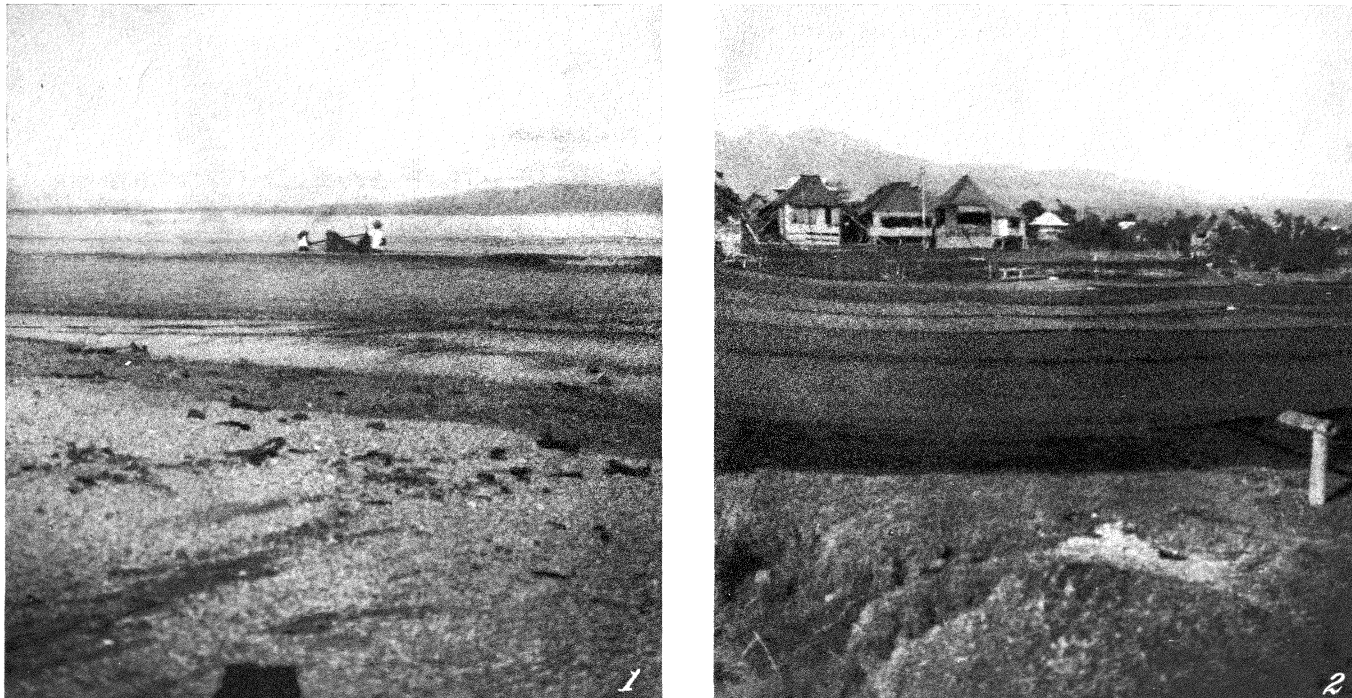


PLATE 4.

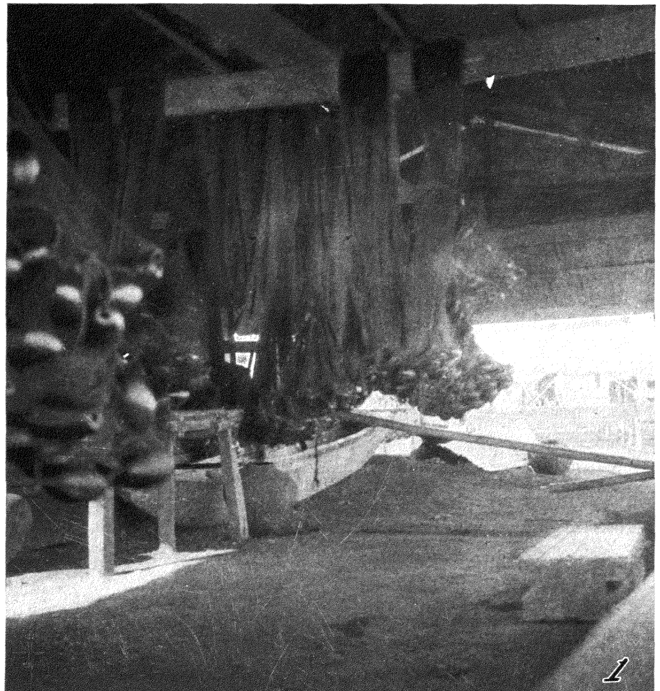


PLATE 5.

PLATE 6.

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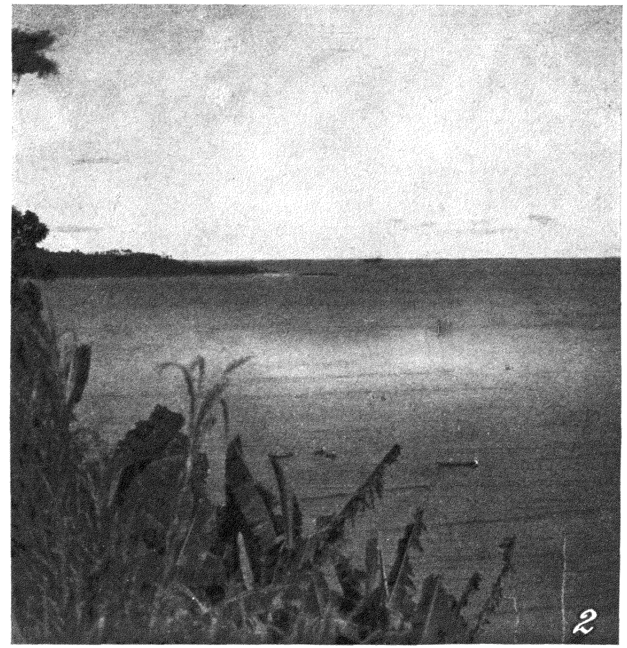

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PLATE 7.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

AYKROYD, W. R. Vitamins and other dietary essentials. 2d ed. London, W. Heinemann (Medical books) ltd., 1936. 226 pp. Price, 7s. 6d.

BEVAN-BROWN, C. M. Individual psychology: theory and practice, by C. M. Bevan-Brown, G. E. S. Ward, and F. G. Crookshank. London, C. W. Daniel co., ltd., 1936. 79 pp. Price, paper, 2s. 6d.

BLATZ, W. E. Nursery education; theory and practice. New York, W. Morrow & co. inc., 1936. 365 pp., tables. Price, $3.50.

British museum (Natural history). Instructions for collectors No. 3. Reptiles, amphibians and fishes. 5th ed. London, Printed by order of the Trustees of the British museum, 1936. 15 pp., illus. Price, 4d.

BRUMPT, E. Précis de Parasitologie. Paris, Masson et cie, Editeurs, 1936. 2 vols., plates, figs. Price, 200 fr.

COLWELL, JOHN. Daily log for physicians. Champaign, Illinois, Colwell publishing co., 1936. Price, $6.

COPPLESON, V. M. Clinical handbook for residents, nurses and students. 2d ed. Australia, Angus & Robertson ltd., 1936. 205 pp. Price, 6s.

COUTIERE, HENRI. Connais-toi ou la physiologie sans pleurs. Paris, Librairie polytechnique Ch. Beranger, 1936. 174 pp.

DAVIS, J. E. Principles and practice of recreational therapy for the mentally ill. New York, A. S. Barnes & co., 1936. 206 pp. Price, $3.

DENHAM, H. J. Increased production in agriculture. Oxford, Hall, The Printer ltd., 1932. 35 pp. Price, 1s.

DRABBLE, J. Textbook of meat inspection. Australia, Angus & Robertson ltd., 1936. 353 pp., illus. Price, 21s.

DUERK, HILARION. Psychology in questions and answers. New York, P. J. Kenedy & sons, 1936. 230 pp. Price, $1.50.

FERGUSON, BURR. Facts and phagocytes; the story of the development of hydrochloric acid therapy. Ohio, Youngstown, Medical success press, 1936. 270 pp., illus. Price, $5.

GEYER, JOHN C. Textile waste treatment and recovery. A survey of present knowledge concerning the treatment and disposal of waste waters produced in the textile industries. Washington, D. C., The Textile foundation, inc., 1936. 118 pp., figs. Price, paper, $1.

GHOSH, RAKHALDAS. A treatise on materia medica and therapeutics, including pharmacy, dispensing, pharmacology, and administration of drugs. 14th ed. Calcutta, Hilton & co., 1936. 724 pp., illus., table. Price, Rs. 7, As. 8, or 12s. 6d.

GREENWOOD, MAJOR. The medical dictator and other biographical studies. London, Williams and Norgate ltd., 1936. 213 pp. Price, 7s. 6d.

HATCHER, ROBERT A. Useful drugs; a selected list of essential drugs with brief discussions of action, uses and dosage. 10th ed. Chicago, American medical association, 1936. 240 pp.

HECK, NICHOLAS HUNTER. Earthquakes. Princeton, Princeton university press, 1936. 222 pp., illus., maps. Price, $3.50.

International institute of agriculture. International problems of agriculture. (Discussions at the XIIth Meeting of the General Assembly of the International Institute of Agriculture, October 22 to 27, 1934). Rome, Villa Umberto I (110), 1935. 80 pp.

International union of forest research organization. Forest bibliography with the index number 634.9 F. An International decimal classification on the basis of Melvil Dewey's system. Adopted on the recommendation of the International committee on Forest Bibliography, 1906–1933. Oxford, Hall, The Printer ltd., 1936. 100 pp.

KAALUND-JORGENSEN, OTTO. Experimental studies on a transmissible myelomatosis (reticulosis) in mice. Copenhagen, Levin & Munksgaard, 1936. 142 pp., plates, tables. Price, Swedish cr. 12.

KILPATRICK, WILLIAM. Sugar factories and sugar machinery. London, Institution of mechanical engineers, 1933. pp. 615–684., illus., tables.

KNOPF, S. ADOLPHUS. Heart disease and tuberculosis; efforts, including methods of diaphragmatic and costal respiration to lessen their prevalence. New York, N. Y., 1936. 108 pp., illus. Price, $1.25.

MCBRIDE, E. D. Disability evaluation, principles of treatment of compensable injuries. Philadelphia and London, J. B. Lippincott co., 1936. 623 pp., illus., tables, diagrs. Price, $8.

MCCANDLESS, JAMES SUTTON. Development of artesian well water in the Hawaiian Islands, 1880–1936. Hawaii, Honolulu, 1936. 79 pp., illus.

MARSHALL, C. E. Colloids in agriculture. London, Edward Arnold & co., 1935. 184 pp., illus. Price, 5s.

MATHOT, A. L. C. Crystallisation and pan-boiling. Calcutta, Thacker, Spink & co., (1933), ltd., 1935. 56 pp., diagrs. Price, Rs. 3/8.

MONTAGUE, J. F. Why bring that up? A guide to and from seasickness. New York, Home health library, 1936. 130 pp., illus. Price, $2.

NEEDHAM, JOSEPH. Order and life. New Haven, Yale university press, 1936. 175 pp. Price, $2.50.

NOBLE, R. J. Latex in industry. New York, The Rubber age, 1936. 384 pp., illus. Price, $7.

PROFACE, DOM. College men: their making and unmaking, by Dom Proface, with a foreword by Dean Theodore A. Distler. New York, P. J. Kenedy & sons, 1935. 314 pp. Price, $2.

RAST, KARL. Modern views of atomic structure, by Karl Rast. Tr. from the German by Dr. W. O. Karmack. London, Frederick Muller ltd., 1935. 156 pp., diagrs. Price, 7s. 6d.

SELLING, LOWELL S. Diagnostic criminology. Ann. Arbor, Michigan, Edwards brothers, inc., 1936. 175 pp. Price, $2.25.

SPENCER, L. J. A key to precious stones. New York, Lee Furman, inc., 1937. 237 pp., illus. Price, $2.50.

SPIVACK, J. L. The surgical technic of abdominal operations. Chicago, S. B. Debour publishers, 1936. 718 pp., illus., figs. Price, $10.

STADLER, HANS. Richtlinien für Schwangerschaftsunterbrechung. Herausgegeben von der Reichs-Aerztekammer. Munich, J. F. Lehmanns Verlag, 1936. 180 pp., illus., tables. Price, Rm. 3.75.

UNDERHILL, FRANK P. Toxicology or the effects of poisons. Thoroughly revised by Theodore Koppanyi. 3d ed. Philadelphia, P. Blakiston's son & co., inc., 1936. 325 pp. Price, $2.50.

WARDEN, CARL J. Comparative psychology: a comprehensive treatise. Vol. I. Principles and methods, by Carl J. Warden, Thomas N. Jenkins and Lucien H. Warner. New York, The Ronald press co., 1935. 506 pp., illus. Price, $4.50.

REVIEWS

Deserts on the March. By Paul B. Sears. University of Oklahoma press, Norman, Oklahoma, 1935. 231 pp. Price, $2.50.

This book could be regarded as a text on soil conservation. It is written in a style that makes for easy reading and for continued interest. As a demonstration of the injurious effects of improper utilization of soil, and the measures that must be taken to arrest the continued destruction wrought by the injurious forces of nature, it is the most complete seen so far. The whole object of this book is to present to the reader the conditions that exist with regard to soil and the forces at work, and to demonstrate that, for the continued benefit of mankind, a balance of nature must be maintained.—H. C.

The Chemists' Yearbook, 1936. Founded by F. W. Atack and edited by E. Hope. Sherratt & Hughes, Manchester, England, 1936. 1257 pp. Price, 21s.

The eighteenth edition of this handbook contains a considerable amount of physical and chemical data. To bring the book up to date, extensive revisions have been made in the chapters dealing with essential oils, tanning materials, dairy products, and related subjects. The analyses of sulphuric-acid-treated oils, alcohols, and wetting agents have been added. Modern methods are given for the analysis of leather, coal, liquid and gaseous fuels, lubricants, ceramic materials, tobacco, and numerous other products. It is undoubtedly an excellent compilation, and very useful for ready reference.—A. P. W.

Trail-Blazers of Science. By Martin Gumpert. Translated from the German by Edwin L. Shuman. Funk and Wagnalls Co., New York, 1936. 306 pp. Price, $2.50.

This book contains a group of essays giving the life stories of some half-forgotten pioneers of scientific research, men who lived at different periods from the sixteenth to the twentieth century. Among the prominent names mentioned are Vesalius, the founder of anatomy; Servetus, the discoverer of the minor circulation of the blood; Galileo, who worked out the laws of falling bodies; Lamarck, founder of the theory of the evolutionary origin of species; Mayer, discoverer of the law of conservation of energy. The book ends with some notes about Dr. Harvey Cushing, the brain surgeon who is regarded as a type of the future scientist.

These essays are made unusually interesting by the local color and setting which they give. They point out very clearly that in the early centuries there was always opposition to genius and to the development of science.—A. P. W.

Our Insect Friends and Foes and Spiders. A Series of Fascinating Stories of Bee, Ant, Beetle, Bug, Fly, Butterfly, Moth, and Spider Life. Published by The National Geographic Society, Washington, D. C., 1935. 252 pp., illus. Price, $2.50.

In this book the National Geographic Society has succeeded in bringing forth a most complete collection of information on the most common insects of interest to man. The information is presented in a popular style that can easily be understood by the layman. The book is especially interesting and instructive to students of natural history and to all lovers of nature. For teachers of biology, the book should be most helpful. In the home it should be a source of enjoyment and recreation, as well as education. The book is bound in durable maroon cloth, gold-embossed, and has 64 pages of colored plates and 161 illustrations. There are nine interesting chapters with a foreword by the President of the society and editor. The book is provided with an index.—G. M.

Foods and the Law; Manual for the Business Man on the Laws of the United States. By Alexander P. Blanck. Peter Smith, New York, 1935. 246 pp. Price, $2.50.

The first part of this book is devoted to citations from the food laws and their interpretation by government rulings and court decisions. The second part reproduces the entire body of federal laws relating to food, conveniently arranged.

Food laboratories engaged in the enforcement of the food laws, food manufacturers, and others interested in foods will find in this book a valuable guide. It is written in clear and plain language, by an informed and scholarly lawyer.—F. D. R.

Spanish influence on the Progress of Medical Science with an Account of the Wellcome Research Institution and the Affiliated Research Laboratories and Museums Founded by Sir Henry Wellcome. The Wellcome foundation, London, England, 1935. 121 pp.

This book is a condensed summary of facts of great importance to the history of medicine, especially mediæval medicine, showing clearly and forcefully the part that Spain has played in the progress of medical science. Several Moorish-Spanish physicians were accorded deserved honor, all from the Moorish cities of Cordova and Toledo, which were then great centers of learning. Aben Guefit, Albucasis, Avenzoar, Averroes Maimonides are among the great names mentioned. The establishment of charitable institutions was given great impetus, so that today we see them in great numbers not only in Spain, but everywhere she carried her influence as a colonizer and evangelizer. The Spain of the 15th, 16th, and 17th centuries likewise produced other great men, like Servet, who discovered pulmonary circulation; Vesalius, the father of scientific anatomy, although non-Spanish, was in the service of Charles V. The discovery of cinchona through the agency of Spanish subjects ushered in the era of modern specific medication.—J. P. B.

Earthquakes. By Nicholas H. Heck. Princeton University press, Princeton, New Jersey, 1936. 222 pp. Price, $3.50.

The author says in his preface with regard to the nature of this work: "Seismology has made great advances in recent years, but not for years has a broad and comprehensive picture been presented for the general reader with a discussion from every viewpoint. The purpose of the present volume is to meet this need and accordingly it is not for the specialist." Captain Heck has very adequately and satisfactorily accomplished his purpose.

Seismology underwent rapid and important developments after the World War. Now the science may be said to have reached a stage where a popular presentation can be made which will not become out-of-date too quickly. We believe that this volume will fill a long-felt need, and will serve its purpose for many years.

The nature of earthquakes, as well as their detection, noninstrumental and instrumental, is explained in several chapters. Then follow discussions on the distribution of earthquakes, conspicuous earthquakes with emphasis on those of the United

States, earthquake-resistant construction, and a final chapter on the history of seismology. I have had many requests in recent years for just such a book as Captain Heck has made available.
—W. C. R.

Why Bring That Up? A Guide to and from Seasickness. By J. F. Montague. The Home Health library, New York, 1936. 130 pp. Price, $2.

Sailing across the sea is but to divorce oneself from the boresome daily routine, and the discomfort which one may meet during this trip is of no moment since seasickness can be prevented or at least minimized. The first thing the author of this book counsels is to avoid rush in the preparation for travel, as the getting of a passport, the preparation of income tax receipts and other pertinent matters concerned with leaving the country, for he considers a tired mind and body as a good and ready recipient for the dreaded seasickness. The parties given by friends before sailing should be avoided as much as possible, for they are conducive to seasickness. The author lays stress on the evacuation of the large intestine by means of a enema before going to ship, and some pertinent preparation for use at sea, as belladonna plaster, tablets of sodium barbital (pento) or sodium nitrite tablets, and enema bag, and a pair of smoked gogles. At sea he counsels the avoidance of overeating, alcohol, coffee, and also of strong odors, as of perfumes and tobacco smoke. He advises attendance of all parties given on board but not indulgence of drinking bouts, on participation in all games on deck, and frequenting going the deck, so as to have the fresh sea breeze. Observation of these rules will accustom the body to the movement of the boat. Other chapters deal with the when, where, and how to travel. The places discussed are mostly around the east coast of the United States and those reached by crossing the Atlantic Ocean.—C. D. A.

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BRUCELLA INFECTION (INFECTIOUS ABORTION) OF SWINE IN THE PHILIPPINES

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FOUR PLATES

Traum was the first to recognize a specific variety of *Brucella* infection of swine in some hog farms in California. The identity of the responsible organism was later thoroughly studied by various investigators in America and other countries, who recognized it as a distinct variety, namely, *Brucella abortus suis* Traum. In an epizoötic in Denmark (1929–1932) Thomsen(12) prepared an excellent and comprehensive monograph on the various forms of the disease as it occurred at that time in Denmark. Judging from the literature, the infection appears to be well distributed in many hog-raising countries of the world today. Recent progress in the modernization of hog-farming everywhere has placed this disease among those of the most vital importance in the swine industry.

In the Philippines its presence was first suspected in a consignment of breeding sows purchased by the erstwhile Bureau of Agriculture from the Davis Farm of the University of California in 1918. The animals were intended to reënforce the breeding herd of the Bureau at the Alabang Stock Farm. Shortly upon their arrival a number of them aborted, and soon the infection spread to other animals. Were it not for the timely isolation, segregation, thorough disinfection, and disposal of the aborting sows, the entire year's crop of sucklings might have been lost. Unfortunately, owing to pressure of work with outbreaks of rinderpest at that time, these cases of abortion were not studied in the laboratory to determine definitely the responsible causative factor. Strict sanitary and hygienic measures apparently saved the situation for the time being, and nothing alarming occurred until the outbreaks covered in the present paper. Several years ago a culture was isolated in Japan from the aborted fœtus of a sow imported from Great Britain, but only in 1936 did Nohmi, Katow, and Karasawa(11) recognize their culture as *B. abortus suis* Traum.

MATERIALS AND METHODS

Infection at the Correctional Institution for Women.—In the latter part of 1932 the Correctional Institution for Women in Mandaluyong, Rizal, purchased some breeding pigs from Alabang Stock Farm for the purpose of introducing new blood in their herd. March 14, 1933, Mr. Piatos, in charge of the hog project of the institution, brought to our laboratory dead fœtuses from an aborting sow for diagnosis (Plate 1, fig. 1). Saline suspensions of the spleen, stomach, lungs, and livers of the fœtuses were injected into four guinea pigs. One guinea pig showed diarrhœa and weakness, and was killed May 7. The organs were cultured on Huddleson's gentian-violet agar, at 37° C. for two months, but no growth was obtained. The other pigs were killed and no lesions were found. April 2 another batch of dead fœtuses were received for abortion examination. Organ emulsions were injected into two pregnant guinea pigs subcutaneously and two pregnant rabbits received applications of infused organs in the vaginal cavity. One pig aborted, the other died and upon autopsy showed characteristic lesions in the spleen and liver (Plate 1, fig. 2). Cultures obtained from the aborted guinea-pig fœtuses yielded pure growth, presumably of *B. abortus suis* Traum. This strain was designated as C. I. W. No. 1. The serum of the aborting guinea pigs was strongly positive in plate and tube agglutination tests, in dilutions of 1: 500 and above. For some reason the pregnant rabbits did not abort, presumably due to underdosage or to a less effective route of inoculation.

In view of these findings, arrangements were made with the authorities of the Correctional Institution for Women for permission to test the infected herd. Blood samples were obtained from the ears of the suspected sows and boars for agglutination test. Of nine sows tested, five were found highly positive, two highly suspicious, and two suspicious. One boar was negative. The animals being of breeding stock, it was decided to segregate them, and regular monthly testing was instituted in order to save those that would recover. Sows that showed no improvement in three monthly tests were destroyed.

The second culture, C. I. W. No. 2, was isolated from sow No. 16, which was sent to the laboratory to be destroyed May 3, 1933. Being strongly positive, the serum was collected for stock positive serum. Suspensions of spleen and lymph glands from this animal were injected into six guinea pigs. June 6, one guinea pig died; one was killed for the purpose of isolating the organisms. Both showed typical lesions of abortion in the spleen and liver, consisting of tuberclelike focal necrosis (Plate 1, fig. 2). One moribund guinea pig, which was bled for serum test, proved highly positive in a dilution of 1: 500. One pig died but showed no lesions. Two other guinea pigs aborted. Pure cultures, presumably of *B. abortus suis*, were obtained from the spleen and liver of the first guinea pig, which was killed. This culture was designated as C. I. W. Strain No. 2.

Infection at the Alabang Stock Farm.—In view of the conclusive diagnosis established in the outbreak at Mandaluyong, the Alabang Stock Farm became the subject of the next inquiry.

In the preceding paragraphs it has been stated that some of the breeding sows at the Correctional Institution originated from Alabang Stock Farm. The first blood test, according to the rapid-plate method, of suspected sows in Alabang, was made April 30, 1933, on sixteen animals. Nine reacted strongly, and were immediately disposed of. Among the remaining seven, three were suspicious and four negative. The tube test caught two more positives of the suspicious group which were included in the list to be destroyed. The results obtained were immediately reported to the Director of Animal Industry who ordered immediate disposal of the infected pigs. Eleven animals of sixteen tested were destroyed. At the present writing the disease in the farm appears to be under perfect control, as a result of systematic routine blood tests and the immediate slaughter of positive animals for the past three years. In the last testing of the herd only two cases were found; these also were disposed of at once.

Organs obtained from the aborted fœtuses from an Alabang sow gave pure cultures, presumably of *B. abortus suis* Traum; these were designated as A. S. F. Strain No. 1. The methods of isolating the organisms were in every respect similar to those employed in the outbreak at the Correctional Institution for Women.

Isolation of organisms.—In all cases the three strains herein reported were isolated from organ infusions of infected fœtuses, such as are shown in Plate 2, figs. 1 and 2, and the spleen of sick sows or guinea pigs planted on Huddleson's gentian violet agar. The emulsions of the organs were sown on the surface of the media and incubated under partial oxygen tension by placing the tubes in a sealed glass chamber with a lighted lamp allowed to expire. The first cultivation usually was slow, requiring about a month at 37° C.; but once adapted to artificial media, the strains under study never failed to grow on ordinary liver-infusion agar.

BACTERIOLOGICAL AND BIOLOGICAL IDENTIFICATION OF THE CULTURES RECOVERED

Morphology and staining characteristics.—In general characteristics the organisms under study in liver-infusion broth correspond to *B. abortus suis* Traum. They are gram-negative, nonmotile, nonsporulating rods of variable size, but generally larger than the organism of Bang.

Cultural characteristics in different media.—The behavior and cultural characteristics of the three strains in the following media were as follows:

Sugars—

On sixteen different sugars (glucose, mannite, maltose, sorbitol, levulose, galactose, xylose, isodulcite, inosite, dextrin, dulcite, arabinose, raffinose, salicin, lactose, and sucrose) no changes were observed.

Milk—

Rendered alkaline but no curdling.

Beef-liver infusion agar—

Slow and sparse colonies.

Potato—

Turning yellowish brown.

Liver-infusion agar—

Growth is abundant with brown tinge when old.

Liver-infusion broth—

After a week at room temperature a thick sediment collects at the bottom of the tube. (Typical porcine type.)

Loeffler's medium—

Slow and scanty growth.

Lead acetate paper—

Blackened after 48 hours. (Typical porcine type.)

Nitrates—

Reduces nitrates readily. (Typical porcine type.)

Agar stab—

Delicate growth along stab line. No growth in deeper part of the stab.

Gelatin shake—

Gray colonies extending to one centimeter below the surface.

Gelatin plate—

Fine, pin-point colonies appear after three days.

Differentiation from B. abortus Bang.—For purposes of differentiation the three strain, C. I. W. Nos. 1 and 2, and A. S. F. No. 1, were each placed on differential media, together with California No. 80 (porcine) and a culture of *B. abortus* Bang from the United States Bureau of Animal Industry (U. S. B. A. I.) as known controls. This method was used by Huddleson(7) as being specific, and confirmed by other workers in this field as such. The following table records the reactions on these media:

TABLE 1.—*Reactions of C. I. W. Nos. 1 and 2, A. S. F. No. 1, California No. 80, and U. S. B. A. I. on differential dye media.*

Culture.	Growth on differential dye media.				Remarks.
	Thionin agar slant 1:50,000.	Basic fuchsin agar slant 1:25,000.	Gentian violet agar slant 1:100,000.	Liver-infusion broth.	
C. I. W.[a] Nos. 1 and 2, and A. S. F.[b] No. 1 (unknown).	Good	Inhibited	Inhibited	Dense, heavy sediment.	Reactions typical of *B. abortus suis* Traum.
			Controls		
California No. 80 (*B. abortus suis*).	Good	Inhibited	Inhibited	do	Do.
U. S. B. A. I. (*B. abortus* Bang).	None	Good	Good	Thin sediment	Reactions typical of *B. abortus* Bang.

[a] Correctional Institution for Women [b] Alabang Stock Farm.

In Table 1 the reactions of the three swine strains under study in the dye media compared with a known porcine strain, California No. 80, and a bovine strain, U. S. B. A. I., were recorded. As a result of the tests in the differential media, and the cultural and morphological characteristics in all the other media employed, there is no doubt that the three strains herein reported are all of the porcine type, *B. abortus suis* Traum. Repetitions of the foregoing differential tests have yielded uniformly similar results.

Serum reactions.—It is generally admitted that type differentiation by serological methods is not conclusive, since cross reactions exist between types. Such reactions merely indicate group relationship. The sera of infected pigs agglutinated the antigens prepared from stock cultures of *B. abortus* Bang, and California strain No. 80, of porcine origin. An imported bovine serum from aborting cows likewise agglutinated the antigens from the three field cultures under study. It is quite evident, then, that the bovine and porcine types of abortion can not be differentiated by agglutination.

OBSERVATIONS DURING THE OUTBREAKS

Symptoms and lesions.—In the aborting sows a characteristic white purulent discharge from the genitalia was regularly noted. In one instance a boar showed a pronounced orchitis which became chronic, and upon castration the testes revealed varying degrees of abscessation; another boar was highly positive in the agglutination test, although it appeared normal, and upon palpation the testes were rather indurated. Although the abscesses in the testicles may heal up, other foci may persist, as shown in Plate 4, figs. 1 and 2. It is stated that pure cultures of the organism may be isolated from such abscesses. The infected uteri of sows with the chronic white discharge, upon incision, showed a metritis of long standing. However, in many positive sows and gilts no untoward manifestation of disease was discernible beyond a record of past abortions and poor breeding. A number of sows were known to farrow normal litters after a previous abortion. These observations tally very closely with those of Graham et al.(2) in Illinois.

Organs of predilection.—In pigs actively infected with *Brucella suis* the spleen and liver are favorite points of attack, from which organisms may be isolated. Guinea pigs injected with infected tissue or culture invariably show lesions in this organ, especially in the liver. Here typical tuberclelike nodules appear one to two months after inoculation (Plate 1, fig. 2). The nodules are white, subcapsular, and are scattered in the organ. On section of the individual nodules, a true picture of focal necrosis may be observed without giant cells. Frequently organisms have been isolated from the internal lymph glands, the uterus, the submaxillary gland, the kidneys, and the afterbirth of the infected sow. The aborted fœtuses have been found in the present study to be a very reliable source for obtaining pure cultures of *B. suis,* because all the organs are saturated with the organisms. Direct cultures from the spleen of freshly aborted fœtuses are not difficult to obtain, as already mentioned elsewhere.

Condition of aborted fœtuses.—In Plate 1, fig. 1, the fœtuses appear normally developed in certain cases, while in others, (Plate 3) there is advanced mummification at the time of abortion. Likewise, some sows abort before the fœtuses are fully developed (Plate 2). Without serum diagnosis it is evident that such abortions may be mistaken to be due to other causes. With the present knowledge of the disease in swine it is obvious that all cases of abortion should be given the necessary serum test to rule out *Brucella* infection. Since there is no way of distinguishing forms of abortion by other means than the serum test, the latter should be adopted as a diagnostic method, especially in localities where infectious abortion in swine is known to exist.

INCIDENCE OF INFECTION IN HOGS KILLED AT THE MANILA ABATTOIR

For purposes of this study, a preliminary survey of the blood of local pigs slaughtered at the city abattoir was undertaken. Of 1,975 blood specimens collected on the killing floor and subjected to the rapid agglutination test, 2.2 per cent turned out positive. For lack of available funds we were unable to secure the carcasses of serum-positive hogs for the isolation of the organism from this source. Furthermore, this work had to be suspended due to the appearance of foot-and-mouth disease in the abattoir. At this writing pressure of other work prevents the continuation of this survey. However, it will be resumed in the near future.

TRANSMISSION OF BRUCELLA ABORTUS SUIS INFECTION AND ITS TRANSMISSIBILITY TO MAN

Transmission in swine.—For the present report transmission experiments were not conducted, but the work of Howarth and Hayes(5), and of Johnson and Huddleson(9) in the United States seems to indicate that the boar plays an important rôle. Milk of infected mothers may transmit the infection to the young by ingestion, but it is the consensus that the most prolific sources of infection are contaminated feed and water in infected premises, and the infected boar.

The observations of Hayes(4), regarding certain inconsistencies between natural infection and outcome of pregnancy, are rather interesting. He noted that positive sows from the uterus of which *B. abortus* has been isolated may farrow normally. Likewise, sows having positive sera may farrow normal pigs. On the other hand, serum-negative sows may abort or farrow dead pigs. He concludes that a positive diagnosis of abortion infection in a sow does not indicate the outcome of pregnancy. However, the presence of the infection in any herd in whatever form must be considered a potential source of economic loss that is bound to manifest itself sooner or later in the form of failure to conceive, as observed by Johnson and Huddleson, or the more common occurrence of intermittent abortion among the infected sows. The infected boar which develops a chronic orchitis not only may be incapacitated for breeding but also becomes a spreader of the disease to other sows through coition. It is at once obvious that such breeding conditions run counter to profitable hog raising.

Transmissibility to man.—This phase of the swine abortion in the Philippines has not been investigated, and the reports mentioned in the following paragraphs are merely informative in nature.

In the study of Huddleson, Johnson, and Hamann(6) in the Michigan packing houses, some illuminating information may be gained in advance. Of 3,975 hogs examined serologically and bacteriologically, 7.74 per cent were positive serum reactors, and the infective organisms were isolated from 13.31 per cent of the reactor hogs. Simultaneously a study of the blood of 167 employees in four packing establishments and stock yards revealed agglutination reactions in 10.7 per cent of the individuals. The development of a clinical case of undulant fever in one establishment eight months after the first test necessitated a retest of 18 employees who showed agglutination reaction to dilutions of 1:25, 1:100, 1:200, and 1:500. In 100 cases of undulant fever treated with "brucellin," Huddleson, Johnson, and Beattie(8) isolated 16 cultures of *Brucella* organisms from the blood of 85 cases. Of these, 7 were *B. abortus* Bang, 5 *B. abortus suis*, and 4 *B. melitensis*. In a personal communication to the writer Dr. W. de Leon (1), chief of the laboratories in the Philippine General Hospital, Manila, in his preliminary work on the sera of suspected undulant fever patients in the hospital, reports 12 cases that reacted positively to *B. abortus* Bang antigen in a dilution of 1: 100 to even 1: 500; 3 of these were aborting women. Isolation of the organisms from the blood of positive patients is now being conducted by Doctor de Leon and his assistants to determine what type of *B. abortus* organism is responsible. I venture to suspect that *B. abortus suis* might be the causative agent in these cases, since pork is preëminently the meat eaten in the Philippines.

McAlpine and Slanetz (10) in Connecticut in studying the glucose utilization of the bovine and porcine *B. abortus* group, including *B. melitensis,* found that all 10 strains of *B. abortus* of human origin, which he tested, were closer to the porcine group than others. Considering the greater virulence of the porcine type in man than that of other types, this finding can readily be accepted without discussion, for the *Brucella suis* organism is known to be capable of invading the host even through the unbroken skin. In this respect it is somewhat similar to *Bacillus pestis* of bubonic plague in man.

Graham and Michael (3) state that from the years 1929 to 1933, 6,708 cases of undulant fever were reported to the United States Public Health Service. The states reporting the largest number of cases were New York, 969; Iowa, 595; Missouri, 533; California, 515; Ohio, 480; Illinois, 407; Kansas, 346; and Minnesota, 295. Of these, Iowa, Missouri, Illinois, Kansas, and Minnesota have swine populations of over 3 million. The above authors are quoted thus: "It would seem that there may be a significant relation between the incidence of undulant fever in man and the size of the swine population."

It may be gleaned from the foregoing observations that people handling fresh pork in abattoirs and packing houses, meat markets, and similar places are particularly exposed to infection, principally through skin abrasion or by ingestion of contaminated food and water. While conditions in the Philippines are such that the pork industry is not yet highly developed, the presence of the infection here and its transmissibility to man calls for appropriate preventive and sanitary measures. From this standpoint alone, regardless of its vast economic significance to the hog industry, porcine infectious abortion becomes a disease of importance in relation to public health.

DISCUSSION

The biological and bacteriological characteristics of the three strains presented in this report definitely show that the organisms in question are *B. abortus suis* Traum. Whether or not the disease in hogs was introduced from abroad or native cannot be ascertained with accuracy, since for many years prior to this study imported hogs have been distributed to the different parts of the country. The fact, however, that the isolation of the organisms was made from pigs of imported breed, favors the view that the disease must have been introduced. Moreover, with the discovery by Howarth and Hayes of the outbreak in the Davis Farm, University of California, in 1931, it may be taken that the outbreak of abortion in Alabang among the stock of swine purchased from the Davis farm in 1918 was really infectious abortion introduced from California.

In identifying these three cultures or strains, only standard and accepted methods have been employed, supported by adequate known controls. The results of differential tests, such as animal inoculation and cultural behavior in liquid and dye media, and others, to which these strains have been subjected, point conclusively to the porcine type of organism.

The symptomatology and morbid changes observed in both sexes of infected pigs correspond closely to and were often identical with those observed by other workers in other countries (Hayes and Thomsen). Likewise, the condition of aborted fœtuses in different stages of pregnancy were similar to those noted by others (Graham et al.).

The fact that the cultures obtained from cases in the two outbreaks presented in this report produced abortion in pregnant guinea pigs is further evidence of their identity as true abortion organisms. Moreover, the sera of these aborting guinea pigs when tested against a known *B. abortus* antigen yielded a high positive titre (1:500 and above). Inversely, an antigen prepared from each of the three strains separately likewise agglutinated a known positive serum from abroad. There is, therefore, no room for doubt that the disease exists in this country, and the fact that it is transmissible to man should motivate concerted action towards effective control and eradication, not only from the standpoint of hygiene and sanitation as pertains to man, but also from its more important economic aspect, namely, its destructive effect on the hog industry.

A partial survey by agglutination of the blood of 1,975 pigs slaughtered at the Manila abattoir showed that 2.2 per cent of the total were positive for abortion. Whether or not this positivity has any direct relation to the incidence of certain indeterminate fevers reported in this country in human beings, among which may have been undulant fever, has not been actually determined. However, the work of Huddleson, Johnson, and Hamann, in connection with an outbreak of undulant fever in a Michigan packing house, definitely established a direct relationship between the outbreak and the finding of *B. abortus suis* in the fresh pork of those establishments. This relationship was supported by the presence of agglutination reactions in the sera of 10.7 per cent of the employees of one packing house in one test and 60 per cent in another. Again, according to the reports of the United States Public Health Service for 1929 to 1933, mentioned by Graham and Michael, the relation between the incidence of undulant fever in man and the size of the swine population is undeniably significant. The fact that of 16 cultures isolated by Huddleson, Johnson, and Beattie from the blood of 85 patients with undulant fever 5 were *B. abortus suis,* proves conclusively that this type was the cause of undulant fever in about 30 per cent of their cases.

In a personal communication Doctor De Leon of the Philippine General Hospital reported twelve serologically positive cases of suspected undulant fever patients, three of whom were aborting women. Although the isolation and identification of the *Brucella* organism from human patients have not been accomplished as yet, it is reasonable to suspect that the porcine variety (*B. abortus suis*) is the responsible agent in the majority of these cases, on account of the intimate association with, and the handling of pigs by, the people, and the fact that pork is the most commonly eaten meat of the country.

SUMMARY AND CONCLUSIONS

1. Two outbreaks of porcine *Brucella* infection have been described and reported, and three strains of *B. abortus* organisms having the characteristics of *B. abortus suis* Traum have been isolated and identified.

2. The findings in this report would indicate that the disease has been introduced in this country from California.

3. The symptoms and lesions observed in both sexes were characteristic of the disease encountered elsewhere.

4. Transmission in swine is known to occur through the ingestion of contaminated material or even through the unbroken skin.

5. The organisms are commonly found in the lymph glands, spleen, uterus or penis and testicles of the infected animal, while the fœtus may be entirely saturated with them, including the allantoic membrane and its fluid.

6. Isolation of the organism from the tissues of the aborted fœtus and the infected sow was accomplished either by direct culture on special Huddleson's medium according to his technic or by culturing the infected organs of guinea pigs showing lesions of the disease from inoculation of infected tissues.

7. Although a positive serum diagnosis in a sow does not indicate the outcome of pregnancy, this uncertainty is highly destructive to swine breeding and the industry in general.

8. Abortion of sows from *Brucella* infection occurs in all stages of pregnancy.

9. Agglutination tests of the sera of 1,975 hogs killed at the city abattoir showed an incidence of 2.2 per cent.

10. Agglutination tests by Doctor de Leon (personal communication) of the sera of suspected undulant fever patients at the Philippine General Hospital revealed twelve positive cases, three of whom were aborting women.

11. In an infected farm routine serum agglutination test and the immediate slaughter of all positive animals along with thorough disinfection were found most effective in placing the disease under control.

12. *B. abortus suis* is virulent in man and was the cause of undulant fever in about 30 per cent of the cases studied by Huddleson, Johnson, and Beattie.

13. Although the responsible agent has not as yet been isolated and identified from human patients reported by Doctor de Leon, *B. abortus suis* is highly suspected in these cases.

14. The fact that this organism is considered the most virulent of the group and has been shown to cause undulant fever in man, calls for special sanitary handling and disposal of fresh pork as a control and as a public-health measure.

ACKNOWLEDGMENT

Thanks are due to Drs. Anacleto B. Coronel and Ramon A. Acevedo, for their assistance in this work.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Aborted fœtuses three and one-half months old from a Black Poland China sow, Correctional Institution for Women, Mandaluyong, Rizal. (The other two fœtuses were badly macerated and could not be photographed.) Photo by Modesto Bantola.

2. *sp*, Spleen, and *l*, liver of a guinea pig showing *fn*, tubercle-like focal necrosis 69 days after subcutaneous injection of spleen suspension from an infected sow.

PLATE 2

FIG. 1. Aborted fœtuses one month old from Red Berkshire sow, 1934.

2. One fœtus with the allantoic membrane removed.

PLATE 3

Aborted mummified fœtuses two months old from Red Berkshire gilt, Alabang Stock Farm, 1934.

PLATE 4

FIG. 1. Apparently healthy Poland China boar with infectious abortion abscess, *ab*. Its serum is strongly positive.

2. A close-up picture of the infected testicle with healed abscesses and scars, *sc*.

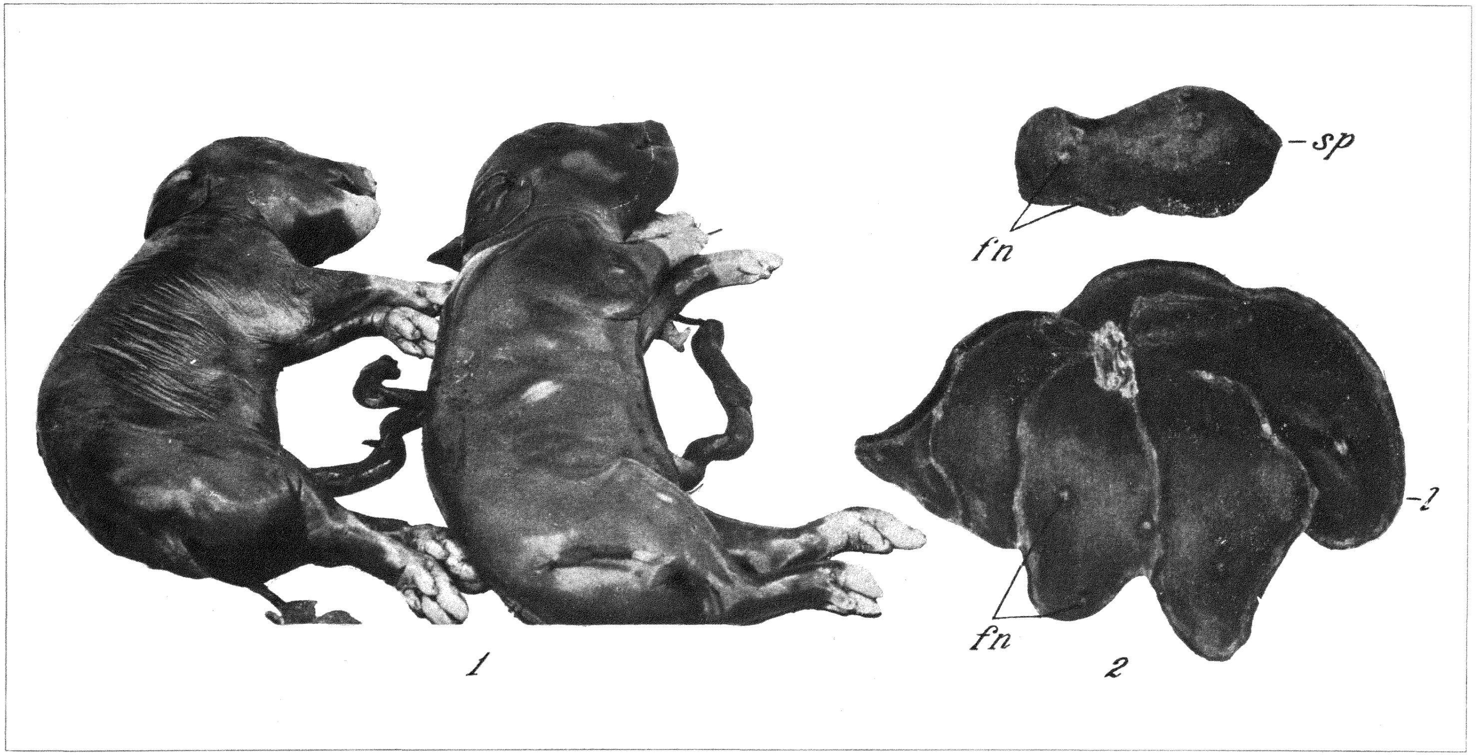

PLATE 1.

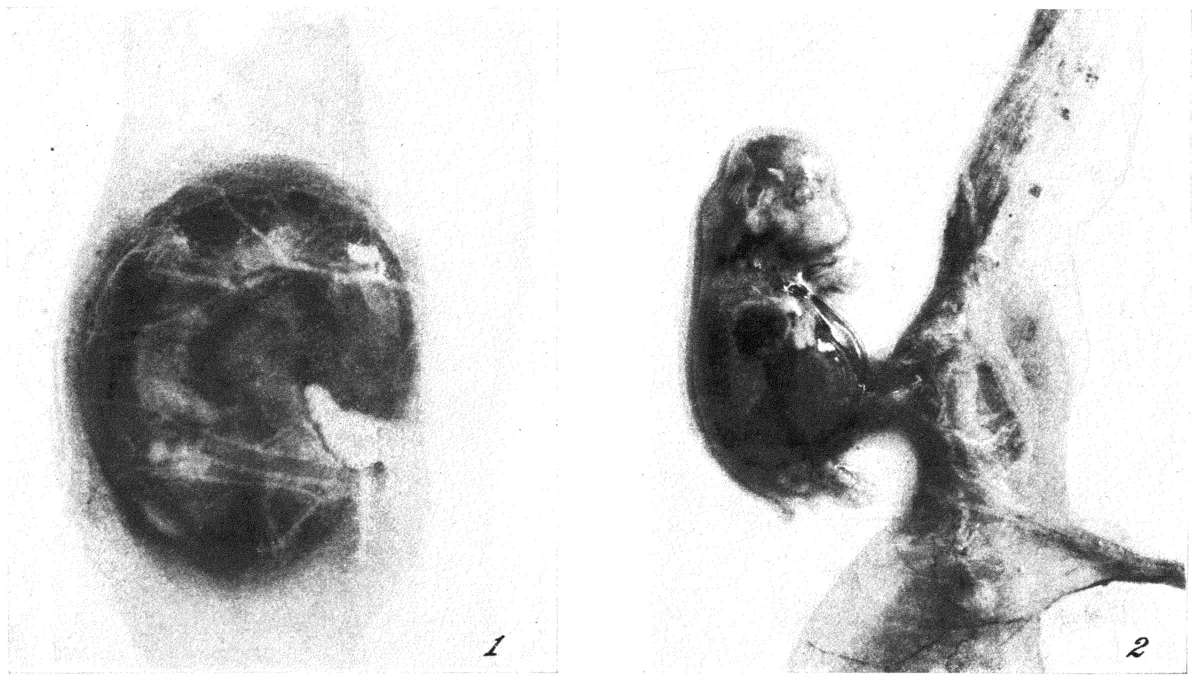

PLATE 2.

PLATE 3.

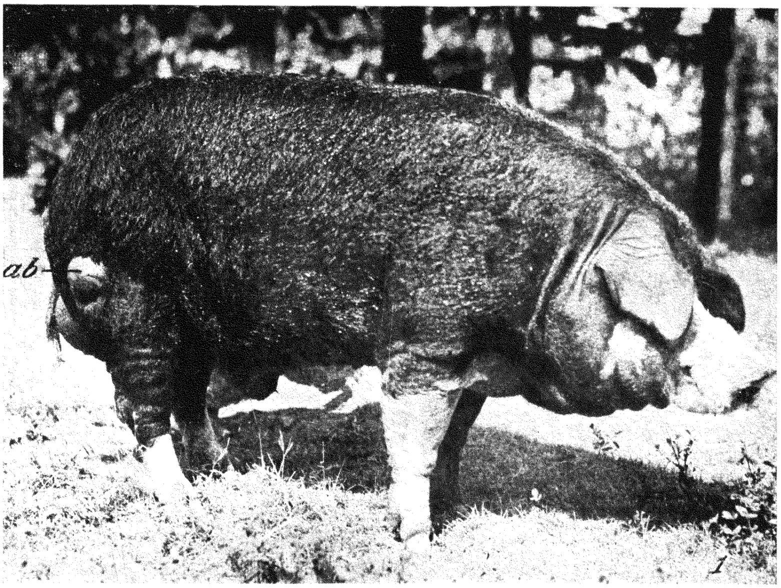

PLATE 4.

A NEW SPECIES OF AMANITA

By JOSÉ MIGUEL MENDOZA and SIMEONA LEUS-PALO
Of the National Museum Division, Bureau of Science, Manila

ONE PLATE

Formerly it was generally believed that *Amanita* does not exist in the Philippines. Very recently, however, some species of the genus were discovered in high altitudes, as in the vicinity of Baguio, Mountain Province, where a more or less subtropical climate prevails, with high humidity at certain seasons.

Collecting in Manila, January 2, 1936, the senior author and Mr. Buenaventura Reyes found an unrecorded species of *Amanita* in Malate. January is usually a cool month in Manila and at the time of collection of this specimen there were several days of continuous rain. This is the first record of a species of *Amanita* growing in the lowlands in the Philippines.

AMANITA MANILENSIS sp. nov.

Praedita est haec species; pileo succulento et verrucoso qui prima aetate oblongo, serius convexo, aetate vero provecta late convexo, 3.5 cm lato, cano-fuscente ad centrum, subcano vel cano versus marginem; lamellis perpluribus, albis, non affixis; stipite albo, crasso, farto, ad basem bulboso sed gradatim se minuendo ad pileum, 5 mm in diametro ad minimum, 9 mm ad maximum, circa 3.9 cm longo; annulo conspicuo, semper vigente, albi coloris, ad medium stipitis invento; volva tenui, adnata, subfusca, versus marginem inaequali; sporis hyalinis, obovatis, nonnumquam rotundis vel ellipticis, 6 ad 6.60 $\mu \times$ 5.4 ad 6 μ; basidiis clavatis, granulatis, 21.03 ad 28.5 $\mu \times$ 6 ad 7.5 μ; cystidiis perpaucis, 30 ad 51 $\mu \times$ 8.5 ad 10.5 μ.

Pileus [1] oblong convex when young becoming broadly convex when expanded, mouse gray at the center, becoming paler toward the margin, fleshy, thicker at the center; about 3.5 centimeters broad, covered with sharp pointed warts which are denser and larger at the center, becoming sparse and finer toward the margin. Margin at first entire, later cracking with age. Gills free, white, moderately numerous, broad near the margin, grad-

[1] This description is based on fresh full-grown specimens collected January, 1936.

ually narrowing toward the stem, long gills intermixed with short ones. Stem stout, white, stuffed, well formed, tapering gradually toward the pileus from a round somewhat bulbous base, about 5 mm in diameter on the upper end and about 9 mm at the base, 3.9 centimeters long. Annulus very prominent, persistent, white, showing remainder of a veil; located on the midway of the stem. Volva thin, pale brown, adnate, irregular at the margin, covering entirely the base of the stem. Spores white in mass, hyaline under the microscope, obovate, sometimes round, 6 to 6.6 μ long, 5.4 to 6 μ broad; average 6.33 μ long, 5.61 μ broad. Basidia numerous, clavate, granular, 21.03 to 28.5 μ long, 6 to 7.5 μ broad; average 24.7 μ long, 6.72 μ broad. Cystidia very rare, long-cylindric to elliptic, sometimes slightly pointed, 30 to 51 μ long, 8.5 to 10.5 μ broad; average 39.6 μ long, 9.12 μ broad.

LUZON, Manila, *Phil. Nat. Herb. 2582, Jose M. Mendoza and B. Reyes* (type) January 2, 1936, on the ground, under acacia, *Samanea saman* (Jacq.) Merr.

Amanita manilensis resembles very closely *A. aspera* Fr. in appearance. It differs however, in the size of the spores and in the form of the cystidia. In *A. manilensis* the spores are much shorter than those in *A. aspera.* The cystidia in *A. aspera* are subglobose with short constricted base, while in *A. manilensis* they are long-cylindric to elliptic.

Most deadly poisonous mushrooms belong to *Amanita,* such as *A. phalloides, A. muscaria,* and *A. aspera. Amanita manilensis* sp. nov. is suspected of being poisonous.

ACKNOWLEDGMENT

The writers acknowledge their obligation to Dr. A. H. Smith, of the University of Michigan, for the loan of *Amanita* specimens which were used for comparison; to Rev. Francis X. Reardon, S. J., of the Ateneo de Manila, for translating a brief English diagnosis into Latin.

ILLUSTRATION

PLATE 1

FIG. 1. *Amanita manilensis,* a section of the gill, showing the hymenium with cystidia, basidia, and spores; × 667.

2. *Amanita manilensis;* × 1.7.

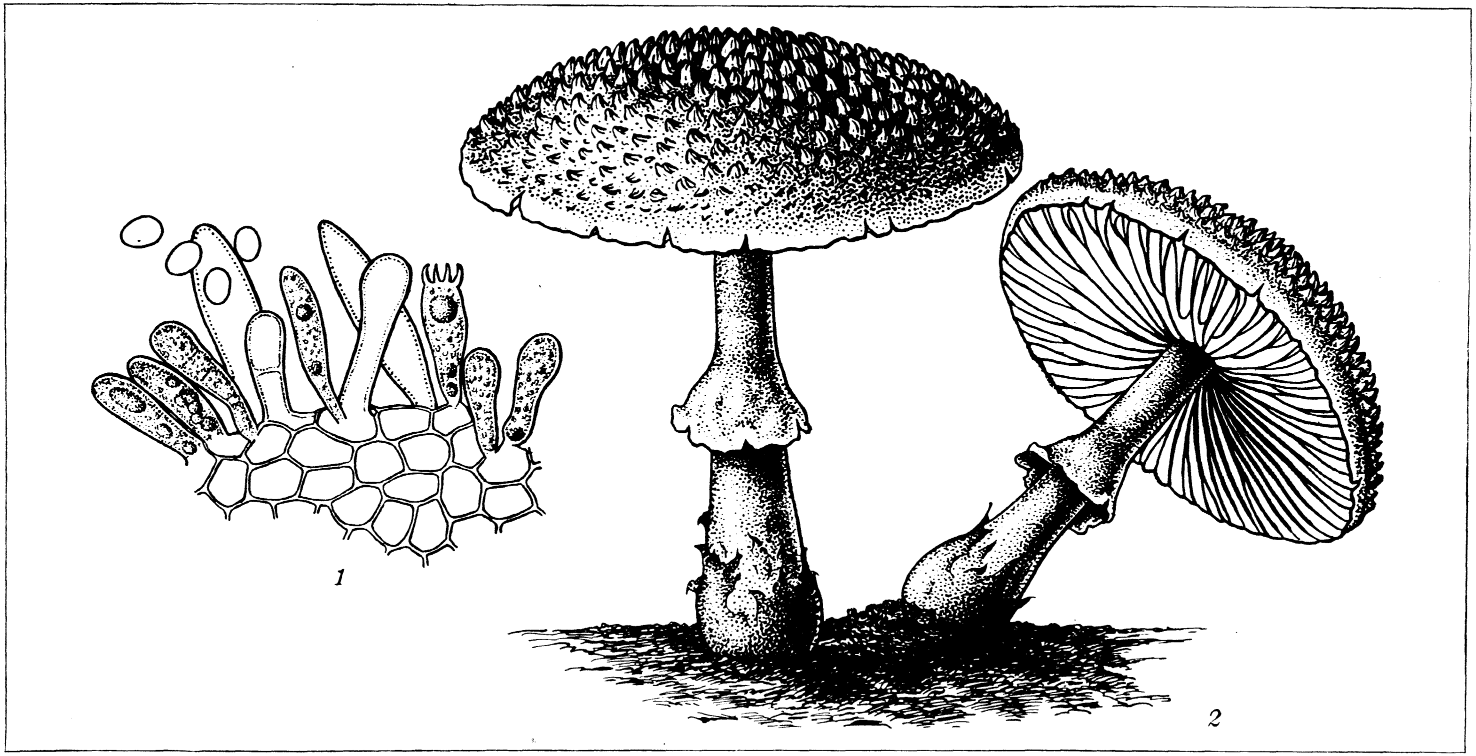

PLATE 1.

HERPETOMONAS MUSCARUM (LEIDY) IN LUCILIA SERICATA MEIGEN [1]

By GERVASIO C. BELLOSILLO

Of the National Museum Division, Bureau of Science, Manila

FIVE PLATES

Herpetomonas muscarum (Leidy), which is commonly found parasitic in the digestive tracts of nonbiting flies, is one of the most extensively studied flagellates. An important problem is the relationship of the parasite to the larva and pupa of its host. Patton stated in 1910 that he could not find the parasite in larvæ living in horse dung. In 1921, however, he reported larvæ infected with *Herpetomonas muscarum*, in which the infection carried over to the adult. Becker (1923) was unable to find larvæ infected with parasites, both in attempts at experimental infection and in examination of larvæ taken from exposed places in Westport dump, Baltimore. MacKinnon (1910) observed infected larvæ of certain dung flies.

Below are reported studies of the morphology and life history of the flagellates, as well as the results of experiments on infection in adult and larval flies.

MATERIALS AND METHODS

Materials.—The flies were collected by the writer between September and March by means of fly traps. By using as bait under the trap a piece of fish or meat, it was possible to catch in a few hours various kinds of flies, among which were a great number of *Lucilia*. A bottle with a narrow opening was placed inside the trap, and the flies desired were caught by hand and dropped into the bottle. By the use of traps and fly cages much time was saved as compared to that required in using the net.

The larvæ were fed liver, hamburger steak, horse meat, yolk of egg, cooked fish, and molasses, and the flies were given ba-

[1] The observations and experiments reported in this paper were carried out in the Department of Zoölogy of the University of California at Berkeley. The writer wishes to thank Dr. Harold Kirby, Jr., under whose direction the work was undertaken, for his advice and criticism on the manuscript and experiments, and to acknowledge his indebtedness to Dr. Charles A. Kofoid for suggestions and criticisms.

nanas, strawberry jam, molasses, granulated sugar, fresh fish, and meat.

Methods.—For the study of the forms of the organisms found in the different regions of the gut the following method was used. The legs and wings were removed and the specimen was fastened in the dissecting dish with the ventral surface down. A slit was made through the length of the body, extreme care being taken in opening the visceral cavity. After the body wall was pinned back, the digestive tract was carefully removed with dissecting needles, care being taken not to break the intestinal wall. Then the gut was stretched out on a slide in a drop of normal saline solution and covered with a cover slip, so that the exact regions where forms of the parasite occurred could be studied. For rapid examination, however, the head was first cut off, and the gut teased out from the posterior end in normal salt solution.

For permanent mounts the digestive tract was divided into five sections, each section being carefully smeared on a clean slide with the aid of dissecting needles. Then the slide was immediately dipped into a fixative.

In the examination of the larvæ for *Herpetomonas muscarum*, both the posterior and the anterior ends were cut off with sharp scissors, and the digestive tract was teased out and placed on the slide in normal salt solution.

The following fixatives were used: Schaudinn's, with and without acetic acid, Flemming's fluid, Korpenchenko's A and B solutions, and Zenker's, without acetic acid. The first two were used at 60° C. as well as cold. For staining, Delafield's hæmatoxylin, Heidenhain's iron-hæmatoxylin, Mallory's triple stain, and Feulgen's nuclear stain were used with varying degrees of success. Light green and orange-G were used as counterstains. Most satisfactory results in the use of light green were obtained when it was dissolved in 1 per cent solution in clove oil. The flagellates fixed with Schaudinn's solution with acetic acid and stained with Heidenhain's iron-hæmatoxylin gave the best results. Mallory's triple stain did not give good results.

When the organisms were fixed with Korpenchenko's A and B solutions and stained with Heidenhain's iron-hæmatoxylin, very good preparations were obtained, except that the flagella were not shown clearly.

The vital stains used were neutral red and Janus green B in 1 per cent solution in absolute alcohol.

MORPHOLOGY AND DIVISION

The flagellate stage of *Herpetomonas muscarum* is best observed in the crop of the fly. There the flagellates may be found together with the ingested food of the infected fly.

Morphology.—In the crop the writer has seen cysts, and trypaniform, stumpy, and adult forms (Plate 1, figs. 1 to 8; Plate 3, figs. 50 to 53). The trypaniform organism in this region of the gut is, no doubt, the young organism derived from the cyst which has newly been ingested by the fly (Plate 1, figs. 3 to 5). In the midgut have been found long flagellates, stumpy forms, and even encysted forms (Plate 3, figs. 50, 54, 56, and 61). The stumpy forms are numerous in both the posterior and anterior ends of the gut but infrequent in the middle portion. The encysted stage is not very common in this region. The majority of the forms are of the long flagellated and giant types. In the hind gut are found the same forms as in the midgut, but together with many cysts and trypaniform stages. The fæces contain all the forms that are usually found in the hind gut, and are infective to other flies.

In lightly infected flies the Malpighian tubules are not infested with the parasites, but in heavily infected ones the parasites are generally found swarming in the Malpighian tubules. This condition is very evident in the larvæ that are heavily infected with the organisms about twenty-four hours after they are fed with molasses after infection and also in flies that have newly emerged from the pupal stage. This matter will be discussed below. However, once infection is heavy, the parasites are usually found in clusters, either attached to the intestinal wall on the peritrophic membrane or free within the lumen of the intestine. Both on the slides and in living material clusters were observed with the flagella entangled with each other and pointing toward the center. This arrangement also occurs in trypaniform types having short flagella (Plate 2, fig. 21). A number of dividing forms, which the writer believes to occur at all stages of the development of the organism, are usually present.

In the adult stage (Plate 1, figs. 6 and 7) *Herpetomonas muscarum* possesses a long, relatively rigid, slightly flattened body, at the anterior end of which one, or frequently two, long flagella emerge. The length of the organism at this stage ranges from 9 to 36 microns and the width from 1½ to 6 microns. Wenyon (1913) states that the organism is leaflike, resembling a blade of grass. According to the writer's observations, the flagellates do not resemble a blade of grass, but are round or oval in cross section. A similar form was reported by Becker (1923). The posterior end may be sharply pointed or slightly or broadly rounded.

Although it is possible, as Lwoff and Lwoff (1931) and others have pointed out, that the structure usually called the parabasal body in Trypanosomidæ is not homologous with the parabasal body of Trichomonadidæ, the writer has followed the terminology of recent writers on *Herpetomonas* in this paper.

Anterior to the nucleus is the so-called parabasal body, which varies in size according to the size of the organism, and in form may be ovoid, bar-shaped, heart-shaped, or bean-shaped (Plate 5, fig. 5). In certain stages of the development of the flagellates it is found posterior to the nucleus. Robertson (1927) states that the parabasal body in *Trypanosoma raiæ* is apparently a very dense mass of chromatin, and, colored with Feulgen's nucleal reaction, takes a vivid red stain. The same fact has been observed by the writer in staining *Herpetomonas muscarum* with Feulgen's. Fixed with Schaudinn's solution with acetic acid, or with Korpenchenko's solution, it takes a deep iron-hæmatoxylin stain, and is very well differentiated. In unstained preparations the structure appears as a refractile granule at the base of the axoneme. It is surrounded by a clear space. Wenyon (1913) has stated that this space is inclosed by a membrane, but this has not been verified by the writer.

In *Herpetomonas muscarum* the writer has been unable to find a rhizoplast connecting the nucleus with either the blepharoplast or the parabasal body.

The blepharoplast is located just anterior to the parabasal body (Plate 5, fig. 5, *bleph*) and probably is connected with it by fibrils, although, because of the minute structure of the organism, the writer has not seen these.

According to Strickland (1911) and Wenyon (1913) the clear space anterior to the parabasal body (Plate 5, fig. 5, *ant cl ar*) is the cytostome through which food may be ingested by the flagellate. The writer has studied this structure very carefully, but, like Becker (1923), has been unable to find evidence to support this conclusion.

According to Prowazek (1904) an axial filament in *Herpetomonas muscarum* extends from the blepharoplast with the kinetoplast to another so-called blepharoplast or centrosome, near the posterior end of the flagellate. With this observation the writer is, for the most part, in agreement.

The rhizostyle commences at the blepharoplast and extends to the posterior end of the cell, terminating in a chromatic granule (Plate 5, fig. 5, *chr gran*). This structure is similar to that described by McCulloch (1915) in *Crithidia leptocoridis*, except that in *Herpetomonas* the rhizostyle is not attached to the nucleus but passes over it (Plate 1, figs. 6 to 14). This condition was clearly ascertained in a few specimens which were stained lightly enough to make clear differentiation of the cellular contents possible.

The writer regards the rhizostyle as a permanent organelle which is present throughout the life history of the flagellate, in the adult and in the trypaniform stages and cysts. In the cyst and trypaniform types the formation of the rhizostyle is similar to that in adults (Plate 2, figs. 25 to 31).

The axoneme of the flagellum (Plate 5, fig. 5, *flag*) arises from the blepharoplast and proceeds anteriorly as a fine line, until it reaches the margin of the cell, where it thickens to form the marginal granule (Plate 5, fig. 5, *mar gran*). The extracytoplasmic portion of the flagellum is much more sturdy and takes a heavier stain than the axoneme. In the adult stage the flagellum is about three times as long as the body.

In fresh material the parasites appear to be possessed of a single flagellum, except those that have evidently reached the later stages of division. But in the fixed material the appearance is different. The organism almost always appears with two flagella lying side by side enclosed by a cytoplasmic sheath (Plate 3, fig. 50).

In organisms that have divided almost completely each individual possesses one flagellum (Plate 2, figs. 17 and 18). The crithidial and trypaniform types in the majority of cases possess only one flagellum, except when the actual division is taking place (Plate 2, fig. 21). The majority of workers, including Patton (1908), Porter (1909), MacKinnon (1910), Becker (1923), and others, have agreed that the biflagellate appearance is due to the tendency of these organisms to be almost constantly in a stage of division.

In the resting stage in the nucleus the karyosome varies considerably in form. The chromatic material of the karyosome may be arranged in four granular masses or may form into a ringlike body with one or more chromatic strands crossing it (Plate 2, figs. 36 and 40). Forms with a single chromatic mass at the middle of the chromatic ring, and with the chromatic material arranged as in two polar caps, also frequently occur (Plate 2, figs. 41 and 42). The last may be mistaken for a dividing form.

In *Herpetomonas muscarum* a number of globules and the parabasal body may be vitally stained with neutral red. These globules are scattered throughout the body (Plate 4, figs. 66 and 67) although in some cases they are gathered either in the region just posterior to the parabasal body or in the posterior region of the flagellate (Plate 4, fig. 68). The grouping of the neutral red staining globules near the parabasal body makes it difficult to distinguish this body. The writer has also stained the parabasal body of *Trypanosoma lewisi* with neutral red (Plate 4, fig. 69).

By using the method suggested by Hall (1929) the writer obtained the following results with Janus green B. The first structure to take up the dye is the parabasal body which has remarkable affinity and appears as a very bright bluish structure. The other structures that are stained with the dye are the rod-formed mitochondria and vacuoles, scattered throughout the cytoplasm and especially numerous at the anterior and posterior ends of the organism (Plate 4, figs. 62 to 65). One side of the vacuole is always more deeply stained than the other. Shipley (1916) states that some of these vacuoles contain small granules in their anterior part which also stain vitally with Janus green. The writer has searched for these in his preparations, but could not find satisfactory evidence of their presence.

The vacuoles which stain with Janus green are the same in size and form as those which stain with neutral red. Bowen (1928) states that Janus green B will stain the neutral-red-staining vacuoles lightly in time. That the vacuoles that are stained with Janus green are exactly the same in *Herpetomonas muscarum* as those stained with neutral red the writer is, however, unable to affirm at present. When the organisms are stained simultaneously with both dyes, the parabasal body stains dark red, the vacuoles red, and the numerous mitochondria light bluish green.

Binary fission.—The first indication of binary fission is a divided blepharoplast and a duplicated flagellum. According to Patton (1908), Wenyon (1913), MacKinnon (1910), Becker

(1923) and others, the doubling of the flagellum comes about through the growing of another one from the new daughter blepharoplast. The writer has observed the same process of flagellar formation (Plate 1, figs. 6 and 7).

As the blepharoplasts move away from one another, the parabasal body commences at the posterior region to split longitudinally (Plate 1, figs. 8 and 9). With the statement of Becker (1923) that the process of division of the parabasal body is influenced by the blepharoplast, the writer is in full accord. The parabasal body continues to divide, each daughter moving to the periphery of the organism (Plate 1, figs. 9 to 13). They are then separated, one passing to each individual. The parabasal body seems to have an oblique position during binary fission (Plate 1, figs. 11 to 14; Plate 2, figs. 15 to 17), but assumes its position at the same level of the body after the division is completed (Plate 2, fig. 18).

During the splitting of the parabasal body, the division of the nucleus proceeds. The position of the nucleus during elongation is purely accidental (Plate 1, figs. 9 to 14; Plate 3, fig. 52) and can be attributed to the form of the body of the organism.

Just before elongation, fine, scattered chromatin granules, which later form into an equatorial plate, appear at the center. The rest of the chromatic material is gathered into two polar caps with the equatorial plate between them (Plate 2, figs. 44 and 45). This appears to be the metaphase stage. Feebly developed spindle fibers may be observed at this time. This condition may be noted both in the adult and in the encysted form (Plate 2, figs. 26 and 42). The equatorial plate separates into two daughter equatorial plates which move toward the poles (Plate 2, figs. 46 to 48). The number of chromosomes cannot be ascertained. The daughter chromosomes form into groups near the two opposite chromatic caps. Here they become fused with the chromatic caps forming two daughter karyosomes.

During the process of division the body of the cell continually increases in size until the cytoplasm of the mother cell commences to split longitudinally from the anterior to the posterior ends, remaining connected only by a cytoplasmic strand (Plate 2, figs. 15 and 16). As the two daughter individuals grow in size, the cytoplasmic strand breaks, forming two complete individuals with active movements (Plate 2, figs. 17 and 18). In this stage the nucleus assumes the resting condition. The parabasal body divides simultaneously with the dividing nucleus, except in a few cases in which the parabasal body may have already divided before the completion of the nuclear division (Plate 1, fig. 10).

Becker (1923) states that in the trypaniform type usually one flagellum and a nucleus are present, but occasionally dividing forms with two parabasal bodies are found. The writer has confirmed this observation. In addition to this the writer believes that division is similar to that of the adults. The fact that the trypaniform and encysted types divide has not been clearly demonstrated before, so that a few figures have been made to illustrate the stages of division in the cysts found in the hind gut (Plate 2, figs. 25 to 31).

The writer has observed the method of encystment described by Becker (1923) and Strickland (1911), in which the cyst is derived from the trypaniform type. The body of the organism gradually shortens and the middle or posterior portion of the body becomes enlarged. The parabasal body moves backward, taking a position near, just anterior to, or at one side of the nucleus. During this process the flagellum is discarded, leaving the intracystoplasmic axial filament (Plate 2, figs. 24 to 33). The clear space which the writer has named the anterior clear area is conspicuous. The encysted flagellates divide in the same manner as do the adults.

RELATIONSHIP BETWEEN HERPETOMONAS AND FLIES

Relationship to adult flies.—In order to determine the exact mode of infection in the digestive tract of the fly, an experiment was carried on in the following manner.

Eight uninfected flies were placed in each of four clean aquarium jars covered with clean sterilized cheesecloth, and fed with newly infested meat from the cage where wild flies had fed on it for two hours. After twenty-four hours when aquarium jar 1 was examined, five of the flies were infected with *Herpetomonas*. The infection occurred in the crop and the midintestine. On the third day the same number were infected in aquarium jar 2. The infection was much heavier and occurred in the crop, midgut and anterior end of the hind gut. Rounded forms were not found. On the sixth day the infection was much heavier in the flies in aquarium jar 3. Stumpy as well as a large number of flagellated forms were found throughout the digestive tract. The flies in aquarium 4 were left undisturbed until the sixteenth day, so that the infection with flagellates became very heavy. The intestine swarmed with flagellates of all forms. Stumpy forms occurred in the crop, rarely in the midintestine, and in the posterior part of the midgut and the anterior portion of the hind gut. Flagellated and round stumpy forms were found in the crop, flagellated trypaniform stages and cysts in the midintestine, flagellated forms, large trypaniform, and encysted stages in enormous numbers in the hind gut.

This experiment demonstrates the manner in which the infection is carried from fly to fly by means of contaminated food.

In an experiment to determine the effect, if any, of the parasites upon the host, two cages were used, one having wild and the other uninfected flies. The flies in the cages were fed with uninfected fresh meat. Beginning two hours later, the flies were left without food for more than twenty-four hours. Both infected and uninfected flies were examined for food content. The infected flies had no food left. Some of them were dying, whereas the clean ones had food left and were still active.

This experiment confirms Patton's (1910) conclusion that the swarm of flagellates passes up to where the food is and absorbs it. The same author stated that when infected flies were fed with jam and juice of horse dung the parasites completely disappeared. The writer fed flies with strawberry jam alone and this did not affect the growth of the parasites.

Relationship to fly larvæ.—A diversity of opinion has existed concerning the relation of *Herpetomonas* to fly larvæ. According to Prowazek (1904), transmission of *Herpetomonas muscarum* is hereditary, by which he means that the parasites are passed through various stages of development of the fly from the egg to the adult. Patton (1910), in his experimental infection of *Musca nebulo,* found no evidence of hereditary transmission. He further stated that in his investigation the parasites were not found in the larvæ bred in horse dung, and that the long flagellates were found in very young larvæ fed on the dead bodies of flies, but never in the mature larvæ, pupæ, or flies bred from these larvæ. The same author, however, reported in 1921 that the larvæ of *Musca nebulo* are commonly infected with *Herpetomonas muscarum,* and that the infection is carried over to the adults, so that when the adults hatch out they are infected. Becker (1923) gives evidence that the organism is not transmitted hereditarily and cannot be found in the digestive tract of the larvæ. He wrote, "During the months of July and August, 1922, I examined two hundred fly larvæ, principally *Lucilia* and *Phormia* in various stages of development, taken from the most exposed places in Westport dump, Baltimore. No infected larvæ could be found. I also examined sixty *Musca domestica* larvæ taken from a pile of horse manure but I found no infection." Strickland (1911) was unable to find infected larvæ in *Lucilia.* Prowazek (1904) found infected *Sarcophaga* larvæ. MacKinnon (1910) reported larval infection in *Scatophaga* and *Homalomyia,* but was unable to find it in larvæ of *Musca domestica.* Becker states, "It is difficult to draw any conclusion from the conflicting observations of various authors, but it seems that one or two factors must be at work here. It is possible that the larvæ of certain species of muscoid flies are capable of infection with *Herpetomonas,* and that certain others are not. Then there is another possibility that certain environmental conditions, relating to moisture, temperature, character of food, flora of the larval intestine, etc., are factors which determine whether or not the larvæ could be infected."

The writer undertook investigations to determine whether the larvæ of flies are infected with the parasites. The back of a restaurant was selected as a site to breed fly larvæ. The restaurant had a large-sized fly trap beneath which heads of chicken and fresh fish were placed for flies to feed on. After feeding they flew upward and were caught in the trap. Before the female flies left the baits, they laid their eggs on them. Within twenty-four hours, as the weather at that time was favorable for hatching, the eggs hatched. The larvæ fed on the chicken heads and fish. The baits were constantly infected with the flagellates by flies laying eggs and feeding on them. More than sixty larvæ, both young and old, were examined but not a single one was found infected.

Another experiment was performed to determine whether the larvæ of *Lucilia sericata* could be naturally infected by *Herpetomonas muscarum.*

More than fifty infected flies were put in a cage. The flies were fed with fresh beef liver placed in a petri dish. The liver was kept moist with sterile normal saline solution until 10 P. M. That same morning a large number of eggs previously laid were placed on the liver. At 10 A. M. the next morning the eggs were already hatched. Eight larvæ were examined with negative results. In the evening six of them were examined, and found uninfected. The larvæ and the infected liver were transferred into three test tubes. All the test tubes were placed in aquarium jars with sterile sand. The jars were covered with cheesecloth and put in a large box covered also with cheesecloth. Every morning some of them were examined, and no infection was found. After the larvæ stopped feeding, they crawled out of the test tubes, dropping on the sand, into which they burrowed to pupate. In two weeks they emerged from the pupæ as adults. The newly emerged flies were examined with no positive results.

In this case the larvæ feeding on infective meat were not infected. The results of this experiment did not agree with those reported by Patton (1921).

The writer performed another experiment to determine whether the larvæ of *Lucilia* could be induced to take in *Herpetomonas* by feeding on dead flies.

Wild flies were dissected and put into a test tube, where they were kept moist by the addition of a few drops of sterile normal saline solution. Twenty-one one-day-old larvæ were dropped into the test tube. After six hours one of them was examined and found to contain herpetomonads. The next day three others were found infected. Fresh dead flies were added to maintain a sufficient food supply.

Eight of the larvæ were taken out and fed on old meat in another test tube. Twenty-four hours later no infection was found. In this case the old meat used by the larvæ was not favorable for the growth of the parasites.

Two and three days after the beginning of the experiment the rest of the larvæ feeding on dead flies were examined and found infected.

As the larvæ could be infected with the parasites by feeding on the infective digestive tracts of the flies moistened with normal saline solution, the writer carried on further experiments to determine whether or not the larvæ can be infected with the parasites at any age and the infection carried over the adult stage under natural conditions. Horse meat, yolk of egg, and molasses were selected as food for the larvæ during the experiment, and they were kept at room temperature.

In the first of these experiments fifty two-hour larvæ were fed with heavily infected digestive tracts of the flies moistened with normal saline solution. A day later eight were examined, and six found infected. The contents of the digestive tract included an enormous number of bacteria and flagellates of different forms. The larvæ were transferred to fresh horse meat in a test tube. A day later, of eight examined, four were positive. Adults and a few round forms were present. The bacterial infection was very heavy, and the flagellate infection light.

A day later, of six examined, all were negative. On the next day the larvæ migrated to sawdust to pupate. Eight were examined and all found negative. Five flies which emerged twelve days later were negative.

In a second experiment fifty twenty-four-hour-old larvæ were infected with the parasites in the same way. The next day eight were examined and all found positive. The infection was light in some, heavy in others. The larvæ were transferred to fresh horse meat in a test tube. A day later, of ten examined, eight were positive. The infection, which was light, included round and trypaniform forms. The bacterial infection was very heavy. On the next day, of eight examined, seven were negative and one was lightly infected. The rest migrated for pupation. Two weeks later the flies began to emerge. All were negative for *Herpetomonas,* but the bacterial contents of the digestive tracts were heavy.

In a third experiment fifty forty-eight-hour-old larvæ were fed with infective digestive tracts of flies moistened with normal saline solution. A day later, of ten examined, all were positive. The remainder were transferred to fresh horse meat in a test tube. The next day only five of ten were positive, and these contained rounded and trypaniform stages. The same day at night the larvæ began to migrate to pupate. When two weeks later the adults emerged, all were found negative.

In another experiment larvæ approximately three days old were fed with digestive tracts of flies heavily infected with flagellates. Larvæ of this age are somewhat difficult to infect, as the sudden change of nutrition seems to hinder them from taking the new food, so that a method was devised that would force them to emerge into the infective food. Furthermore, at this age, when they had been continually feeding on the ground horse meat, it is nearly time for them to stop feeding.

Twenty-five three-day-old larvæ were dropped into the infective medium in a vial, and a test tube inserted into it leaving an inch space at the bottom where the larvæ were forced to stay, with an air space between the outside of the test tube and the inside of the vial. This method is remarkably effective in the infection of the larvæ as they are forced to emerge into the infective food and thus to ingest the parasites in the medium.

A day later six were examined, and four were infected. They were left free to migrate into the sterile sawdust in a glass jar covered with perforated tin cans.

Fifteen days later the flies began to emerge, and were examined as they gradually emerged. None was found infected with *Herpetomonas*.

Further experiments were carried on with ground fresh horse meat, yolk of egg, and molasses (New Orleans molasses) as food for the larvæ.

In the first of these, fifty twenty-four-hour-old larvæ were infected with *Herpetomonas* by feeding on heavily infected digestive tracts of wild flies. They did not grow much larger than they had been, owing to lack of food. After infection they were transferred to the fresh horse meat. They grew very fast and the flagellates were beginning to disintegrate when they were examined the next day. They were again transferred to the yolk of egg. Within twenty-four hours they were carefully examined for parasites. A light infection was found. The larvæ did not grow as rapidly as when they were fed with meat.

They were at last transferred to molasses in another test tube. After twenty-four hours they were examined again for parasites. Strange as it may seem, the infection was found very heavy; even the Malpighian tubules were swarming with flagellates. The larvæ did not grow in size and the length of the time to pupation was increased to eight days. In spite of their undersized condition they pupated and emerged in less than the usual time. The emerged flies were carefully examined for flagellates, with the result that ten out of fifteen were found heavily infected both in the guts and in the Malpighian tubules.

In a second experiment a mixture of the three kinds of food was fed to the infected twenty-four-hour-old larvæ. They grew faster and became as large as those which had been fed with meat alone. The flies took approximately fifteen days to emerge and were examined at the time they appeared. Two out of twenty-five examined were heavily infected.

The results of these experiments indicate that the larvæ of different ages can be infected with the organisms either heavily or lightly, but the flagellates disintegrate from twenty-four to forty-eight hours after the infection has taken place by rounding up or dying out when the larvæ are fed with horse meat alone. Undoubtedly, the old meat does not favor the growth of the parasites because of the bacterial and perhaps other elements in it that do not give them favorable nutritive value. Entirely different results have been obtained by feeding the larvæ on various diets; namely, fresh horse meat, yolk of egg, and molasses. The parasites grew rapidly and were carried to the pupal and adult stages.

Hereditary transmission of infection.—An experiment was then carried on to determine whether transmission of *Herpetomonas muscarum* is hereditary. The materials used were a large box covered with cheesecloth, a tin can, fish, sand, infected flies, and fly eggs.

Wild flies were put in a cage and fed with fresh fish. By watching them and using a cage appropriate for the work, the writer was able to catch the exact individuals that laid the eggs on the food, and these were examined for parasites and found to be heavily infected. The newly laid eggs were transferred to the sterile fish which were placed in a shallow sterile tin can in a sterile aquarium jar covered with cheesecloth. In twenty-four hours the eggs were hatched. Within five days the larvæ stopped feeding; they migrated into the sand under the tin can to pupate. Two weeks later adult flies emerged from the pupal stage. These newly produced individuals were examined for *Herpetomonas* and found uninfected. The experiment was carried to the third generation with the same result.

This experiment showed that the flagellates were not hereditarily transmitted.

DISCUSSION

Why the larvæ generally are not infected when they are gathered in natural conditions can be understood by the kinds of food they feed on, their behavior during feeding, and their reaction to some environmental factors. They are usually found feeding on carrion, manure, garbage, and other refuse. These kinds of food are not very well suited to the livelihood of parasites, owing to their bacterial content and other elements which may become detrimental to growth of the flagellates unless favorable food for the organisms is ingested. Food that really favors the growth of parasites is not usually used by larvæ, as they are generally limited to the same food from the time they have started feeding to the moment they are ready to pupate. In this way there are no cycles of constant food changes, such as the adult flies generally have. Owing to the presence of toothlike structures, which are used for grabbing rather than for sucking, the larvæ are different in food habits and method of taking in food from the adult flies, to which the lack of fluid to thin out the bacterial contents for organisms to freely move around can be attributed. When the bacterial contents are thick the parasites lose their power of motion, resulting in their dying out or rounding up. Patton (1921) has stated that overgrown bacteria in culture cause the death and the rounding up of the parasites.

Another factor, it seems to the writer, is the method of feeding. Observation shows that the larvæ are not generally found on the surface but are partially buried in the food with their posterior ends out. This position often occurs after the surface of the food, for example, carrion, has been used up, leaving already used materials at the top and unused food at the bottom on which the animals feed. Undoubtedly the waste materials at the top are not being used, and are not suited to the existence of the parasites in case contamination by adult flies occurs.

Experimentally, the larvæ are negative to light. If they happen to be in the light after hatching they immediately migrate to the dark or dig themselves into the food, which keeps them free from infection of the flagellates from the newly extruded excrement of flies.

In adult flies constant changes of food content take place in the alimentary canal. The writer has observed constantly during the time he was catching his specimens that flies feed on various kinds of food. They may be found on flowers; in decayed or fresh fruits, such as apples, bananas, grapes, and others; on both spoiled and fresh meat by which they are generally attracted to lay their eggs; and in decayed vegetables, manure, sugary food, and filthy materials. The chances of infection are very great, owing to the ability of flies to move constantly from food to food. The larvæ have little or no chance for infection. Their habits, their reaction to environment, and the kind of nutrition they consequently get, militate against the presence of the flagellates in the larvæ.

SUMMARY

1. The flagellate *Herpetomonas muscarum* is entozoic in *Lucilia sericata* in Berkeley, California. About 99 per cent of the flies are found infected during fall and spring, but seldom during winter, from the latter part of December to the latter part of February.

2. The infection occurs throughout the alimentary canal and, if it is heavy, even in the Malpighian tubules.

3. A study has been made of the morphology of the flagellates.

4. The structures that can be stained intravitally with Janus green are the parabasal body, mitochondria and vacuoles; and with neutral red the vacuoles and the parabasal body.

5. The cysts and trypaniform types divide by the same process as that taking place in the adults, except that nuclei do not exhibit various forms in the resting stage.

6. The flies and larvæ may be infected by any type of flagellate.

7. The larvæ can be infected at any age during the larval stage by feeding on infective digestive tracts of the wild flies. As the flagellates live only from twenty-four to forty-eight hours when the larvæ are fed with horse meat, it cannot be expected that the infection could be carried over to the imago.

8. The parasites are carried over to the adult flies from the time the larvæ are infected, when the larvæ are fed with molasses, or with a mixture of 1 part molasses, 2 parts yolk of egg, and 10 parts of horse meat.

9. The normal absence of the flagellates in the alimentary canals of the larvæ is due to the kind of food.

10. No hereditary transmission of the parasites occurs in the fly.

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ILLUSTRATIONS

[All figures in Plates 1 to 3 were made from specimens fixed with Schaudinns' fluid and stained with Heidenhains' iron-hæmatoxylin; those in Plate 4 were made from living material stained with Janus green B and neutral red; Plate 5, figs. 1 to 4 drawn from fixed materials; fig. 5, a diagrammatic drawing showing structures.]

PLATE 1

FIGS. 1 and 2. Cysts newly ingested by a fly, showing rhizostyles and chromatic granules; × 1,466.

3 to 5. Individuals with their axonemes grown out of the cells as flagella, showing the gradual migration of the parabasal body to the anterior and that of the nuclei to the middle of the cells. The rhizostyles also elongate simultaneously with the body of the cells; × 1,466.

6 and 7. Individuals in resting stages, showing the gradual growth of the rhizostyles to join the daughter chromatic granules. The rhizostyle is passing over the nucleus; × 1,466.

FIG. 8. The nucleus is in the prophase stage with the chromomeres at the middle of the chromatic ring; × 1,466.

FIGS. 9 and 10. Flagellates with their nuclei in the metaphase stage, each having two polar chromatic caps and the equatorial plate between them. The positions of the elongation of the nuclei represent two types, oblique and longitudinal. The parabasal bodies are dividing; × 1,466.

11 and 12. The nucleus of fig. 11 is in the early anaphase stage, and that of fig. 12 in the late anaphase, both with the persistent nuclear membrane around them; × 1,466.

13 and 14. In fig. 13 the two daughter nuclei are connected dumb-bell fashion. The parabasal body has almost completely divided. In fig. 14 the achromatic mass has been cut in by the nuclear membrane, thus forming two completely separated nuclei; × 1,466.

PLATE 2

FIG. 15. Thin cytoplasmic sheath at the middle of the cell; × 1,466.

FIGS. 16 and 17. Gradual splitting of the cell body into two daughter individuals, each having a rhizostyle; × 1,466.

FIG. 18. A completely divided individual, with the blepharoplast still undivided showing a rhizostyle and an axoneme. It represents the stage just before the trypanosome type; × 1,466.

19. Trypanosome type with parabasal migrating toward the region posterior to the nucleus; × 1,466.

20. An individual with the parabasal body at the posterior region of the cell; × 1,466.

21. Trypaniform flagellates in rosette formation; × 1,466.

22. A crithidial form. Note the undulating membrane; × 1,466.

FIG. 23. A trypaniform flagellate which has almost completely rounded and formed into a cyst; × 1,466.

24. Cyst with distinct cyst wall and resting nucleus; × 1,466.

25. Cyst with its parabasal body located anteriorly; × 1,466.

FIGS. 26 to 28. Cysts with their parabasal bodies and nuclei in the process of division; × 1,466.

29 to 31. Cysts with their nuclei and parabasal bodies completely divided; × 1,466.

32 and 33. The two completely divided cysts; × 1,466.

34 and 49. Diagrammatic representation of the different nuclear stages; × 1,466.

34 to 42. Various forms of nuclei in resting stages, from the adult long-flagellate forms; × 1,466.

FIG. 43. Nucleus in the prophase stage with the chromatic granules (chromomeres) in the chromatic ring; × 1,466.

FIGS. 44 to 48. Nuclei showing stages of mitotic division, from the early metaphase to the late anaphase; × 1,466.

FIG. 49. Nucleus in the late telophase showing achromatic mass connecting the two daughter nuclei; × 1,466.

PLATE 3

FIG. 50. A stumpy type with the nucleus in the resting stage, showing the incomplete growing flagellum and rhizostyle; × 1,466.

FIGS. 51 and 52. Individuals with nuclei dividing horizontally to the body. In fig. 51 the rhizostyle is clearly shown, originating from the blepharoplast; × 1,466.

FIG. 53. The completely divided stumpy type; × 1,466.

54. A giant-type organism with a nucleus in metaphase stage; × 1,466.

55. A clublike form with the posterior end enlarged; × 1,466.

FIGS. 56 to 58. Gradual shortening of the body; × 1,466.

59 and 60. The individuals have already rounded up, with their long flagella still connected with the axoneme. The rhizostyle also persists; × 1,466.

FIG. 61. The flagella have already fallen off, leaving only the rudimentary axonemes; × 1,466.

PLATE 4

FIGS. 62 to 65. Aggregation of mitochondria in both anterior and posterior portions of the cell. Stained with Janus green B; × 1,980.

66 to 68. Grouping of the vacuoles (vacuome) in posterior and anterior regions. Stained with neutral red. Both stains stain the parabasal body; × 1,980.

FIG. 69. *Trypanosoma lewisi* with its parabasal body stained with neutral red.

PLATE 5

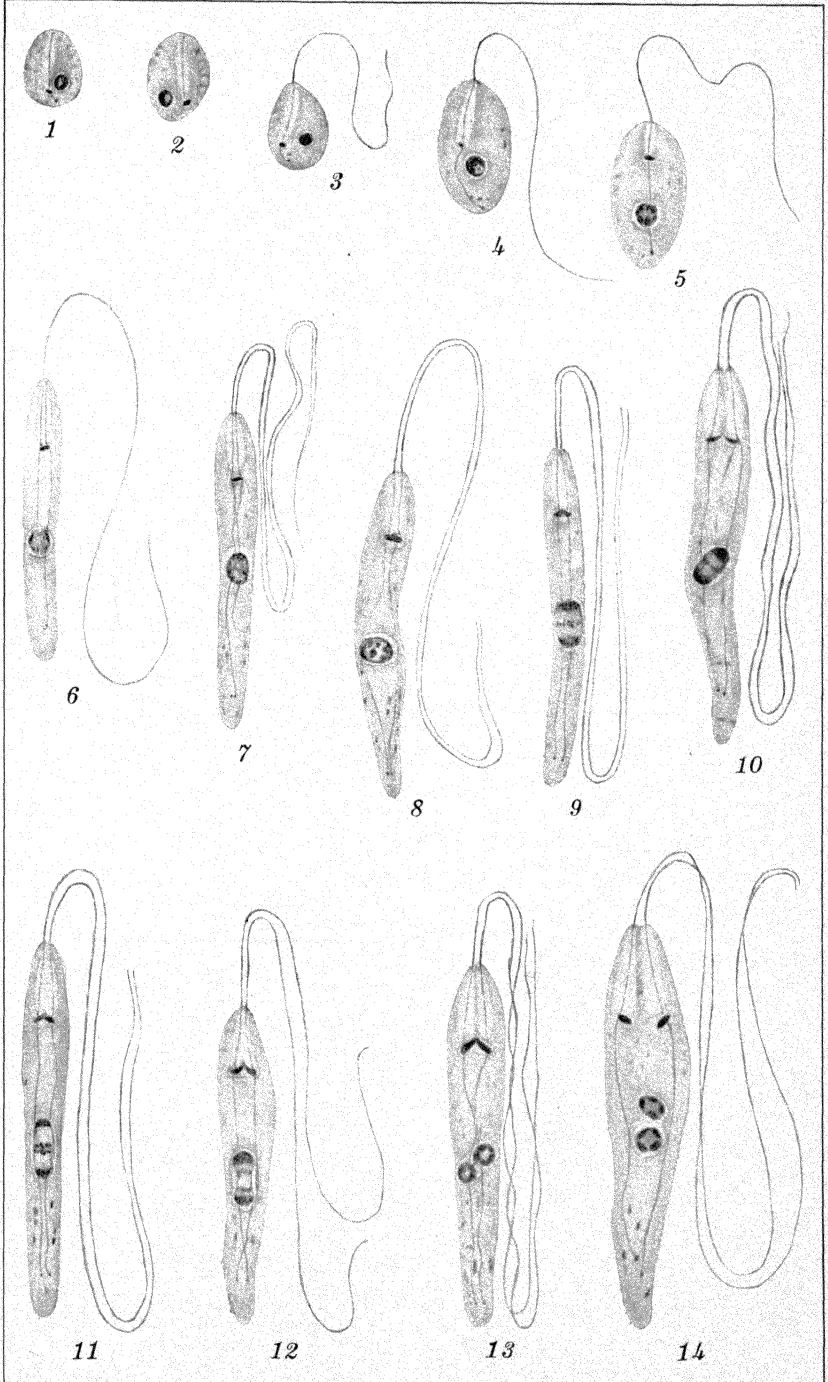
FIG. 1. *Herpetomonas muscarum* (Leidy), undivided trypaniform type; × 2,000.

2. Dividing trypaniform form; × 2,000.

FIG. 3. Cyst with nucleus in resting stage; × 2,000.

4. Dividing cyst; × 2,000.

5. *Herpetomonas muscarum* (Leidy), a diagrammatic drawing showing structures. *flag*, Flagellum; *mar gran*, marginal granule; *ant cl ar*, anterior clear area; *bleph*, blepharoplast; *pb*, parabasal body; *rhiz*, rhizostyle; *perip*, periplast; *nuc mem*, nuclear membrane; *kar*, karyosome; *chr*, "chromidia;" *chr gran*, chromatic granule.



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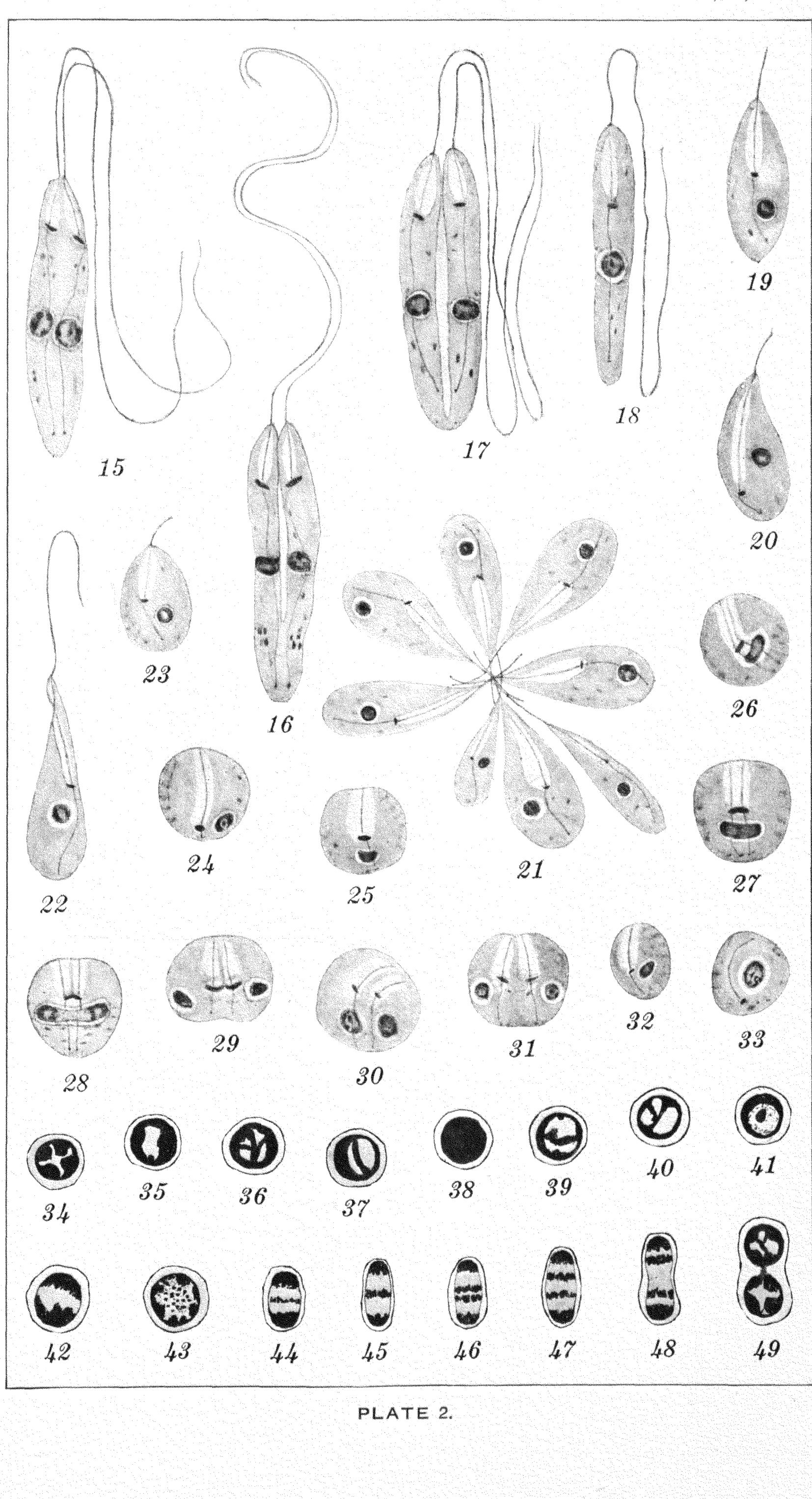
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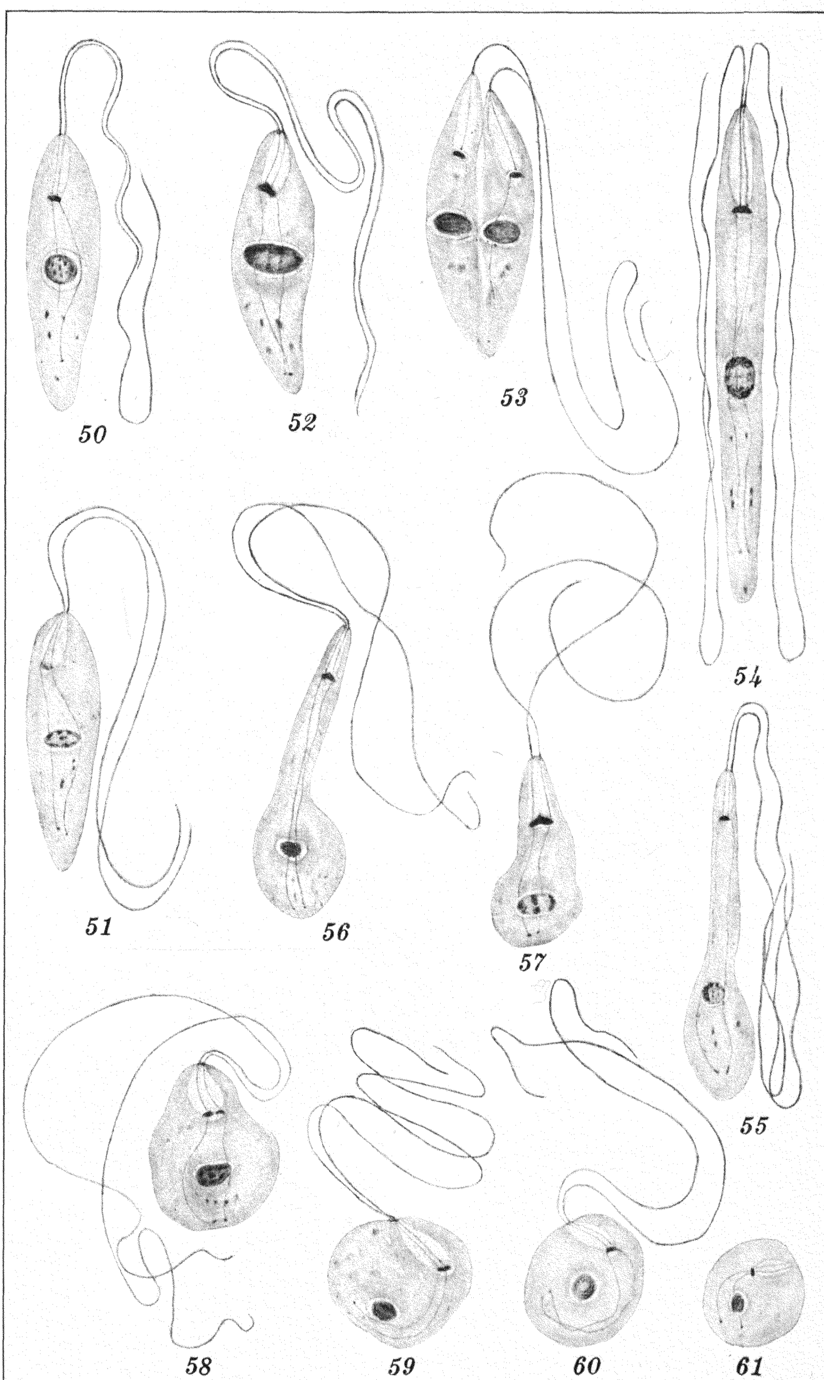
PLATE 2.



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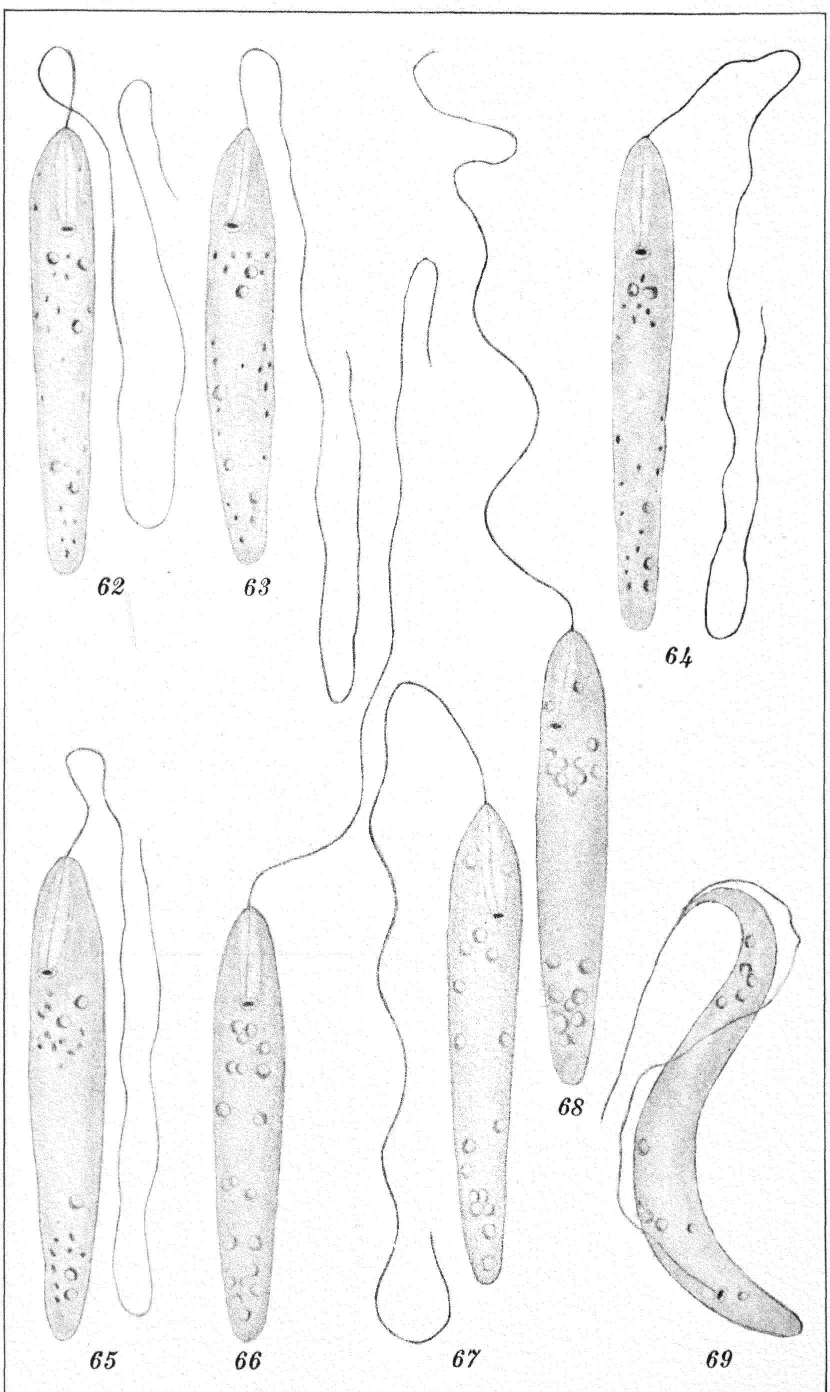

PLATE 4.

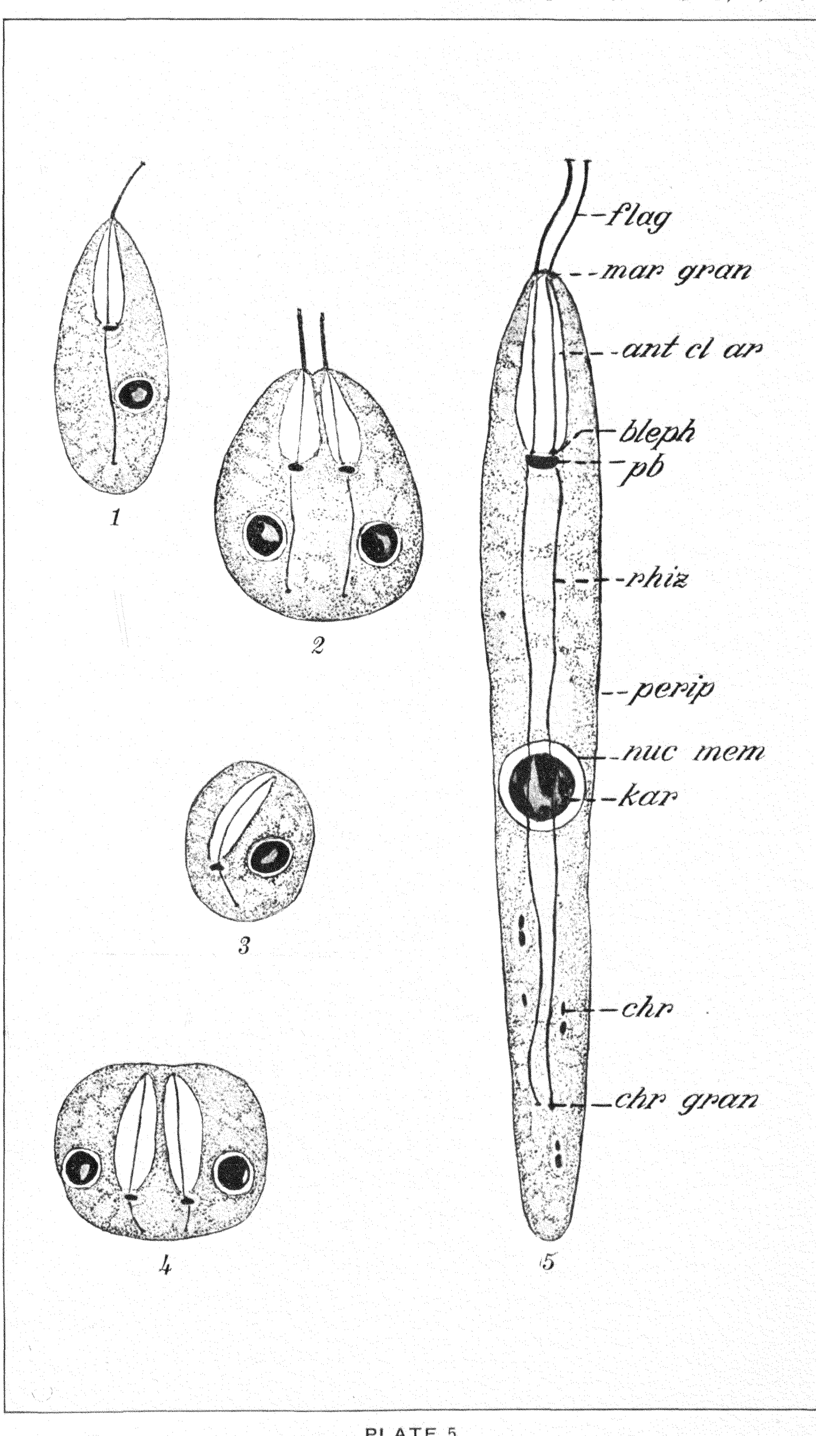
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PLATE 5.

THE BIOLOGY OF MOINA MACROCOPA STRAUS WITH SPECIAL REFERENCE TO ARTIFICIAL CULTURE [1]

By Gervasio C. Bellosillo

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ONE PLATE

INTRODUCTION

Moina macrocopa Straus, a species of Cladocera, is found in various temporary pools in Manila and its immediate vicinity. This organism is very prolific, though relatively short-lived. It is considered by almost all aquarists and fish lovers as the best live food for nearly all ornamental fishes, both imported and native. As such it is nutritive and palatable, promotes early fecundity, and can be fed to any size of fish except the newly born, which feed on microörganisms.

SYSTEMATIC POSITION AND SYNONOMY

Dr. Robert Gurney,[2] tentatively identified our waterflea as *Moina dubia* Richard, but sent the specimen to Mr. D. J. Scourfield [3] for verification. The latter regarded it as not of that species, and placed it as *Moina* sp.

Except in the coloration, which is influenced by food, our material fully answers Birge's (1918) description of *Moina macrocopa* Straus:

> No supra-ocular depression; claws not pectinate; antennules of male with sense seta in middle or below; first foot of male with long flagellum. *Moina macrocopa* Straus 1820.
>
> Not very transparent; yellowish or greenish. Head extended. Terminal part of post-abdomen long, with 10-12 spines besides bident. Two ephippial eggs. ♂ with elongated head; 5-6 hooks on antennule. Length, ♀ to 1.8 mm.; ♂, 0.5-0.6 mm.
>
> Pools, Wisconsin, Nebraska, Colorado, N. Dakota; doubtless widely distributed.

According to Birge (1918) the genus *Daphnia* was first established by Muller (1785). Straus in 1820 described a new

[1] Read before the Fourth Philippine Science Convention, February 24, 1937.

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[3] 6 Chadwick Road, Leytonstone, England.

species, *Daphnia macrocopus.* Baird in 1850 founded the genus *Moina* and described a species, *M. rectirostris,* in which he included *D. macrocopus* Straus. Herrick (1895) believed *D. macrocopus* to be synonymous with *M. brachiata* Jurine. Hudendorff in 1878 reported *M. flagellata* from Central Russia which Herrick (1895) regarded as the same species as *M. paradoxa* Weismann, believed by him to be identical to *M. fisherii* Hellich and *M. azorica* Moneiz. Sars (1903) described *M. macrocopa* Straus from Central Asia. Birge in 1918 considered *M. flagellata* Hudendorff and *M. paradoxa* to be the same as *M. macrocopa,* and regarded *M. brachiata* and *M. rectirostris* as distinct species.

GEOGRAPHICAL DISTRIBUTION

This species is widely distributed throughout the world. Straus (1820), Weismann (1877), and Hudendorff (1776) reported it from Europe, Sars (1803) from Central Asia and (1916) South Africa, Herrick (1895) and Birge (1918) from the United States, Bar (1924) from Ceylon and South America, and Terao and Tanaka (1928) from Japan.

In Manila, in San Pedro Makati and Pasay, Rizal Province, and in Calamba, Laguna Province, it is found in practically all temporary standing fresh water, near houses. It is probably well distributed throughout the Philippines, although its distribution there has not yet been studied.

HISTORICAL REVIEW

In 1879 Weismann, according to Banta (1925), set forth the hypothesis that in Cladocera there is an innate sexual cycle quite independent of environmental influences. Grosvenor and Smith (1913), working on *Moina rectirostris,* found that the innate sexual manifestations in Cladocera are not influenced by internal factors but by environmental influences. In 1925 Banta concurred in this view with regard to *M. macrocopa.*

Allen and Banta (1929) pointed out that the fertilized sexual egg of *M. macrocopa* hatches out as a female, which reproduces parthenogenetically young that may be either parthenogenetic females, sexual females, or males. The parthenogenetic females of this and succeeding generations may also reproduce all three kinds of individuals. Similar sexual differentiation occurs in *M. rectirostris,* as found by Grosvenor and Smith (1913).

Banta (1921) states that bacteria constitute the principal food element of soil-manure cultures. He further states that "while a certain amount of uniformity is attainable in such a culture medium such mass cultures are quite variable and it is obvious that this can scarcely be considered a "Standard" food. It is probable that the proper bacteria could be reared on agar plates at definite intervals and a really standard food thus obtained." Stuart and Banta (1931) announced that the number of bacteria available as food for Cladocera in different make-ups and dilutions of manure solution used in culturing these animals are found by counts to be exceedingly variable.

Viehoever (1933) recommends yeast as a remarkable food concentrate, partially replacing meat, having three times the nutrient of beef, and serving to overcome weakness and lack of appetite in diabetic patients, possibly on account of its high (2 per cent) content of lecithin or nucleic substance, and facilitating the breeding of *Daphnia.* Viosca, according to him, provides infusoria as food for *Daphnia* once or twice a day and feed his infusoria with a bacterial culture about every second day (1 glass per crock or tub). He further states that cotton-seed meal in amounts of 0.01 to 0.02 per cent is very good for laboratory breeding, and that excellent results are obtained with soy-bean-flour experiments in maximum amounts of 0.01 to 0.02 per cent.

As a *Moina* culture medium, Terao and Tanaka (1928) used one part of Jenning's and Lynch's solution of oatmeal for rearing Rotifera, and two parts of rain water which contained a large quantity of *Scendesmus.*

No literature is available on postembryonic development, the number of fecundities and the number of young produced during a life span, the hydrogen-ion concentration range, and the rôle of iron in culture media of *Moina macrocopa.*

Although apparently long present in the Philippines, the organism was not known there until early in 1934, when ornamental fish culture was in its infancy in the Islands. Aquarists who first found it by accident mistook it for *Daphnia* sp.

COMMON NAMES

Daphnia are commonly known as waterfleas. Our species is at present generally called "daphnia" in Manila. Like *Moina, Daphnia* is a genus belonging to the family Daphnidæ, order Cladocera, and is at present not found in the Philippines. Since daphnia is used as a common name for a different genus, "moina," being the right name, should be used as the common name of this waterflea. The native name applied to this animal is "kutung tubig." Unfortunately, it is little used.

OBJECT OF THE PRESENT WORK

Due to the rapid growth of ornamental fish culture in Manila and in other parts of the Philippines, the economic importance of moina for fish food becomes more and more apparent. Since this animal is abundant only during the rainy season, there is great need of raising it artificially. Before that can be done, however, considerable biological investigation is necessary with regard to the life history, and the invironmental requirements of this organism.

The present work was undertaken in answer to this need. Field observations were made in Manila and Pasay, Rizal Province, at various suitable times in order to determine seasonal occurrence and abundance of natural enemies, types of natural habitat, and other biological data. Observations were made early in the morning, at noon, in the afternoon, and shortly after rainy weather.

DESCRIPTIONS

Parthenogenetic female (*Plate 1, figs. 6 and 7*).—Adult, 0.9 to 1.8 millimeters long, yellowish to reddish. Body thick and heavy, not completely covered by carapace. Carapace without spine. Carapace valves obscurely reticulated, subrounded-oval when seen laterally, ventral margins armed with setæ. Antennule small and hairy, slightly tapering on both ends, one-jointed, freely movable, with terminal sensory filaments, and a seta almost at middle. Head extended, large, thick, rounded in front and without supra-ocular depression. Abdomen represented by a horseshoe-shaped fold. Postabdomen extended into a conical postanal part, bearing from eight to ten ciliated spines and a bident, and dorsally pubescent with rows of hairs. Claws small, each with a row of fine hairs at both lateral aspects. Abdominal setæ very long, two-jointed, first bare, second ciliated. Antennæ strong, beset with rows of hairs, setæ of rami ciliated. Dorsal ramus four-jointed, with a spine and three two-jointed setæ at distal end of last segment, one at distal end of third segment, and a spine attached dorsally at end of second segment. Ventral ramus three-jointed with three two-jointed setæ at distal end of the third and one each at distal end of the first and second segments. At distal end of the main trunk with a two-jointed long seta between the rami, and two two-jointed long setæ lying side by side near the basal region. Mature parthenogenetic female almost monstrously deformed by the young in the brood sac, the latter cavity subspherical in shape, extending laterally beyond the ordinary limit of the shell (Plate 1, fig. 7).

Sexual female.—Adult essentially like the parthenogenetic female. Sexual female more normal in shape. Dorsal half of valves mostly transformed by very pronounced reticular markings and thickening into a two-valve padlike case for the two ova. It can be easily distinguished through the naked eye by the opaque appearance of the ephippium (Plate 1, fig. 5) at the back of the animal.

Male.—Adult elongated, much smaller than female, 0.5 to 0.7 millimeter in length. Head elongated and comparatively large, less strongly arched above, and much produced forward. Eye comparatively large, with about eight lenses. Antennules curved, with two sensory setæ in the middle, one longer than the other, and at the end five to six claws and sensory filaments. First foot with a long hairy three-jointed flagellum, two two-jointed ciliated setæ, and two spines, one seta moderately short and the other long. Carapace comparatively long, not completely covering the body. Carapace valves, when seen laterally, subrounded oval, ventral margins bearing somewhat distant setæ.

Female nymphal instars.—Tables 1 and 2 show three nymphal instars credited to this species. First instar 0.40 to 0.65 millimeter long, hyaline. Second instar 0.68 to 0.90 millimeter long, slightly yellowish. The nymph gradually increases in size until it reaches a length of about 0.95 millimeter before the third molting. General characteristics similar to those of adults.

Eggs.—This organism, as nearly all Cladocera, has two types of eggs, the parthenogenetic and the sexual. When the eggs are ripe they differ markedly in appearance.

Parthenogenetic eggs newly laid in the egg pouch are oblong and yellowish. They gradually become rounded and large, reaching a length of about 0.13 millimeter. Parthenogenetic eggs produce both males and females (Plate 1, fig. 6).

Two sexual eggs are inclosed in an ephippial case. They are rounded-oblong, and can stand fairly hard pressure. They are about 0.18 millimeter wide and 0.20 millimeter long. The ephippium which envelops the sexual egg is bean-shaped, apparently inflated, anteriorly broader than posteriorly, dorsally thickened, flattened above, and nearly straight when viewed laterally, and ventrally thin, subrounded, and hyaline. Sexual eggs produce only females.

LIFE HISTORY AND HABITS

The life-history records in the present report are based on observations under natural conditions and on cultures carried under laboratory conditions.

Unless otherwise stated, the materials used were drawn mainly from one parthenogenetic female obtained in August, 1934, from a pool near Balagtas Street, Pasay, Rizal Province, and cultured in soil-manure medium.

In the study of the type of sexes the ephippial eggs were gathered and placed on pieces of blotting paper in a petri dish by means of a pipette, and dried either in the sunshine or in an insect drier; then they were transferred to the soil-manure medium to hatch. The newly hatched young were either isolated singly or in groups. In the study of the life span and the proportion of sexes under uncrowded conditions, sister moina were singly isolated in 1- × 3-inch vials, each containing 20 cc of soil-mungo or soil-manure medium. Examination of the various stages was made at intervals of from ½ hour to 1 hour, or oftener, by placing the vials one at a time before a bright diffused light during the day and before an electric light at night, for purposes of observing the process of molting and noting the already dropped exuviæ. To study the proportion of sexes under crowded conditions, ten mothers were placed together in bottles each containing 100 cc of soil-manure medium, and the medium was changed daily. For purposes of counting, the animals were poured into a cone-shaped strainer made of fine silk cloth, drawn out of the strainer by means of a pipette, and placed in watch glasses containing small amounts of water to which a little of 1 per cent chloritone had been added. The mothers were selected from the groups and returned to their respective bottles. The counting was greatly facilitated by the use of a low-power Zeiss dissecting binocular microscope.

PARTHENOGENETIC FEMALE

Postembryonic period.—In Tables 1 and 2 the period between molts varies from 6.08 to 11 hours in individuals cultured in soil-mungo medium, and from 6.5 to 10 hours in those cultured in soil-manure. All of the thirty-two singly isolated organisms cast their skins three times during their postembryonic development. In those cultured in soil-mungo medium, the average duration of the first stage is 6.73 hours, of the second, 8.56, and of the third, 9.67, with 24.89 hours as the total average period from birth to the adult stage. In those cultured in soil-manure, the average duration of the first stage is 6.53 hours, of the second, 8, and of the third, 9.73; with the total average period of 24.26 hours between the time of birth to that of adulthood.

Life span.—Terao and Tanaka (1930) found that *M. macrocopa* cultured in constant temperature has an average duration of life of 4.778 days in 35° C., 6.515 in 27° C., 9.283 in 20° C., 14.365 in 15° C., 10.188 in 9° C., and 4.158 in 4° C. The maximum duration of life in moina is then at 15° C. Tables 1 and 2 give the life span of moina at room temperature, ranging between 27° C. and 31° C. in Table 1 and between 26 and 31.5 in Table 2.

Tables 1 and 2 show that 100 per cent went through their postembryonic development. The span of life in Table 1 varies greatly between the minimum duration of 4.23 days and the maximum of 13.50 days, the average being 8.72 days. In Table 2 the minimum is 7.96 days, and the maximum 14.15 days, the average being 12.82 days. The average life span in soil-manure (Table 2) is proportionally higher than that of Terao and Tanaka at nearly the same temperature; the difference may be due to food conditions.

Fecundity.—The total number of young produced during a life span by each of the thirty-two cultures, together with the total number of young in each brood and the average number per brood, is given in Tables 3 and 4. The number of young produced varied from 7 to 24 in Table 3, and from 3 to 32 in Table 4, showing exceedingly great difference in the production of young. Large numbers of young were produced in the second, third, fourth, and fifth broods, averaging between 12.26 and 18.8 in soil-mungo medium and between 16.23 and 28.38 in soil-manure medium. In soil-mungo medium the minimum number of young produced per life span, where the mother dies after the third brood, is 65, and the maximum, where the mother dies after the eleventh brood, is 165; only two mothers out of nineteen lived beyond the eleventh brood. In soil-manure medium the minimum number of young produced, where the mother dies after the seventh brood, is 126, and the maximum, where the mother dies after the thirteenth brood, is 214; three mothers out of thirteen lived beyond the thirteenth brood. The fecundity of the thirteen mothers that produced 2,846 young in soil-horse-manure medium is considerably higher than that of the nineteen mothers that produced 2,091 young in mungo-culture medium.

TABLE 1.—*Life span, interval between birth and adulthood, and length of reproductive period in soil-mungo medium.*

Culture No.	Duration of each stage between birth and adulthood, in hours.				Adult to 1st brood.	Intervals between broods, in hours.										Last brood to death in hours.	Life span in days.
	1st.	2nd.	3rd.	Total.		1st to 2nd.	2nd to 3rd	3rd to 4th.	4th to 5th.	5th to 6th.	6th to 7th.	7th to 8th.	8th to 9th.	9th to 10th.	10th to 11th.		
1	6.50	8.50	9.50	24.50	24.00	24.00	25.19	24.33	24.33	24.33	24.18					24.33	9.14
2	6.50	8.50	9.00	24.00	24.50	24.83	26.00	24.42	23.00	23.50	26.00					24.50	9.20
3	6.50	8.50	8.08	23.08	24.67	23.75	27.58	24.18	22.67	23.67	24.83	30.33	27.00	24.50		7.00	11.51
4	6.50	7.50	9.00	23.00	24.50	23.92	26.08	24.33	22.67	24.50						20.50	8.02
5	6.67	8.50	9.33	24.50	24.00	24.00	25.83	24.00	23.18	24.00	24.00	28.50	27.18			11.00	10.19
6	6.67	8.50	8.33	23.50	24.67	23.75	26.50	24.08	22.67	24.00	24.00	29.67	27.33	24.50	25.50	12.00	13.01
7	6.50	8.50	9.50	23.50	24.00	24.83	26.08	24.08	24.25	23.50	25.50					24.50	9.18
8	6.50	8.67	9.33	24.50	24.33	26.50	24.00	24.33	24.00	25.58	27.25					1.00	8.40
9	6.50	8.50	9.83	24.83	24.67	23.75	25.18	24.08	24.33	23.18						.50	7.11
10	6.08	8.50	10.67	24.75	24.50	23.67	25.67	24.18	22.00	23.50	24.50	25.00	27.00	24.50	25.00	25.00	13.30
11	6.08	8.67	10.50	25.25	26.00	24.00	25.50	23.50	23.50	23.18	24.85					.50	8.18
12	7.08	9.18	9.00	25.26	24.33	23.33	26.18	24.18	23.83	23.83	25.00	27.50				1.50	9.37
13	7.83	8.67	9.50	26.00	24.18	23.83	26.00	24.18	23.33							0.00	6.15
14	7.25	8.67	11.00	26.92	24.00	23.50	25.18	24.00	22.67	23.67	26.50					20.50	9.04
15	7.08	8.50	10.50	26.08	23.50	23.50	25.18									13.33	4.23
16	7.08	9.67	9.50	26.25	24.50	23.50	25.18	24.00	23.50	22.83	27.00					7.00	8.49
17	7.08	8.00	9.67	24.75	24.00	23.50	26.00	24.00	33.50	23.00	24.92					0.00	8.07
18	6.75	7.50	11.00	25.25	23.50	23.67	25.85	27.50								12.00	5.74
19	6.75	9.67	10.50	26.92	24.50	23.33	25.00	24.00	24.18	25.83						5.00	7.37
Minimum				23.00													4.23
Maximum				26.92													13.30
Average	6.73	8.56	9.67	24.89	24.33	23.96	25.69	24.29	23.38	23.75	25.27	28.24	27.13	24.50	25.25	11.06	8.72

The difference is due to food conditions, as will be explained later.

Incubation period of parthenogenetic eggs.—No attempt was made to study definitely the maturation division in both parthenogenetic and sexual eggs. However, Allen and Banta (1929) state, "In both the parthenogenetic and sexual egg the maturation division occurs within five minutes after egg laying. About five minutes before a clutch of parthenogenetic eggs is laid, the mother molts and discharges from the brood chamber the preceding clutch of young. The ripe eggs may thus be fixed in the mother's ovary immediately after the discharge of the young."

Thus the incubation period of the parthenogenetic eggs, that is, the time required for development from the egg laying in the brood chamber from the germarium to the extrusion of the young, can be approximated as between the last molting of the nymphal instar and the extrusion of the first brood and the intervals between broods thereafter. In Tables 1 and 2 the incubation periods may be represented as from the last molt of the postembryonic stage to the first brood, and from the first brood to the second, and so on, which show a variation of from 23.28 to 28.24 hours in soil-mungo medium and from 20.51 to 26.44 hours in soil-manure.

INCUBATION PERIOD OF SEXUAL EGGS [4]

The sexual egg differs from the parthenogenetic in the length of the incubation period. It develops a conspicuous egg case, the ephippium, which is dropped at random by the mother on the bottom of the medium. The length of the incubation period depends upon the environment, since the egg is protected by the ephippial case and can withstand for a long time desiccation and considerable pressure, especially during the dry season. In the laboratory the eggs were dried at a temperature of about 40° C. in an insect drier for $\frac{1}{2}$ month. Twenty egg cases each containing two eggs were transferred individually to twenty vials containing soil-manure culture medium. Only 24 eggs hatched from 2 to 5 days thereafter; the rest failed to hatch.

It is probable that in nature *M. macrocopa* is capable of producing two kinds of sexual eggs, those which require a long resting period and those which do not. Wood (1932) found that twenty of twenty-four fertilized eggs (83 per cent) hatched without

[4] No detailed life-history study was made of the sexual mother.

TABLE 2.—*Life span, interval between birth and adulthood, and length of reproductive period in soil-manure culture medium.*

Culture No.	Duration of each stage between birth and adulthood, in hours.				Adult to 1st brood.	Intervals between broods, in hours.			
	1st.	2nd.	3rd.	Total.		1st to 2nd.	2nd to 3rd.	3rd to 4th.	4th to 5th.
20	6.50	8.00	9.50	24.00	20.00	21.50	22.00	23.33	23.83
21	6.50	8.00	9.50	24.00	21.50	20.50	20.50	26.00	25.00
22	6.50	8.00	10.00	24.50	22.00	20.50	20.50	25.50	25.50
23	6.50	8.00	9.50	24.00	20.50	21.00	20.00	24.50	24.50
24	6.67	8.00	9.50	24.17	21.50	21.50	20.19	24.30	21.50
25	6.67	8.00	10.00	24.67	22.00	20.00	20.50	24.50	24.50
26	6.50	8.00	10.00	24.50	21.00	20.50	20.00	24.50	25.00
27	6.58	8.00	10.00	24.58	20.50	20.50	20.50	26.00	25.00
28	6.50	8.00	9.50	24.00	20.50	20.00	20.00	24.50	25.00
29	6.50	8.00	9.00	23.50	20.00	20.00	20.50	24.50	25.00
30	6.50	8.00	10.00	24.50	20.00	21.00	20.50	24.50	24.50
31	6.50	8.00	10.00	24.50	21.00	21.00	21.00	24.00	27.00
32	6.50	8.00	10.00	24.50	20.00	21.00	20.50	24.00	24.50
Minimum				23.50					
Maximum				24.67					
Average	6.53	8.00	9.73	24.26	20.81	20.69	20.51	24.63	24.68

Culture No.	Intervals between broods, in hours.								Last brood to death, in hours.	Life span in days.
	5th to 6th.	6th to 7th.	7th to 8th.	8th to 9th.	9th to 10th.	10th to 11th.	11th to 12th.	12th to 13th.		
20	28.00	25.00	23.50	27.50	25.00	23.00	25.00		2.00	13.07
21	24.50	27.00							2.00	7.96
22	25.00	27.00	23.50	25.50	25.00	24.50	26.00		0.50	13.15
23	25.00	27.00	23.00	25.50	25.00	23.50	25.50	24.00	2.50	13.98
24	26.50	26.00	22.50	27.25	26.00	23.75	25.50		0.00	12.94
25	26.00	26.00	23.00	26.00	24.50	24.00	25.50	26.50	2.00	14.15
26	26.00	25.50	23.00	27.33	26.00	23.00	26.00		0.00	13.01
27	24.50	26.00	23.50	24.50	25.50	22.50	25.00	22.00	8.50	14.09
28	26.00	27.00	23.00	26.00	24.00	24.00	25.50		4.00	13.06
29	26.50	25.00	22.50	27.00	25.50	23.50	24.00		12.00	13.31
30	24.50	26.00	22.50	27.00	26.00	23.00	26.50		1.50	13.00
31	27.00	26.00	22.50	26.75	25.00	23.75	26.00		2.00	13.23
32	26.50	26.50	22.50	27.00	24.00				20.50	11.73
Minimum										7.96
Maximum										14.15
Average	25.85	26.15	22.92	26.44	25.13	23.50	25.50	24.17	4.42	12.82

TABLE 3.—*Number of young and proportion of sexes produced by parthenogenetic females in soil-mungo medium.*

Culture No.	1st brood.		2nd brood.		3rd brood.		4th brood.		5th brood.		6th brood.	
	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.
1	15	0	0	10	16	0	20	0	19	0	13	0
2	17	0	0	15	16	0	15	0	0	17	12	0
3	14	0	14	0	12	0	1	17	14	0	0	13
4	17	0	2	15	14	0	16	0	0	15	10	0
5	18	0	0	11	16	0	14	0	0	20	9	0
6	16	0	14	1	15	3	13	0	18	0	12	0
7	17	0	0	13	15	0	0	11	0	9	14	0
8	16	0	0	16	0	15	16	0	0	18	7	0
9	16	0	0	16	16	0	4	14	0	14	13	0
10	13	0	17	0	14	2	0	12	17	0	0	12
11	14	0	15	0	16	0	0	16	18	0	7	0
12	15	0	17	0	0	16	11	0	0	22	8	1
13	14	0	17	0	1	15	19	0	0	17	0	0
14	0	14	15	0	17	0	17	0	0	15	10	0
15	0	14	17	0	18	0	0	0	0	0	0	0
16	14	0	17	0	16	0	0	18	19	0	10	0
17	13	0	14	0	0	11	17	0	0	16	9	0
13	12	0	18	0	17	0	0	18	0	0	0	0
19	0	15	16	0	17	0	16	0	0	18	12	0
Total	241	43	193	97	236	62	179	106	105	181	146	2
Minimum												
Maximum												
Average brood	14.94		15.26		15.68		18.8		16.89		10.1	
Percentage of males	15.1		33.4		20.1		37.5		63.3		15.1	

Culture No.	7th brood.		8th brood.		9th brood.		10th brood.		11th brood.		Total number of each sex.		Total number of young.
	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	
1	19	0	0	0	0	0	0	0	0	0	102	10	112
2	8	0	0	0	0	0	0	0	0	0	68	32	100
3	16	0	12	0	0	11	15	0	0	0	98	41	139
4	0	0	0	0	0	0	0	0	0	0	59	30	89
5	13	0	13	0	18	0	0	0	0	0	101	31	132
6	14	0	0	14	17	0	18	0	0	10	137	28	165
7	18	0	0	0	0	0	0	0	0	0	64	33	97
8	14	0	18	0	0	0	0	0	0	0	71	49	120
9	0	0	0	0	0	0	0	0	0	0	49	44	93
10	12	0	0	15	14	0	12	0	10	0	109	41	150
11	11	0	0	0	0	0	0	0	0	0	81	16	97
12	24	0	14	0	0	0	0	0	0	0	89	39	128
13	0	0	0	0	0	0	0	0	0	0	51	32	83
14	20	0	0	0	0	0	0	0	0	0	79	29	108
15	0	0	0	0	0	0	0	0	0	0	35	14	49
16	12	0	0	0	0	0	0	0	0	0	88	18	106
17	15	0	22	0	18	0	0	0	0	0	108	27	135
18	0	0	0	0	0	0	0	0	0	0	47	18	65
19	15	0	14	0	0	0	0	0	0	0	90	33	123
Total	211	0	93	29	67	11	45	0	10	10	1,526	565	2,091
Minimum											35	10	49
Maximum											137	49	165
Average brood	15.1		15.25		15.6		15.0		10.0		14.9		111
Percentage of males	0		23.8		14.1		0		50.0		22.24		

TABLE 4.—*Number of young and proportion of sexes produced by parthenogenetic females in soil-manure medium.*

Culture No.	1st brood.		2nd brood.		3rd brood.		4th brood.		5th brood.		6th brood.		7th brood.	
	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.
20	14	0	29	0	29	0	0	28	15	0	0	20	0	7
21	13	0	29	0	23	0	25	0	0	13	16	0	7	0
22	11	0	30	0	24	0	0	28	14	0	12	0	16	0
23	14	0	25	0	31	0	0	28	16	0	19	0	0	11
24	12	0	32	0	28	0	0	28	19	0	15	0	0	6
25	14	0	28	0	29	0	0	28	19	0	0	15	10	0
26	15	0	29	0	25	0	0	28	17	0	1	13	0	11
27	14	0	5	24	26	0	0	28	0	10	16	0	0	4
28	14	0	29	0	28	0	0	29	15	0	0	15	0	6
29	16	0	28	0	24	0	0	22	0	20	13	0	14	0
30	14	0	29	0	26	0	0	29	19	0	15	0	0	13
31	15	0	24	0	26	0	0	26	16	0	17	0	0	9
32	14	0	28	0	30	0	0	27	18	0	0	14	12	0
Total	180	0	345	24	349	0	25	329	168	43	123	77	59	66
Minimum														
Maximum														
Average brood	13.85		28.38		26.85		27.23		16.23		15.38		9.62	
Percentage of males	0		6.5		0		92.6		23.08		38.5		52.8	

Culture No.	8th brood.		9th brood.		10th brood.		11th brood.		12th brood.		13th brood.		Total number of each sex.		Total number of young.
	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.			
20	9	0	0	14	9	0	10	0	0	14	0	0	115	83	198
21	0	0	0	0	0	0	0	0	0	0	0	0	113	13	126
22	0	4	13	0	0	10	23	0	0	0	0	0	143	42	185
23	8	0	0	18	8	1	21	0	0	10	4	0	146	68	214
24	8	0	14	3	10	0	19	0	0	7	0	0	157	44	201
25	0	4	13	0	0	13	24	0	0	8	3	0	140	68	208
26	0	4	0	19	6	0	23	0	0	4	0	0	115	79	194
27	9	0	0	17	16	0	26	0	0	7	0	3	112	93	205
28	0	6	9	0	19	0	0	10	0	8	0	0	114	74	188
29	0	7	10	0	12	0	21	0	10	0	0	0	148	49	197
30	7	0	11	8	0	9	17	0	0	7	0	0	147	57	204
31	6	0	0	10	14	0	18	0	0	9	0	0	136	53	189
32	0	5	17	0	0	12	0	0	0	0	0	0	119	58	177
Total	47	30	87	89	94	45	202	10	10	74	7	3	1,706	780	2,486
Minimum	----	----	----	----	----	----	----	----	----	----	----	----	112	13	126
Maximum	----	----	----	----	----	----	----	----	----	----	----	----	157	93	214
Average brood	6.41		14.92		11.58		19.27		8.4		3.33		15.44		191
Percentage of males	38.9		50.6		32.5		4.7		88.09		33.3		31.38		----

having been dried, and three that had not hatched after a week of daily examination were put out in a bottle to dry. Five weeks later, when put in water, all three hatched. The twenty-fourth egg was discarded. She tried a second group of sixty sexual eggs and a third group of sixty-seven eggs from the same line, of which 77 and 78 per cent, respectively, hatched without having been dried.

To ascertain the time required for sexual eggs to hatch without drying, twenty-five newly extruded ephippial egg cases were transferred each to a vial containing horse-manure medium. Two to twenty-two days later twenty hatched. The remaining eggs were dried for five days, after which they were transferred to a fresh medium, where six young developed; the rest were regarded as having been disintegrated. Thus this species seem to maintain itself, in the Philippines as well as in the United States, regardless of whether or not the body of water in which it lives dries up.

MALE

Like the young parthenogenetic female, the newly-born male readily swims about in the medium, seemingly searching for food. Its first instar is from 0.4 to 0.45 millimeter long, and the second from 0.44 to 0.55 millimeter. It is hyaline in color. It molts twice before it becomes an adult. The first instar occurs after about 7 to 8 hours, and the second takes about 8 to 9. Molting takes place every 18 to 21 hours thereafter. The life span of the male is from 5 to 9 days in the soil-manure medium, about 6.9 days on the average.

MOLTING

Molting is essentially the same in all sexes and stages. When the adult female molts, the middorsal line of the body splits for the exit of the young, the ephippium, or the body of the animal itself. Shortly after the extrusion of the young or the ephippial eggs, the animal whirls around vigorously untill the exuvia is completely separated from the body. The animal has no fixed place for molting, as it constantly moves about, presumably looking for food.

COPULATION

The male, after the second molting, begins to copulate with the sexual female who becomes mature after the third molting. As observed in the culture experiment, when the male was intensely excited he made a few abortive attempts before he succeeded. With his antennules, he seized any female, whether sexual or parthenogenetic, and at first clasped her at any part of her body. When the female was a parthenogenetic one, she fought vigorously to get free, and the male soon released her. If the female was a sexual one ready for mating, he stayed sufficiently long to complete copulation. In copulation, the male slightly opens his carapace and takes hold of the female. The female becomes motionless, allowing the male to adjust himself, until he reaches the anterior margin of one side of the female. He then bends his abdomen ventrally, so that it extends posteriorly to between the ventral margins of the female's carapace. In this position he moves his abdomen about, presumably ejecting his spermatozoa. After the male has adjusted himself the female carries him about. The mating lasts about 15 minutes.

PROPORTION OF SEXES

The proportion of sexes in moina is very difficult to determine, as it is controlled by environmental factors; namely, food, crowding, temperature, and others. Working on *Moina rectirostris*, Grosvenor and Smith (1933) concluded that by isolating the parthenogenetic females at birth until the extrusion of the brood at a temperature of 25° C. to 30° C., the production of sexual forms is entirely suppressed. In their experiment parallel cultures of related females crowded together in the culture glasses at a temperature of 25° C. to 30° C. gave 30.3 per cent males, and at about 14° C. gave 52.3 per cent males; isolated females at 14° C. gave 19.1 per cent males, and in an ice chest at about 5° C., 5.4 per cent males, and crowded together, they gave 42.5 per cent.

According to Stuart and Cooper (1932), isolated moina mothers reared in 500 ml of highly diluted medium will occasionally produce males; a low percentage of males in small broods of young and retardation of mothers in diluted medium make it seem probable that the production of males is due to lack of food; crowded mothers reared in various dilutions of medium and with frequent changes to prevent the accumulation of excretory substances, produce males in proportion with the dilution of the medium; crowded mothers reared in constantly flowing medium produce males, provided the medium used in the experiment is sufficiently diluted.

Stuart, Cooper and Coody (1933) found that under certain experimental conditions carbon dioxide (CO_2) may be employed to suppress completely the production of male cladoceran young by crowding the mothers, while under other conditions, presumably associated with depression periods, carbon dioxide is wholly ineffectual in the suppression of the male production.

Isolated mothers.—In conjunction with the experiment on the number of broods that the mothers can give during their life time, the numbers of males and females were also determined to study the proportion of sexes by the isolated mothers during their life time. To determine the optimal and minimal food conditions for the organisms, two media were used, shown in Tables 3 and 4. Table 3 shows that the average percentage of males in the first brood was 15.1, in the second 33.4, in the third 20.1, in the fourth 37.5, in the fifth 63.3, in the sixth 15.1, in the seventh 0, in the eighth 23.8, in the ninth 14.1, in the tenth 0, and in the eleventh 50, with the total average percentage of 22.24. The lowest percentage of males, in the seventh and tenth broods, was 0, and the highest, in the fifth brood, was 63.3.

A study of the total numbers of each sex produced by every mother during her life time shows that the ratio of males to females is very variable, with the females always outnumbering the males.

In soil-manure medium (Table 4) the proportion of males to females produced during the life spans of thirteen females was slightly greater than in cultures reared on soil-mungo medium. The average percentage of males in the brood of the first was 0; in that of the second, 6.5; in that of the third, 0; in that of the fourth, 92.6; in that of the fifth, 23.08; in that of the sixth, 38.5; in that of the seventh, 52.8; in that of the eighth, 38.9; in that of the ninth, 50.6; in that of the tenth, 32.5; in that of the eleventh, 4.7; in that of the twelfth, 88.09; and in that of the thirteenth, 33.3. The total average percentage was 31.38. Here again we found that during the life spans of all the mothers the females always far outnumbered the males, the minimum numbers of males produced being 13, and the maximum, 93.

Crowded mothers.—The experiment on crowded mothers (Table 5) was carried only to the fourth brood, since the number of mother in every bottle was gradually decreasing. In the brood of the first mother, the average percentage of males was 22.64; in that of the second, 37.95; in that of the third, 41.44; and in that of the fourth, 49.33. The total percentage was 36.94. The total number of young produced by parthenogenetic females crowded together in bottle at room temperature was 2,473 females and 1,446 males. The males amounted to 36.94 per cent of the total number of young produced. The percentage of males produced by the isolated mothers is 31.38, against 36.94 per cent

TABLE 5.—*Proportion of sexes produced by crowded mothers.*

Culture No.	First brood.				Second brood.			
	Female.	Male.	Average brood.	Average of male.	Female.	Male.	Average brood.	Average of male.
				Per cent.				*Per cent.*
101	90	17	10.70	15.90	85	41	12.60	32.50
102	100	20	12.00	16.60	71	34	11.70	32.40
103	105	17	12.70	13.90	57	55	12.40	49.10
104	90	15	10.50	14.30	53	45	12.25	45.90
105	69	25	9.40	26.90	111	53	16.40	32.30
106	76	40	11.60	34.40	83	117	20.00	58.5
107	104	25	12.90	19.30	79	73	15.20	48.00
108	65	43	10.80	39.80	155	8	16.30	4.90
Total and average	699	202	11.33	22.64	694	426	14.61	37.95

Culture No.	Third brood.				Fourth brood.				All broods.			
	Female.	Male.	Average brood.	Average of male.	Female.	Male.	Average brood.	Average of male.	Female.	Male.	Average brood.	Average of male.
				Per cent.				*Per cent.*				*Per cent.*
101	39	56	11.80	58.80	58	22	13.30	27.50	272	136	12.14	33.33
102	47	30	12.80	38.90	37	43	13.30	53.75	250	127	12.45	33.25
103	49	43	13.10	46.80	44	25	11.50	36.20	255	140	12.85	37.45
104	42	55	13.90	56.70	25	46	11.80	64.50	210	161	12.11	43.39
105	124	50	19.90	28.70	57	90	21.00	61.20	361	218	16.68	37.65
106	163	17	22.50	9.40	86	66	19.00	43.43	408	240	18.28	37.04
107	114	59	19.22	34.10	65	72	18.40	52.50	362	229	16.43	38.75
108	58	83	20.10	58.10	72	61	19.00	45.60	350	195	16.55	35.77
Total and average	629	393	16.68	41.44	442	425	15.91	49.33	2,473	1,446	14.69	36.94

produced by crowded mothers. It is most probable that the number of males increases proportionally with the density of the population under fixed environmental conditions.

NATURAL HABITAT

Moina macrocopa lives in filthy and dirty environment throughout the year, especially in fresh-water pools polluted with decomposing material. It may be found in stagnant pools and ditches near or under houses, where food particles, dead grass, decaying wood, empty cans, manures, and other refuse which constitute the food necessary for the development of microörganisms, are thrown.

Intermittent rain during the rainy season has some influence on the abundance of moina in nature. The rain makes the water in the pools rise up to a higher level. It brings in food material from various sources, thus causing rapid multiplication of moina and other organisms living in the pools. After a few days, when much water in the pools has already evaporated, part of the moina population dries up, the remainder becoming overcrowded while the food supply becomes exhausted, causing death to many waterfleas and other organisms, which, however, leave sexual eggs in the pools for development under more favorable conditions. However, as long as there is water and food constantly supplying the pools, these organisms may continue to live there throughout the year.

ENEMIES

Like other animals the moina is beset by many enemies. It was observed that related crustaceans, like the cyclops, crowd out the moina; that the hydra first paralizes and later destroys this species, in spite of its size and strength; that *Vorticella* sp., and Rotifera, notably *Brachionus rubens,* sometimes use the body of the moina as a resting place, covering it almost entirely and thus depriving it of food and hindering its movement; and that bacterial masses and molds entangle it to such a degree as to cause its death. It constitutes the food of many kinds of fishes.

Either by actual separation or avoiding adverse conditions, such as acid media and pollution, these dangers may readily be removed from moina collected for aquarium purposes. Hydra may be killed by immersing the entire catch in 1 per cent salt solution (Viehoever, 1935). Since *B. rubens* goes with the catch from nature, it may be separated by transferring the catch to a large amount of tap water and selecting from it those individuals of moina suitable for culture. Filtering the water before use may help eliminate the infestation of cyclops, Rotifera, and *Vorticella.*

FEEDING

The method of feeding was actually observed with naked eyes and with the use of a 14x hand lens when the animal was freely swimming in the culture medium, and a low-power Zeiss dissecting microscope when it was placed in an uncovered cell deep enough to allow it free play. In describing this process the writer was guided by Hartog's (1902) very illuminating description of the feeding of phylopods and Cladocera.

In feeding, the animal may be seen chasing from the top to the bottom or vice versa, with brisk jerky motions, stopping on the bottom surface, at the inside, of the glass, at the top margin, or at the surface film of the medium, with the cilia of the limbs in constant vibration. The thoracic appendages cause the flow of the water into the shell through the angles on either side between the carapace (Plate 1, fig. 7, *ca*) and the head. Here the flow of water passes the antennules (Plate 1, fig. 7, *ant*) which are thus in a very good position as sense organs for perceiving any change in the properties of the indrought. The stream flows backward between the valves in the spaces traversed by the limb proper. Here the limbs (Plate 1, fig. 7, *ft*), which are armed with rows of ciliated setæ, are efficient in producing current. The food in suspension drifts into the angle where the hind end of the abdomen bends abruptly down, as it passes back. Here the food is turned onward and then under, and along the medium line of the body till it reaches the oral region behind the labium where the play of the mandibles sends it to the gullet to be swallowed.

HYDROGEN-ION CONCENTRATIONS

According to Herms (1929) many species of organisms seem to require a certain hydrogen-ion concentration range in the medium in which they live. During the course of his investigations on mosquitoes he found that *Theobaldia incidens* tolerated a pH range of from 5.4 to 7.6, and *Anopheles maculipennis* a pH range over 7, that is, from 7.2 to 8. Chipman (1934) states that the pH of the cotton-seed meal medium for culturing *Daphnia* was adjusted to 7.2, with the addition of sodium carbonate, and he was able to grow the organisms rapidly and to produce normal clones.

Since pH is said to be important to the lives of organisms, experiments on pH concentration were conducted with soil-manure culture medium.

To determine the pH concentration range in relation to the growth of *M. macrocopa,* examination was made of the pH concentrations of various pools where moina were found growing profusely, and of that of the media used for culturing the organisms. The pH concentration of samples taken from a pool in Pasay, Rizal Province, was 8; back of Philippine Women's University, Manila, 7.5; and in the basement of the Bureau of Science, 9. Soil-mungo culture medium showed a pH concentration of 7; soil-soybean, 7.1; soil-ricebran, 6.8; yeast, 7.8; and soil-manure, 7.5.

In the study of the pH concentration range two main factors were determined; first, the maximum pH concentration in acid (Table 6), and second, in alkaline (Table 7). To determine the pH range in acid, eight similar-sized bottles, 2½ inches in diameter and 5 inches high, with an opening of 1¾ inches in diameter, numbered 1 to 8 and each containing 100 cc of soil-manure medium, were used. Relatively proportional amounts of sulphuric acid ($\frac{n}{10}$ H_2SO_4) solution were added to the medium in all bottles except bottle 1, which was used as check. Six mother moina were introduced into each bottle. The results are noted in Table 6.

TABLE 6.—*pH in relation to growth of Moina macrocopa in acid soil-manure medium.*

Bottle No.[a]	$\frac{n}{10}$ H_2SO_4 solution added.	pH range of medium.		Population.	Condition of moina.
		Newly treated.	4th day.		
	cc.				
1	0.00	7.60	7.60	160	Vigorous, active, reddish.
2	2.28	7.28	7.20	154	Do.
3	2.54	6.85	6.70	165	Do.
4	2.80	6.52	6.40	155	Do.
5	3.07	5.86	6.10	165	Do.
6	3.20	5.50	5.80	160	Do.
7	3.35	5.20	5.50	145	Moved slowly, often stayed on the bottom for about 3 hours, then gradually became active again.
8	3.60	5.00	----------	----------	Moved slowly and died in about 3 hours.

[a] Each bottle contained 6 moina in 100 cc of medium.

The experiment in alkaline media was similarly conducted. Bottle 10 remaining as check, to bottles 11 to 18 was added sodium hydroxide ($\frac{n}{10}$ NaOH) solution in gradually increasing concentrations. The results are given in Table 7.

The results of the experiments clearly indicate that the organisms can tolerate a pH range of from 5.2 to 9.2 in a solution and that they produce normally in spite of the variations in the pH concentrations of the medium.

TABLE 7.—*Growth in relation to pH range of Moina macrocopa in alkaline on soil-manure culture medium.*

Bottle No.[a]	$\frac{n}{10}$ NaOH solution added.	pH range of medium.[b]		Population.	Condition of moina.
		Newly treated.	4th day.		
	cc.				
10	0.00	7.60	7.60	165	Vigorous, active, reddish.
11	3.46	7.80	7.70	160	Do.
12	3.60	8.10	7.90	150	Do.
13	3.80	8.30	8.00	155	Do.
14	3.98	8.60	8.20	160	Do.
15	4.15	8.80	8.30	170	Do.
16	4.30	9.00	8.50	140	Do.
17	4.50	9.20	8.80	150	Moved slowly and gradually became active again.
18	4.67	9.40	----------	----------	Died in 12 hours.

[a] Each bottle contained 6 moina in 100 cc of serum.

[b] All pH concentrations were read by Dr. M. M. Alicante, soil biologist of the Bureau of Science, with the use of a colorimeter.

FACTORS IN LABORATORY CULTURE

Water.—The selection of a suitable water supply is of prime importance for the success of a culture medium. Rain water was found to be excellent. The water from fishponds near the Bureau of Science, Manila, in which algæ and other water plants grow, has been tried with success after filtration through filter paper. Two days after it has been chlorinated, tap water was found excellent for the breeding of moina. It was not observed, however, that newly chlorinated tap water killed the waterfleas.

In moina culture it seems that brownish yellow color indicates optimal conditions for the progress of the desired pollution. As a rule the writer has obtained best results when the media were yellowish, like those of horse manure, and yeast added with ferric chloride or ferrous sulphate. Some culture media containing soy-bean meal, mungo meal, rice bran, and yeast, are practically colorless. However, in nature the water where the moina grows is sometimes clear and colorless.

Oxygen.—It is generally observed that a moina culture, especially in dense growth, consumes large amounts of oxygen. Many collectors have experienced that crowded moina in their containers do not live five hours. In the United States, in collecting daphnia during warm weather, the collectors, knowing that warm water holds less oxygen than cold water, place cakes of ice in the pails containing daphnia to insure the live delivery of the catch. Although in nature the large and highly efficient breathing system furnishes oxygen to moina even in highly polluted water or at the bottom of the pools, they can live on little oxygen. Moina can live in a tightly corked vial containing 5 cc of water for days.

Kerosene spread out on the surface of the water retards the absorption of oxygen from the air. Kerosene spread over natural pools for killing mosquito larvæ did not seem to affect the growth of moina, except when the oil came in contact with the animals. In this connection an experiment was performed in order to test the effect upon moina of kerosene spread on the pool. October 4, 1934, two beakers were filled with the usual concentration of soil-mungo medium. Ten mother moina were introduced into each beaker and the medium was entirely covered with kerosene. In the culture, which was kept up until October 15, 1934, the organisms lived and grew as well as in a big aquarium, cultured simultaneously.

Temperature.—No study has been made as to the temperature best suited for the growth of moina. However, the temperature of the water in which the organisms grow well, both in nature and under laboratory conditions, was found to be from 26° to 31°C.

Light.—In moina culture diffused light is found to be best. According to Viehoever (1935) direct sunlight keeps the growth of bacteria and protozoa in check, thus preventing the excessive growth in certain culture media, although it does stimulate the growth of algæ.

Containers.—Moina can be cultured in various containers, from narrow-mouthed to wide-mouthed jars. In the course of observation many sizes of containers were used. In most cases shell vials of 1½ by 8 to 2½ by 8 centimeters, various sizes of specimen jars, museum jars, aquaria, enamel basins, old cement tanks, and beakers, were found satisfactory. For mass production the writer used aquarium jars containing from 4 to 65 liters of water, old cement tanks of 15 liters, and fruit jars of 1 liter, with satisfaction. The culture containers, tools, and other culture materials should be carefully cleaned and kept away from poisonous materials.

Selection of healthy breeders.—Groups of moina newly taken from nature exhibit various sizes and colors. They are large and small, yellowish to reddish. The bigger and seemingly healthy individuals with reddish color are best for breeders.

Food.—Food is the most important factor in the laboratory breeding of moina. Food must be always available. Infrequent feeding may lead to the development of males and ephippial females, although over-abundance is equally detrimental.

A mixture of changeable and uncontrollable organisms in raw cultures serves as a source of pure culture. Such cultures of chemically and biologically changing composition are obtained upon suspensions of manure, soil, mungo, rice bran, soy bean, and other media, in water, or setting aside rice-straw infusion. They provide culture media for a host of microörganisms, like bacteria and protozoa, that live on the dissolved food nutrients, such as fats, proteins, carbohydrates, and mineral salts.

Banta (1921) ascertained that daphnia may be fed upon a mixture of various protozoa and protophyta from the sediment of ponds containing an abundance of organic matter, upon bacteria, and upon certain unicellular green algæ.

For food, bacteria have been emphasized by various workers who have observed the condition under which moina and daphnia breed in nature as well as in the laboratory. Treillard (1925) claimed that he propagated daphnia in pure cultures of bacteria. Stuart, McPherson, and Cooper (1931) experimented with various kinds of bacteria as food organisms.

Knowing that in many of the manural media urea bacteria would be present, Viehoever (1935) prepared a mineral medium containing urea consisting of 0.02 per cent Liebit extract added to an aqueous solution of K_2HP_4, 0.1 per cent, $MgSO_4$, 0.03 per cent, NaCl, 0.01 per cent, and $FeCl_3$, 0.001 per cent, in which urea bacteria readily grow. While the sterile solution in various concentrations was unsatisfactory, two drops of this selective urea with urea bacteria added to a 30-cc culture of tap water, exposed to direct and diffused sunlight, gave fair to good growth of daphnia.

In view of the fact that certain kinds of bacteria are necessary as food for moina, bacterial analyses [5] of the two most promising of the culture media were made. The bacteria found in soil-manure culture medium were *Flavobacterium aurescens* (Ravenel), *Flavobacterium diffusun* (Frankland), *Bacterium lactis ærogenes* Escherich, and *Micrococcus flavus* (Lehmann), and in soil-mungo culture medium, *Flavobacterium aurescens* (Ravenel), *Micrococcus auranticus* (Schröter) Cohn, and *Bacterium lactis ærogenes*. The number of species thus far found is not definite, since the materials and the media were freely exposed to contamination. No attempt was made to determine which of the bacteria was the best food for *Moina macrocopa*.

The writer used algæ from fishponds for moina culture, after straining the pond water through muslin, but unfortunately the waterfleas did not grow as well on this medium as on soil manure, and lost their natural color. In old yeast, soil-soybean, soil-mungo, and soil-ricebran media, algæ grow at the side and on the bottom inside the aquaria. Moina grows and multiplies in those media, but not as well as in nature. In my experiments, moina grew in yeast, but the offspring became whitish.

COMPARATIVE STUDY OF CULTURE MEDIA

Banta (1921) announced a convenient culture medium for daphnids in the form of soil-manure. Chipman (1934) believes that a satisfactory culture medium having several advantages over the manure infusion is prepared of 1 liter of filtered pond water, 90 grams of garden soil, and 17 grams of cotton-seed meal for stock solution. Bond (1934) announced that ordinary Fleischmann's yeast had been fed for some months to mass cultures of *Daphnia magna* and *Artemia* with excellent results, reproduction and growth being markedly more rapid and population more dense than in any of the usual media, but that it is necessary to have a stream of air bubbling through the medium at all times or the yeast may prove lethal, probably because it gives off carbon dioxide. Weibe (1930) found soy-bean meal a good fertilizer for the production of organic matter in ponds.

Since pond water, as suggested by Banta (1921) and Chipman (1934) is not available throughout the year in Manila, tap water

[5] Bacterial analyses were made by Dr. M. S. Basaca, bacteriologist, Bureau of Science.

was used. According to the analysis of the Metropolitan Water District, tap water is soft, because it contains little bicarbonate, calcium, and magnesium, about 90 parts per million, as calculated from magnesium and calcium content.

In some of the experiments reported below, garden soil was used. According to the analysis made by Mr. Francisco Tantoco, Bureau of Science, the total amount of organic matter in garden soil is 6.09 per cent,—nitrogen 0.078, phosphorus 0.16, calcium 4.75, magnesium 1.27, and potassium 0.327.

Carbohydrates (*gaogao*) (*experiment 1*).—September 20, 1935, ½ gram of gaogao was mixed in 500 cc of distilled water and boiled for 30 minutes. The mixture was divided into two equal parts and distilled water added to make 900 cc in each of two battery jars. The jars were covered with cotton and were autoclaved for 25 minutes under a pressure of 20 pounds. The solution was set aside to cool till morning. Five mother moina were washed in sterile water and introduced into each jar, which was always kept covered. After about 24 hours all mother moina had died, leaving a few young which died the following day without showing perceptible growth.

Soil-soybean culture medium (*experiment 2*).—September 4, 1934, a stock medium was prepared in proportions of 10 grams of soy-bean meal to 1 liter of water, boiled for 25 minutes, and left to cool in a covered beaker for about 24 hours, after which 250 grams of garden soil were added. After thorough stirring, the mixture was loosely covered and set aside in a dark place at room temperature for three days. During this period the mixture fermented and produced considerable gas. At the end of three days the supernatant liquid was decanted and strained off through muslin. The stock solution was restrained, to eliminate any bacterial masses that might have developed.

To determine the right concentration of this medium for rearing moina, stock solution in amounts of 35, 40, 45, and 50 cc was added consecutively each to one of four aquarium jars containing four liters of water each. Ten moina were introduced into each jar. Observation showed that in strong concentrations of the medium bacterial masses formed, either in suspension, at the surface of the medium, or at the side of the jar, interfering with the free movement of the moina and often causing their death, but in a dilution of 35 to 40 cc of strained stock solution added to four liters of water a final dilution was obtained which remained quite clear and in which moina grew. The medium was replenished with 15 cc of strained stock solution after the fourth day. It has been desirable to renew the medium in which the animals were growing at intervals of a week or more. Fresh solution was prepared every week.

In the mass-production experiment fresh catches of moina living under natural conditions were used. Fifty healthy and vigorous mother moina were introduced into each of two aquaria containing 15 liters of water each of the culture medium. As the animals grew in the medium, they gradually became whitish, and their growth was not so dense. The culture was tried with similar results for a month in three old cement tanks each containing 15 liters of culture medium.

Soil-ricebran culture medium (experiment 3).—September 17, 1934, a stock solution was prepared in proportions of 10 grams of rice bran to 1 liter of water, boiled for 25 minutes, and left to cool in a covered beaker for about 24 hours, after which 250 grams of garden soil were added. After thorough stirring, the mixture was loosely covered and set aside in a dark place at room temperature for three days. Like the soil-soybean medium, the mixture fermented and produced considerable gas, forming supernatant liquid which was decanted, and the liquid strained off through muslin.

For determination of the right concentration of the medium the same method as that in experiment 2 above was used, and the right dilution was found to be at from 40 to 45 cc of the stock solution to 4 liters of water. The results were identical to those of the preceding experiments.

Soil-mungo culture medium (experiment 4).—The culture medium was prepared like the soil-soybean medium and the soil-ricebran medium. The method for determining the right concentrations was the same as that followed in the preceding experiments, and from 35 to 40 cc of the stock solution to 4 liters of water was found to be the optimal concentration. The medium seemed somewhat better than the soil-soybean and soil-ricebran media, as the growth obtained was apparently denser and the reddish coloration remained a little longer, due probably to the greater amount of iron present in mungo (Table 11).

TABLE 8.—*Number of young produced on soil-manure and yeast-culture media compared.*

Culture No.	Moina.	Date.	Medium.	Young.	
				Per mother.	Total.
		1934			
1	1	Oct. 2–9	Soil-manure	1,691	
2	1	Oct. 2–10	do	1,766	3,457
3	1	Oct. 2–9	Yeast	484	
4	1	Oct. 2–10	do	387	871

Yeast culture medium alone (*experiment 5*).—September 4, 1934, 150 mother moina were introduced into a uniform suspension of $\frac{1}{8}$ of a fresh cake of Fleischmann's yeast in 50 cc of water, which was poured into an aquarium containing 30 liters of water. On the fifth day the culture grew gradually denser, the animals forming schools around the sides and corners of the aquarium; thereafter the moina decreased in number. The food supply was replenished every fourth day until September 17, 1934, but no apparent increase in the density of the moina occurred. Sexual females and males seemed predominant. The coloration of the animals changed noticeably. The animals were reddish in nature, but generations bred on the medium gradually lost their color and became whitish. The experiment was repeated in a big aquarium tank containing about 65 liters and a series of six old cement tanks, each containing 15 liters of the culture medium, with identical results.

Yeast culture medium with aquatic plants (*experiment 6*).—According to Innes (1935) the main purpose of plant in aquaria is to supply oxygen, which they do under the influence of light, while at the same time they absorb the injurious gas (carbon dioxide) given off in breathing by all animals. September 18, 1934, aquatic plants (*Hydrilla* sp. and *Vallisneria* sp.) were planted in the sand on the bottom of the aquarium. The same quantity of culture medium and the same number of moina as in preceding experiments were used, with similar results.

Yeast medium with air bubbling (*experiment 7*).—The test was performed February 16, 1935, with the same number of mother moina and the same amount of culture medium used in the preceding experiment, but with a stream of air bubbling through the medium at day time. The culture grew dense until about the seventh day, when the organisms decreased in number and became almost completely whitish. Another trial was made with similar results.

Rice-straw infusion (*experiment 8*).—The infusion was prepared in the following manner: On 10 grams of rice straw on the bottom of an aquarium jar containing 4 liters of water, several pieces of gravel were placed to keep the straw from floating. Twenty-five mother moina were introduced. The culture grew rapidly, but lasted only about five days. As the straw stayed longer in the water, molds began to grow on it and entangled the animals that happened to alight on them. The entire medium had to be changed and the receptacle well washed. Several trials were made, and it was found that more straw was unnecessary because molds and bacteria were so abundantly produced that the medium became slimy and foul in a shorter time, and thus unfavorable to the growth of the animals.

Soil-manure culture medium (*experiment 9*).—It was previously stated that soil-manure culture medium was used for culturing the animals from one clone. Banta's (1921) directions for the preparation of the medium are as follows:

> Two pounds of garden soil are placed in a large battery jar (9 in. diameter); to this are added six ounces of finely divided fresh (8 to 15 days old) horse manure and the whole is covered with 10 quarts of strained pond water. The mixture is allowed to stand at 15° to 20°C. without disturbance for three days when it is strained through silk bolting-cloth. The proper straining is facilitated by carefully dipping out and straining most of the supernatant liquid and then agitating the remainder, and with it rubbing a very small portion of the soil through the straining cloth. The solution is then ready for use, though in addition to being thoroughly stirred before being placed in the culture bottles it is usually diluted by adding pond water in the proportion of 1 to 4 to 1 to 2 depending upon the degree of density in the appearance of the solution.

For mass-production culture Banta's method of preparing the culture medium undoubtedly seems tedious and complicated to fish culturists. A much simpler method is the following: One hundred grams of garden soil and 10 grams of dried horse manure (dried for 5 days and stored for future use) are placed in a glass jar; to these are added 4 to 5 liters of water. About half a liter of the solid materials are poured in and finely broken up with the fingers or stirred vigorously with a stick; finally the rest of the water is added, and the solution is allowed to stand for a day or two. Before the solution is used, all debris floating on top of the water should be taken off by means of a net. The sediment is allowed to remain on the bottom of the jar.

Mass-production test (*experiment 10*).—Three aquaria, each containing 50 liters of water, were prepared according to the above proportions. To each were added 1,000 grams of garden soil, and 100 grams of dry horse manure uniformly mixed with 1 liter of water. After the solution had been allowed to stand for 24 hours all floating debris was carefully removed without disturbing the sediment. To each aquarium 300 old-stock mother moina were introduced. In about 5 days the population became so dense that the animals could be seen thickly crowding in all directions of the medium. Parts of the culture were gathered every morning by means of a course conical muslin net to feed a group of 60 fishes, consisting of zebra, moon, and fighting fishes.

In order to maintain a continuous food supply for these fishes, as the thick population of the organisms remained to about the seventh day, rotation methods were used. The medium of one of the aquaria was entirely changed every six or seven days, depending upon the density of the animals, while the organisms of the others were being used for feeding.

In gathering the organisms the net should be wide and deep enough, the rim 6 inches wide and the net 2 to 5 inches deep, depending upon the size of the receptacle. The net should be dipped and moved slowly forward or sideways, and care taken not to disturb the whole medium. The organisms must be transferred immediately from the net to a receptacle containing sufficient water.

In the culture medium the organisms can be maintained for more than a month, if a crowded population is not desired, provided fresh water is added to the medium to replace that which has already evaporated, and the culture stirred slowly once a week. This method has been tested by the writer many times, both in small receptacles containing 4 liters of water and in large ones containing 50 liters.

When the medium gets old, there is a tendency for the formation of bacterial masses, molds, or hydra, at the side of the glass, which may entangle and kill the animals. It is, therefore, necessary to wipe off carefully with a piece of cloth the sides of the aquarium once every two or three days, depending upon the condition of the aquarium.

Comparative study of soil-manure and yeast culture media in number of production (*experiment 11*).—To determine whether soil-manure or yeast medium shows the better production, one two-hour-old female moina was introduced into each of four aquarium jars, two of which contained 4 liters of horse-manure culture medium each, and two, 4 liters of yeast medium. The results are noted in Table 8. The production in yeast culture medium was comparatively small, being 871 as against 3,457 in soil-manure medium. The general appearance of the animals was whitish, and they seemed not as vigorous as those of the soil-manure culture. The result of the experiments seem to indicate that yeast alone as a food is far inferior to soil-manure in moina culture, due to deficiency in iron content, as explained below.

Restoration of color (*experiment 12*).—Since moina become whitish when cultured in soil-ricebran, soil-mungo, soil-soybean, and yeast media, tests to restore their natural color were conducted in the following manner. December 1, 1934, twenty mothers from each of these media were first washed in tap water and introduced separately into 4 glass aquaria containing 4 liters each of soil-manure medium. About 4 days after, the animals turned reddish, as in nature. The experiment was repeated three times with similar results.

THE ROLE OF IRON IN MOINA CULTURE

Both favorable and unfavorable culture media have been observed in the previous experiments, each involving a more or less complex problem. Some culture media, like yeast, grew moina, but the population became whitish and less productive; but when moina was cultured in horse-manure medium, the progeny became reddish, vigorous, and productive. What are the factors that determine these conditions? Are these conditions due to food nutrients?

In moina culture it is the purpose of the medium to provide enriching substances in solution, so as to promote the growth of microörganisms, as bacteria and protozoa. The liquid must contain organic nutrients, such as carbohydrates, proteins, and fats, that may be assimilated by unicellular organisms. Proteins are present abundantly in all but rice straw (Table 9). Carbohydrates and fats are abundant in all ingredients of soy bean and rice bran. Organic nutrients are not sufficient for bodily use; mineral salts, which are abundant in all materials, especially in rice bran, rice straw, and in horse manure, are also essential.

TABLE 9.—*Composition of culture media.*

Sample.	Moisture.	Proteins.	Fats.	Crude fiber.	Carbohydrates.	Ash.
Horse manure [a]	9.46	11.92	2.03	23.40	24.72	28.47
Yeast (Fleischmann's) [a]	69.42	16.95	1.44	1.09	9.08	2.02
Mungo [b]	9.98	24.28	1.15	3.59	57.44	3.56
Soy beans [b]	4.95	39.08	20.07	5.69	24.96	5.25
Rice bran [c]	10.04	11.27	19.08	8.67	40.62	10.32
Rice straw [d]	9.81	3.26	1.06	33.33	36.24	16.30

[a] Analyses made by Mr. E. F. Gutierrez, of the Bureau of Science.
[b] Hermano, A. J. Food values. Bur. Sci. Pop. Bull. 16 Manila (1934).
[c] West, P. A., and A. O. Cruz. Philip. Journ. Sci. 52 (1933) 1–78.
[d] Analysis made by Mr. A. O. Cruz, of the Bureau of Science.

It was found that *M. macrocopa* grew best in soil-manure medium, even though the stock had remained in the laboratory for a long period. The animals reproduced abundantly in the medium for a certain period and remained from yellowish to reddish, like in nature, while in soil-mungo, soy-bean, rice-bran, and yeast culture media the organisms gradually became whitish, indicating an unhealthy condition. To determine the necessary food elements in soil-manure and rice-straw media that result in the yellowish to reddish color of the animal, and the reason for the whitish population obtained in the other media, quantitive analyses were made of the food values of various materials. Table 9 shows that mungo, yeast, and soy bean are rich in proteins; soy bean and rice bran in fat; yeast, mungo, rice bran, and rice straw in carbohydrates. These results prove that organic nutrients had nothing to do with the reddish color and the vigor of the organisms in soil-manure. Horse manure and rice straw contain much more ash than the materials used for the rest of the media, seeming to indicate that the main cause of the reddish color was the presence of mineral salts. Upon tracing its mineral content, yeast (Table 10) was found to contain only a trace of iron.

To determine whether lack of iron was the main cause of the anæmical condition of moina, the following experiments were performed. A uniform suspension was prepared of a little yeast in 6 liters of water. Some of the mixture was placed in each of 11 bottles each containing 450 cc of water. Five bottles were numbered from 1 to 5, another five from B–1 to B–5, respectively, and the one left was used as check. With a narrow-pointed pipette 1, 2, 3, 4, and 5 drops (23 drops equal 1 cc) of ten per cent ferric chloride were introduced into the bottles of the first group, and 1, 2, 3, 4, and 5 of ten per cent ferrous sulphate were introduced into the bottles of the second group, and the mixtures stirred well. Five mother moina were introduced into each bottle. After the third day it was observed that all adult moina in ten bottles containing the ferric compound were from yellowish to reddish, showing an increase in coloration directly proportional to the concentration of iron in the medium, while in the check the adults and young moina became whitish.

The above results indicate that iron salts, existing in organic combination in the materials fed, are necessary for the growth of moina. Analyses for iron content were made on the different materials used in the culture media. The results are shown in Tables 10 and 11.

TABLE 10.—*Analysis of the ash in yeast.*[a]

Constituent.	Per cent.
Phosphorus pentatoxide (P_2O_5)	54.5
Potassium oxide (K_2O)	36.5
Magnesium oxide (M_gO)	5.2
Calcium oxide (CaO)	1.4
Silica (SiO_2)	1.2
Sodium oxide (Na_2O)	.7
Sulphur trioxide (SO_3)	.5
Chlorine (Cl)	trace
Iron (Fe)	trace
	100.00

[a] Reported by the Fleischmann's Yeast Company according to Viehoever (1933).

TABLE 11.—*Iron contents of the materials used in moina culture.*

Samples.	Iron (F_2O_3). Per cent.
Horse manure	0.15
Yeast	0.32
Mungo	0.47
Soy bean	0.38
Rice bran	0.026
Rice straw	0.07

Table 11 shows that the iron content of horse manure is lower than that of yeast, mungo, and soy bean, but higher than that of rice bran and rice straw. Experiments 2, 3, 4, 5, 8, and 9 showed that 35 to 40 cc of soil-soybean stock medium in 4 liters of water, 40 to 54 cc of soil-ricebran in 4 liters of water, and 35 to 40 cc of soil-mungo in 4 liters of water, were the optimal concentrations; whereas in yeast medium $\frac{1}{8}$ of a cake in 30 to 35 liters of water in soil-manure, 10 grams of horse manure and

100 grams of garden soil in 4 to 5 liters of water, and rice straw 8 to 10 grams of straw in 4 liters of water, were found to be the optimal concentrations. Apparently soil manure is more concentrated than any of the media. Yeast contains proportionally more iron than horse manure when the analysis is based on ash, but in the sample the iron content is only 0.004 per cent, while in horse manure it is 0.03. Iron salts that may be taken in either directly from water or contained in the yeast plants themselves and assimilated by the organism do not seem sufficient for the formation of new hæmoglobin in the blood of moina. Experiments show that a yeast medium needs about 2 to 3 drops of 10 per cent of either ferric chloride or ferrous sulphate to 450 cc to restore the color of moina to that found in nature.

Analysis of ash shows that mungo and soy bean contain more iron than horse manure. The best method so far known for the preparation of a culture medium is to make first a stock solution (experiments 2 and 4), 35 to 40 cc of which are added to 4 liters of water. Stronger concentrations are detrimental to the life of moina, as bacterial masses are formed, interfering with the free movement of the animals and often causing their death. However, in this concentration the quantity of iron is not sufficient to assure the favorable growth of the animal. As in the case of yeast medium, it seems advisable to add iron salt to the culture medium to assure the healthy reddish color in the moina.

The iron content of rice-straw ash is 0.07 per cent (Table 11). Since 8 to 10 grams of straw to 4 liters of water was the optimal concentration for moina culture, the quantity of iron salts in the solution from the straw seemed almost sufficient for the growth of the animals as indicated by the color of the organisms cultured in the infusion.

DISCUSSION

Irregularities in the life span and the number of fecundities are shown in Tables 1 and 2. Some moina mothers died after the fourth brood, while others died shortly after the eleventh (Table 1) and thirteenth (Table 2) broods. There are of course, differences between individuals with regard to the events included in a lifetime. Even under generally uniform conditions, life does not proceed in a uniform, unbroken flow, owing to three factors that break up the uniformity; namely, nutrition, growth, and expulsion of the young. Growth and the expulsion of the young seem to be exhausting processes. The varying conditions of the intestine alone which is sometimes full and sometimes nearly empty, with large number of young in the egg pouch, or different stages of emptiness of the digestive canal together with the various stages in egg and young development, provide much variety in life processes. In culture there is the interplay between these alternations and the effect of transfer to new fluid. Early or late death depends to a large extent on the degree of exhaustion owing to production of the young and the various nutritive processes, factors which result in high mortality during the later part of the reproductive period or shortly after its close. Some of the animals come through the reproductive process exhausted, and die soon after. Others are hardly damaged at all by this function, and continue to live until they succumb to old age.

Owing to the fixed character of development in moina and the fixed length of the early phases of life, more uniformly defined periods of fecundity and old age might perhaps have been expected. However, both in nature and under laboratory conditions the length of life span and the degree of fecundity vary extremely, and are undoubtedly dependent on environmental conditions.

Throughout the year the sexual or resting egg plays a unique part in maintaining the species in spite of periodically unfavorable weather, as that of the rainy season, which usually begins in June and ends in January. When the rain falls, the water in the pool rises. During hot weather the pool becomes low or dries up completely. The increase of water during rainy season favors the growth of moina, since the population becomes sparse, resting eggs hatch, and new food supplies develop. Due to evaporation of water as well as to the prolificacy of the species, the pools become over-crowded and the food supply exhausted. Males are produced as well as sexual females that drop their ephippial eggs at the bottom of the pool. Some percentage of the eggs hatch out within three or more days and the young die a few days later. The rests of the eggs undergo a resting or latent period in a dry condition. The embryo of the egg remains living in a dry state until more favorable conditions come. It is in this condition that the species survives the dry season.

Crowding is undesirable in mass production, at least when the organisms are artificially cultured. It causes the parthenogenetic females to produce males, and, as a result, the fertilization of the majority of the sexual females. A sexual female not fertilized by a male may disintegrate her resting eggs and turn into a parthenogenetic female. Inasmuch as in the majority of cases only one out of two eggs develops in the ephippium, only one offspring may be expected from each brood. Naturally the sexual forms become more preponderant as the culture gets older.

Although the number of generations that may be obtained in one year has not been recorded, since the postembryonic development of the parthenogenetic female of moina lasts 24.29 hours on the average, reproduction may be expected at intervals of from 20.81 to 26.13 hours, and if the animal is maintained in a suitable culture medium throughout the year, the number of generations obtained will undoubtedly be very high. In the case of sexual females the number of generations will be greatly lowered, as some sexual eggs that do not require drying hatch irregularly in the medium and others need to be dried before hatching, depending upon the availability of fresh water, in which case the number of generations will depend upon the environmental factors and the nature of the ephippial eggs.

In culture experiments it was noted that the organisms became whitish not long after they had been cultured on media such as soil-mungo, soil-ricebran, soil-soybean, and yeast, where iron was insufficient for the formation of the new hæmoglobin in the blood of moina. In soil-mungo the average life span is 8.72 days, and in soil-manure it is 12.82 days, while in soil-mungo medium the number of offspring produced by 19 mothers is 2,002, and in soil-manure medium it is 2,486 for 13 mothers. Upon tracing the food nutrients of the two media, it was noted that soil-mungo medium was much inferior to soil-manure medium in iron content in final dilution, which probably accounts for the shorter life span and the smaller number of offspring than those obtained in soil-manure medium.

Yeast is a very nutritious food, as shown in Tables 9, 10, and 11. Analysis (Table 11) shows that it is highly rich in phosphorus, potassium, magnesium, and other constituents, but poor in iron. Owing to its deficiency in iron, which seems to be the immediate cause for the lower vitality and reproductiveness in moina, yeast alone is not good for moina culture, but with the addition of an iron salt in the culture water it may become excellent. This fact may be true not only with regard to yeast medium, but also with regard to soil-mungo medium, soil-ricebran medium, and soil-soybean medium.

Moina thrives well in soil-manure culture medium; the offspring remain reddish, vigorous, and productive even after they have stayed long in the laboratory. Soil-manure medium, when new, contains sufficient nutritious food substances for the host of microörganisms in the medium, which may be used as food by moina.

Undoubtedly food influences the prolific growth of moina. Owing to the abundant fresh food nutrients, the period of greatest reproductiveness occurs when the medium is from 2 to 7 days old. Reproduction reaches its highest level when the food is plentiful, and declines as the food supply becomes exhausted. Exhaustion of food supply and liberation of too much carbon dioxide by moina under crowded conditions may cause the death of practically the entire population of the culture. Since the highest rate of reproduction by parthenogenesis occurs when the culture is sparse and the food supply plentiful, it is necessary in mass culture that the growing population be periodically reduced and rotation methods exercised.

SUMMARY AND CONCLUSIONS

1. *Moina macrocopa* grows abundantly in temporary pools in the vicinity of Manila. It is considered to be the best of all living foods for ornamental fishes, and is reported for the first time in the Philippines.

2. The species under discussion has been variously included in *Daphnia macrocopus* Straus, *Moina rectirostris* Baird, *Moina brachiata* Jurine, *Moina flagellata* Hudendorff, *Moina paradoxa* Weismann, *Moina fisherii* Hellich, *Moina azorica* Moneiz, and *Moina macrocopa* Straus.

3. It is commonly called "daphnia" in Manila. Since the daphnia belongs to a different genus, "moina" should be adopted as the common name of this animal.

4. This waterflea is widely distributed throughout the world, having been reported in Europe, Central Asia, South Africa, United States, South America, Ceylon, and Japan.

5. *Moina macrocopa* lives in fresh water polluted with decomposing material. It may be found throughout the year, as long as water and food are constantly added to the pool.

6. Practically nothing is known concerning the life history of a waterflea in the Philippines. Some phases of the life history of *Moina* have been studied in the United States, Europe, and Japan.

7. There are two types of females, sexual and parthenogenetic, which produce sexual and parthenogenetic eggs, respectively.

8. There are three nymphal instars during the postembryonic development. In individuals cultured in soil-mungo medium the average duration of the first stage is 6.73 hours; that of the second, 8.56; that of the third, 10.50. The total average period from birth to adult brood in soil-mungo medium is 24.89 hours, and in soil-manure 6.53, 8.00, 9.73, and 24.26 hours, respectively.

9. The life span in soil-mungo medium was from 4.23 to 13.30 days, an average of 8.72 days, while in soil-manure the life span was from 7.96 to 14.15, an average of 12.82 days.

10. The number of young produced in soil-mungo medium is 2,091 by 19 parthenogenetic mothers; and in soil-manure medium, 2,486 by 13 mothers. In the total number of offspring produced by 32 mothers the females always outnumbered the males. Difference in the number of offspring is considered to be due to food.

11. The incubation periods of the parthenogenetic eggs were approximated from the last molting of the nymphal instar to the extrusion of the first brood, and from any one brood to the succeeding brood. It is calculated from the laying of the eggs from the germarium to the extrusion of the young from the egg pouch.

12. The male molts twice before it becomes an adult. The first instar takes from 7 to 8 hours and the second from 8 to 9; molting occurs from 18 to 21 hours thereafter.

13. The incubation period of the sexual eggs is variable, inasmuch as some of the eggs may hatch from 2 to 3 days after laying and others require an extended period. All fertilized sexual eggs can be dried and made to hatch within three or more days by thorough soaking in the medium.

14. The molting process was found to be essentially the same in all sexes and stages. The adult females molt shortly after the extrusion of the young or sexual egg, and the males from 18 to 21 hours after the second molt.

15. Copulation occurs after the third molt of the sexual female and the second molting of the male. The process of mating is described.

16. The proportion of sexes in moina is found to be difficult to determine, since it is controlled by environmental factors; namely, food, crowding, temperature, and others.

17. Some enemies of moina are found to be cyclops, *Vortiella*, hydra, Rotifera (*Brachionus rubens*), bacterial masses, molds, and fishes.

18. The method of feeding, which is essentially the same in all stages and sexes, has been described.

19. The organism was able to tolerate a pH range between 5.2 and 7.6 in acid and 7.6 and 9.2 in alkaline. The coloration of the animal was reddish and the rate of reproduction similar, which clearly shows that a favorable hydrogen-ion in a certain medium did not play an important rôle in the coloration and prolific reproduction in moina.

20. Water, the proper amount of oxygen, the range of temperature, the condition of light, the kind of containers used, and the selection of healthy breeders are important factors in laboratory propagation.

21. Food is considered the most important factor in the laboratory breeding of moina.

22. Moina may feed on bacteria in soil-manure and mungo media, and bacteria or yeast plants in yeast, and algæ from fishpond sediment. Thus in nature they may feed on very minute organic matter that may be in suspension in the medium in which they live.

23. In sterilized media with food, principally carbohydrates, moina died in 48 hours without a sign of perceptible growth.

24. The organisms, grew and multiplied in soil-soybean, soil-ricebran, soil-mungo, and yeast media, but lost their vigor by gradually turning from reddish to whitish and declined in reproductiveness. In soil-manure medium moina grew normally, retaining their vigor even after they had been cultured for a long time in the laboratory. In rice-straw infusion moina seems to grow normally but becomes entangled by molds which grow out of the straw.

25. With the use of horse-manure medium and by following the culture method herein described, mass production is possible. For culturing moina as food for large number of fishes, the tank in which the animals are cultured should be large enough to accommodate the quantity of moina needed for the number of fishes to be fed. Inasmuch as the exhaustion of the food supply occurs at about the fifth day after introduction of the organisms into the culture medium, the entire change of the medium and rotation become necessary to maintain a continuous supply of the organisms.

26. Since in soil-soybean, soil-ricebran, soil-mungo, and yeast media, the animals gradually turn from reddish to whitish, analyses of food values of the different materials were made. The loss of color was found to be not due to deficiency in fats, proteins, and carbohydrates, but to the lack of iron salts in various concentrations of the media used.

27. Soil-manure is considered to be the best of all the media tested, because, in it, the animals remained in normal condition; the medium may be sufficiently highly concentrated to provide iron in solution for the assimilation of the unicellular organisms serving as food for moina.

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VIEHOEVER, A. Daphnia propagation for experimental use. Am. Journ. Pharm. **107** No. 3 (1935) 103–130.

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ILLUSTRATION

[Drawings by V. V. Marasigan and H. T. Castelo.]

PLATE 1

FIG. 1. Ephippial case in lateral position, showing reticulation and two eggs; about × 12.
2. First nymphal stage; about × 12.
3. Second nymphal stage; about × 12.
4. Third nymphal stage; about × 12.
5. Adult sexual mother moina, showing an ephippial case and eggs in the egg pouch; about × 12.
6. Parthenogenetic mother moina bearing parthenogenetic eggs in the egg pouch; about × 12.
7. Parthenogenetic mother moina with young about to be extruded and showing *se*, setæ; *cl*, claw; *ft*, feet; *ca*, carapace; *œ*, œsophagus; *ant*, antennule; *b*, brain; *e*, eyes; *ce*, cæcum; *an*, antenna; and *r*, ramus.
8. Postabdomen showing ten ciliated spines besides bident and a pair of claws with longitudinal laterally arranged rows of hairs; about × 47.
9. Male moina; about × 12.
10. Antennule showing the number of hooks, and two sensory setæ in the middle; about × 47.
11. First foot of a male; about × 23.

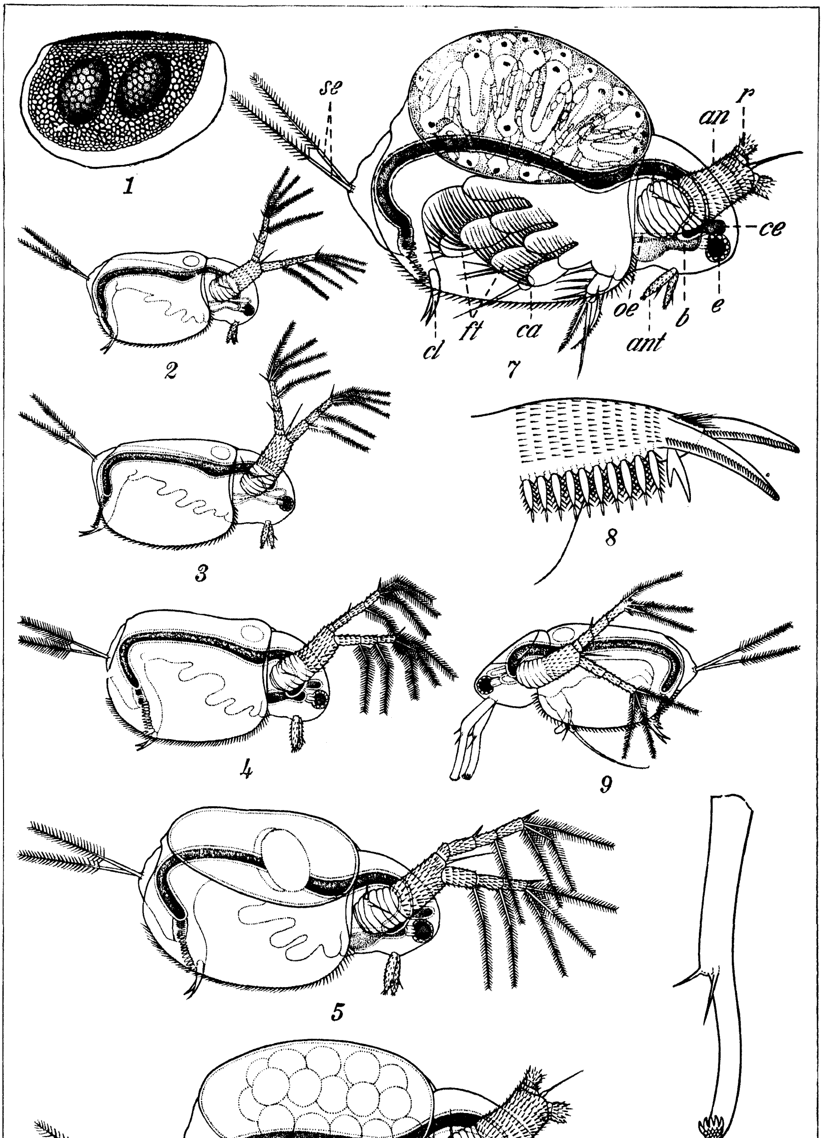

PLATE 1.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

AVERILL, L. A. Adolescence; a study in the teen years. Boston, Houghton Mifflin co., 1936. 496 pp. Price, $2.25.

BELSHAW, H. Recovery measures in New Zealand. Wellington, N. Z. Inst. of Pacific relations, 1936. 61 pp. Price, paper, $0.25.

The British plastic year book, 1937; the handbook and guide to the plastics industry. London, The Proprietors: Plastics press ltd., 1937. 602 pp., illus. Price, 15s.

CLARK, A. H. Crinoidea. [British museum (Natural history) John Murray expedition, 1933–34, Scientific reports, v. 4, no. 4.] London, Printed by order of the Trustees of the British museum, 1936. 22 pp., plate. Price, 2s.

COCKERELL, T. D. A. African bees of the genera Ceratina, Halictus, and Megachile. London, Printed by order of the Trustees of the British museum, 1937. 254 pp., illus. Price, 15s.

FUNK, CASIMIR, and H. E. DUBIN. Vitamin and mineral therapy; practical manual. New York, U. S. Vitamin corporation, 1936. 94 pp.

MARTINDALE, WILLIAM, and W. W. WESTCOTT. The Extra pharmacopœia. Vol. 1. 21st ed. rev. London, The Pharmaceutical press, 1936. 1182 pp. Price, 27s. 6d.

ROBERTS, HARRY. Euthanasia and other aspects of life and death. London, Constable & co. ltd., 1936. 278 pp. Price, 7s. 6d.

TALBOT, G. A monograph of the Pierine Genus Delias. Pt. VI. London, Printed by order of the Trustees of the British museum, 1937. 656 pp., plates. Price, £1.5s.

VATSYAYANA, MALLINAGA. Kama Sutra: the Hindu science of love. Tr. from the Sanskrit by Sir Richard Burton. The Doctor as marriage adviser, by Max Hodan. Introduction by H. H. Ewers. Illustrated by Mahlon Blaine. New York, The Medical press, 1936. 127 pp., illus. Price, $2.

WATERSTON, JAMES. Fleas as a menace to man and domestic animals. [British museum (Natural history) Economic ser. no. 3. 3d rev. ed.] London, Printed by order of the Trustees of the British museum, 1936. 20 pp., illus. Price, 4p.

WHEELER, J. F. G. Nemertea. [British museum (Natural history) John Murray expedition, 1933–34. Scientific reports, v. 4, no. 3.] London, Printed by order of the Trustees of the British museum, 1936. 8 pp., text figs. Price, 1s.

The Wine book of South Africa. Stellenbosch, South Africa, "Wine and Spirit" Publishers, 1936. 224 pp., tables, map. Price, 5s. 6d.

REVIEWS

Useful Drugs; a Selected List of Essential Drugs with Brief Discussions of Action, Uses, and Dosage. By Robert A. Hatcher. 10th ed. American medical association, Chicago, 1936. 240 pp.

The existence of a great number of drugs and their preparations prompted the American Medical Association to publish this volume which is now in its tenth edition since 1913. The list consists of a number of important drugs taken from the United States Pharmacopœia and from the New and Nonofficial Remedies which are known to posses established therapeutic value. The present edition, a thorough revision of the 1934 edition, is based on the United States Pharmacopœia XI and the New and Nonofficial Remedies, 1936.

The definitions, synonyms, properties, incompatibilities, action and uses, and dosage of drugs are treated in convenient form for ready reference.

The student as well as the practitioner will find this book very useful—P. V.

The Extra Pharmacopœia. By William Martindale. Vol. 1. 21st ed. rev. The Pharmaceutical press, London, 1936. 1182 pp. Price, 27s. 6d.

For the second time this valuable reference book is being published in two volumes by the Council of the Pharmaceutical Society of Great Britain. The present volume corresponds to the first part of this "comprehensive summary of the composition and applications of the multitude of old and new, official and proprietary substances about which the doctor or the pharmacist may require information." The physician can obtain from it the necessary information on compounds and preparations of wide use in therapeutics, whereas a general and practical knowledge of the constitution and properties of the chemical, animal and vegetable drugs generally encountered in the compounding and dispensing of medicines is made available to the pharmacist. The valuable notes on the composition of medicinal agents and the practical observations on the results of their application included in this reference are of particular interest to the clinicians.

The revision of the volume under review was carried out under the direction of C. E. Corfield, editor of the British Pharmaceutical Codex, H. Treves Brown, his research assistant, and S. L. Ward, the abstractor. This circumstance explains why the present "Extra Pharmacopœia" is considered a complementary volume to the British Pharmaceutical Codex.

The compilers of the present edition have not failed to examine the new pharmacopœias and formularies that were issued since the publication of the twentieth edition. Consequently they were enabled to bring the materials in line with the requirements of the United States Pharmacopœia XI, the Swiss Pharmacopœia V, the Danish Pharmacopœia, 1933, the addendum to the British Pharmacopœia, 1932, and the National Formulary VI, 1936, besides the British Pharmaceutical Codex, 1934.

One of the important features of the book is the inclusion of information relative to proprietary medicine as regards the name, the source of the article, and other data regarding the preparation. As stated in the preface "the inclusion of names of these proprietary forms of a drug is an important feature of the Extra Pharmacopœia, and provides practically the only concise information available to the doctor by which he can discover whether many of the so-called ethical proprietaries are new products of the research laboratory, or simply older chemicals or preparations making a new appearance in a modified form."

The obtention of the volume under review will certainly be an important addition to a medical and pharmaceutical library.—P. V.

Sex Education. By Maurice A. Bigelow. The American social hygiene association, New York, 1936. Rev. ed. 307 pp. Price, $1.

This book is well written and instructive for the general reader. It presents in simple language the problems of sex education, and the need for their clear understanding among teachers and parents especially. The problems of sex education, including that of who are desirable teachers and the dangers to be avoided, are clearly outlined. Besides sex instruction, it deals with special social problems which should be adequately and sanely met by young people. It is a worth while book for those interested in social conditions and for young people desiring guidance in their social life.—U. D. M.

Cancer Commission Committee Studies. By the California Medical Association. J. W. Stacey, Inc., San Francisco, California, 1936. 123 pp. Paper.

This is only a reprint of the series of studies, reports, conclusions, and recommendations which the above Commission has been publishing in California and Western Medicine during the past five years.

It deals with radiology, gynæcology, tumors, breast tumors, skin and mouth tumors, eye, ear, nose, and throat tumors, genito-urinary tumors, chest tumors, bone tumors, connective-tissue tumors and leukæmias, tumors of the central nervous system, gastro-intestinal tumors, cancer of the rectum, anus, or rectosigmoid, and thyroid tumors. There is an appendix on lymph glands in cancer of the lip, tongue, and mouth, and their treatment. Each group of tumors is the subject of a report of a separate committee. The conclusions and recommendations of the commission are fully orthodox and in line with the accepted views on the prophylaxis and treatment of cancer.—C. R.

Tumors of Bone (Including the Jaws and Joints). By C. F. Geschickter and M. M. Copeland. The American Journal of Cancer, New York City, 1936. Rev. ed. 817 pp., illus. Price, $6.

This is a monumental monograph on bone tumors, including the jaws and joints, written on material from the Department of Surgery of the Johns Hopkins Medical School. The text proper is presented in 25 chapters, the subject of each chapter being developed from the standpoint of clinical features, gross pathology, microscopic features, observations or variants, histogenesis, roentgenographic features, etiology, and prognosis, all of which are briefly summarized at the end and furnished with a bibliography. The various features are also presented in a condensed tabulated form.

The originality of the book makes a critical review somewhat difficult, but some of the authors' most important findings are:

Permanent cures in primary chondromyxosarcomas average about 12 per cent. The usual clinical course of the primary form is a fatal termination in the space of 20 months.

Permanent cures in the secondary chondromyxosarcomas average about 27 per cent. The disease runs from 6 to 8 years.

Permanent cures in sclerosing osteogenic sarcoma are obtained in approximately 25 per cent of patients. Prompt resection or amputation but not deep X-ray or radium therapy is advised. The diagnosis of all three of these conditions depends primarily upon the clinical picture rather than upon the X-ray.

An enlargement of the regional lymph nodes may occur with malign bone tumor but does not indicate metastases to these nodes. It is always a mistake to make a biopsy on the regional nodes for any type of bone lesion, unless metastatic involvement of the bone itself by cancer or by a malign node is suspected.

The great majority of permanent cures have resulted from resection or amputation, with or without pre- or post-operative irradiation. Biopsy, preceding resection or amputation by an interval of days, is not detrimental to cure. The element of risk involved in a properly performed biopsy of the bone which is followed in an interval of fourteen days or less by amputation is so small that one is justified in taking this risk and in sending the X-ray films and sections for consultation. Biopsy may unfavorably influence cure by the escape of fluid into the wound.

The most highly differentiated and the most curable form of bone sarcoma is the periosteal fibrosarcoma.

The foreword dealing with interpretation of clinical findings by Dr. Dean Lewis is very illuminating, as are the 22 rules on diagnostic and therapeutic procedure for bone lesions by Dr. Joseph Colt Bloodgood, which must be read in order to be appreciated; they deal with biopsy—when to and when not to perform it, irradiation, palpation, X-rays, search for infection everywhere, blood Wassermann, blood count, urine or Bence-Jones bodies, blood sugar, fever, blood chemistry, and metabolism test.—C. R.

Leçons de Physiologie Medico-Chirurgicale. By Leon Binet. Masson & Cie., Paris, 1935. 244 pp., plates, figs. Price, 40 fr.

This book contains the first series of weekly conferences given by the author since he assumed the chair of Physiology at the Faculty of Medicine at Paris, with the collaboration of other French clinicians, notably Jean Gosset and M. Kaplan. It includes a wide range of subjects, such as resuscitation, the physiopathology of arterial emboli, arterial atheroma, pneumothorax among the tuberculous, pathogeny and treatment of gastro duodenal ulcers, colibacillosis, syndrome and medical treatment of intestinal obstruction, acute hæmorrhagic pancreatitis, functional testing of the spleen, experimental therapy of acute nephritis, diseases of the spinal cord, the great painful syndromes about the face, spontaneous and artificial rickets, and the antirachitic substances, the thymus and sexual glands and the results of thymopotherapy, the biologic diagnosis of pregnancy, snake venoms, and oil injections. As is to be expected, the subjects are dealt with chiefly from the standpoint of applied physiology, and done in the lucid manner common to many French masters, they cannot fail to interest the physician who must ever keep himself close to the sources, among others, the physiologic background.—C. R.

The Surgical Technic of Abdominal Operations. By Julius L. Spivack. S. B. Debour, Chicago, 1936. 718 pp., illus., figs. Price, $10.

The surgical technic of abdominal surgery contained in one single volume affords medical students an easy and an ever-ready guide, doing away with the necessity of having to consult the usual set of several volumes in which abdominal surgery is only a part.

The chapter dealing with general surgical technic is very illuminating. The important anatomical points in the surgery of the different abdominal organs, with the additional historical background in the evolution and development of technic especially with reference to eminent researchers and surgeons, not only in America but also in continental Europe, is very scholarly, giving as it does to the reader a comprehensive grasp and understanding of the difficulties and shortcomings heretofore met with and the corresponding mistakes overcome and corrected in the introduction and presentation of better technic, together with the still considerable improvement remaining to be accomplished.

The different technics in abdominal surgery are of course found in standard sets, like Bickham; but in this volume they are more concise, with their presentation aided by classical pictures and sketches that drive home the points of simplicity, the minimum of effort on the part of the operator and his assistants, and the optimum of results.

Special mention should be made of the part on the surgery of the stomach, intestines, herniæ, and appendix, in which similar operations and technics are actually being carried out in the Department of Surgery of this Hospital.

The bibliography affords the reader a ready reference to old and new literature dealing with kindred topics.

In recapitulation, the surgical technic of abdominal operations contained in this book by Professor Spivack, a new man in the surgical world, is very useful to students and practitioners alike; to the student because of the accessibility in one copy of his limited library, and its concise and brief form without the danger of his being lost in a haze of intricate surgical elaborations; and to the practitioner for the review of the important steps in the operation he is about to perform. Instructors and professors of surgery, who always prefer to give the widest scope of lectures and demonstrations in teaching the regional surgery of the abdomen within the limited instructional time alloted them in the curricular course, should welcome this volume especially.

—B. R. D.

Spider Wonders of Australia. By Keith C. McKeown. Angus & Robertson Ltd., Sydney, 1936. 270 pp., illus., plates. Price, 6s.

This book is divided into 18 chapters. According to the preface, the author was induced to write the book in view of the many inquiries that have been received by the Australian Museum of Sydney about spiders. The epilogue deals with an ancient Greek maiden Arachne who because of the wrath of one of the gods was changed into a spider. From this Greek legendary character the name of the class Arachnida was derived.

In the introductory chapter the author has cleverly chosen examples of spiders the habits of which vividly portray to the reader "the strangeness of the spider world." He states that in Australia there are some 1,200 species known and that possibly as many remain to be described and classified. Due to popular ignorance and prejudice, spiders are persecuted and are killed unnecessarily. The author enters a plea of a kinder treatment of the majority of these curious, and, in the main, useful and interesting animals. Of the large number of species of spiders in Australia only three are definitely known to be poisonous to man, and this black list includes the so-called Redback or Jockey Spider, *Latrodectes hasselti,* which is also present in the Philippines.

In Chapters 2 to 15, inclusive, the author writes clearly and interestingly of the habits and ways of life of some of the curious spiders of Australia. In this work the author has largely drawn upon his notes and observations, extending over a number of years, for, as he points out in the preface, very little has been written about the habits of Australian spiders. Pertinent observations from the few scattered writings of previous authors are quoted.

The book is interesting reading from cover to cover. Although it is all about Australian spiders, yet the knowledge furnished therein should be of value to persons in other lands undertaking studies on spiders and their habits. The fact that the writer is a scientist, an entomologist who has previously published a similar book entitled, "Insect Wonders of Australia," increases the reader's faith in the accuracy of the observations recorded in this new book—F. Q. O.

THE PHILIPPINE JOURNAL OF SCIENCE

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RICHARD CRITTENDEN McGREGOR

BY CHARLES P. ALEXANDER

Of Amherst, Massachusetts

ONE PLATE

It is with the most profound regret and a feeling of irreparable loss that I have just heard of the death of Richard Crittenden McGregor.[1] I would ask to be permitted to write a little concerning the influence of McGregor in the development of our knowledge of the Tipulidæ of the Philippines. I have been in constant communication with him for more than a dozen years, and during that period have received from him scores of helpful and instructive letters.

Our earliest knowledge of the Philippine Tipulidæ had been derived from the fragmentary collections made by Carl Semper (1859–1864), later discussed by Osten Sacken (1882). Still later, the intermediate collections made by G. Boettcher (1913–1918) and Charles Fuller Baker (1912–1926) had been studied and discussed by Bezzi (1917), Edwards (1926), and the pres-

[1] McGregor was closely associated with the Philippine Journal of Science already at the time this publication replaced the Publications of the Bureau of Government Laboratories in 1906. Volume 1, published in 1906, already contains results of his work on Philippine birds. In 1908 he became officially connected with it in an editorial capacity. From that time on more and more of the editorial details devolved upon him, a fact that was given official recognition in 1919, when he was named Associate Editor. With the reorganization of the Department of Agriculture and Natural Resources into the Department of Agriculture and Commerce, in 1933, he became Chief of the Division of Publications, and from that time until his death, December 30, 1936, he was Managing Editor of the Philippine Journal of Science.—EDITOR.

ent writer (Alexander, 1922–1927). The sum total of all of the above efforts had produced a list of the crane flies of the Islands that obviously was still fragmentary.

About 1924[2] I began corresponding with McGregor and thenceforth received his fullest coöperation in making known the involved tipulid fauna of the Philippines. In the earlier years, while he was still actively engaged in field work connected with his bird studies, he visited certain of the more remote islands of the Archipelago, as Samar and Palawan, and at these times collected a number of interesting Tipulidæ. Thereafter, his increasing duties in conjunction with the editing of the publications of the Bureau of Science restricted his time available for field work. However, during the period between 1928 and 1930, he, with his active and highly efficient coworkers, A. C. Duyag, A. Celestino, and Francisco Rivera, was able to spend various week ends and short vacations away from the heat of Manila in a little house located at Ube, above Majayjay, on the slopes of Mount Banahao in Laguna Province. Several of our most interesting Luzon Tipulidæ were discovered at these times, some of which have never been taken elsewhere in the succeeding years. His enthusiasm inspired Duyag (Benguet, Novaliches; Tablas; Sibuyan; Mindanao) and more especially Rivera (Mountain Province, Cagayan, Tayabas; Tablas; Sibuyan; Mindanao) to continue the collecting of these flies over a period of many years (1924–1934). Between 1930 and 1932 my former student at the Massachusetts State College, Mr. Charles F. Clagg, likewise collected numerous insect specimens in the Philippines (Luzon and Mindanao), and the friendly interest and advice of McGregor proved to be of the greatest value in the success of this undertaking. During October, 1931, Messrs. Clagg and Rivera conducted a very successful joint expedition into the Mountain Province. The total result of all these trips and expeditions was some hundreds of species of Tipulidæ, the majority of which proved to be undescribed and were characterized in the present publication. The following new generic and specific groups were named in honor of McGregor: *Macgregoromyia* Alexander (1929); *Pselliophora mcgregori* Alexander (1925), *Styringomyia mcgregori* Alexander (1925), *Trentepohlia (Trentepohlia) mcgregori* Alexander (1927), and *Trentepohlia (Mongoma) ricardi* Alexander (1930).

[2] Philip. Journ. Sci. 27 (1925) 71–81.

During the past fifteen years I have published in the Philippine Journal of Science more than fifty reports on the Tipulidæ of the Philippines and elsewhere in eastern Asia. I regard this series of papers as being unquestionably the most valuable and important single study that I have made and can unhesitatingly affirm that little of this could have been accomplished had it not been for the friendly interest of my dear friend. The letters from McGregor before me are filled with encouragement and suggestions for the continuance of the work. Constantly he was striving to make available more material for this study. The efficient editing and beautiful publication of the Journal must always remain a monument to him, since it stands unexcelled among the scientific journals of the world. How much of the success of this publication has been due to the faithful efforts of our friend will be fully appreciated by all who have labored with him.

During more recent years his duties as Chief of the Publications Division of the Department of Agriculture and Commerce had more and more confined him to Manila, even during periods when it would have been far better for his health and morale if he could have gotten away to Ube or to Baguio for a time. His letters during this period often contain a somewhat wistful expression of desire to spend a holiday in the Mountain Province or to be able to soon retire to his little property near the city, hopes that were never to be realized when the end came so suddenly. Our dear friend has gone, but his influence on science in the Philippines and elsewhere must long endure. In my own instance, I wish to place on record this sense of deep indebtedness to Richard Crittenden McGregor for his helpful coöperation over many years. I shall always regard him as one of the truest friends I have ever had.

ILLUSTRATION

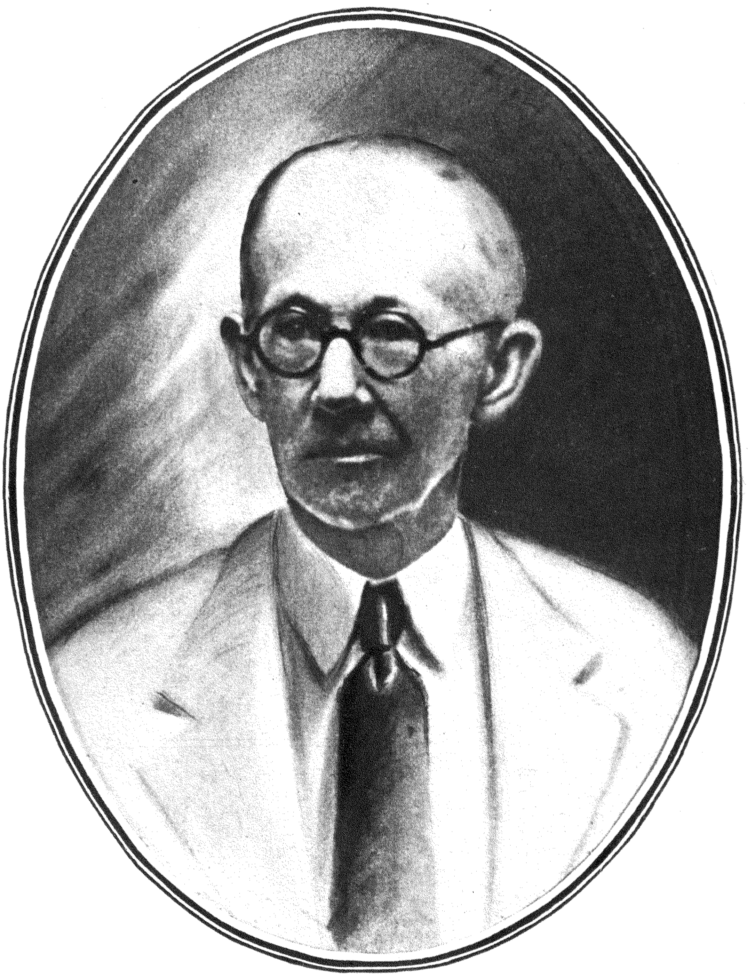

PLATE 1.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXXV [1]

By Charles P. Alexander

Of Amherst, Massachusetts

THREE PLATES

Virtually all of the species discussed in the present report are from southeastern China, where they were collected in 1936 by Mr. J. Linsley Gressitt. A few additional species are from Java, collected by Mrs. M. E. Walsh. I am very greatly indebted to Mr. Gressitt and to Mrs. Walsh for the privilege of retaining the materials in my collection of crane flies.

Our knowledge of the distribution of the Tipulidæ in eastern China is still so fragmentary that I am supplying records of many of the species. Several of these had been known hitherto only from Formosa, while still others had been recorded only from the mountains of Szechwan, western China. I am indebted to Mr. Gressitt for the following notes on the stations in southeastern China, where collections of Tipulidæ were made in 1936.

Kwangtung Province.

Mei-hsien (Kaying, Moejen). Altitude 715 feet (May 29 to June 1; June 7 to 10, and 17 to 20; July 28 to 30). Fairly large city in eastern Kwangtung, about equidistant from Kiangsi and Fukien boundaries, located on the Mei River, a branch of the Han River. Environs largely grassy or cultivated; scattered pines on the hills; valleys with native fruit trees, banyans, bamboos, and others.

Tai-yong. Altitude 2,090 feet (August 2 to 7). Small summer resort in eastern Kwangtung, about 80 kilometers west-northwest of Swatow, northwest of Wu-king-fu, in a cultivated mountain valley, encircled by partly wooded mountains.

Tsin-leong-san (Clear Cool Mountain). Altitude 2,750 feet (June 1 to 7). Small mountain resort in Mei-hsien district, about 18 kilometers south-southwest of Mei-hsien city, located near the summit (3,120 feet) of the range. Mountain partly

[1] Contribution from the Department of Entomology, Massachusetts State College.

grassy, partly with dense shrubbery, low forests, *Cunninghamia,* small swamps, or cultivated tea.

Yim-na-san (Yam-na-shan). Collections at 1,800 feet; summit 4,225 feet (June 10 to 17). Sacred mountain in Mei-hsien district, eastern Kwangtung, about 40 kilometers northeast of Mei-hsien City. Dense forests in canyons and behind monastery; ridges grassy, with *Pinus; Cryptomeria* before Monastery.

KIANGSI PROVINCE.

Hong San. Altitude 5,100 feet (June 21 to July 1; July 14 to 17). Probably the highest mountain (5,200 feet) in regions visited. Located in southeastern corner of Kiangsi, east of Sungwu, very near the Kwangtung and Fukien borders. Densely forested on upper slopes; rice fields in valleys on either side. First half of first visit spent at village (altitude 2,115 feet) in enclosed valley at foot of west side, collecting up side; remainder spent in hut at edge of jungle on south side (altitude 3,100 feet). Second visit spent on east side of pass at north end of mountain.

Tai-au-hong. Altitude 1,750 feet (July 3 to 8). Group of small hamlets in small valley in southeastern Kiangsi, near Kwangtung border, below pass in range. Canyons with fairly dense forest in part; much *Cunninghamia*-lumbered; ridges grassy.

Wong-sa-shue. Altitude 1,900 feet (July 8 to 12). Small village between Sungwu and Tai-au-hong, in southeastern Kiangsi. Collecting done on forested slopes of Ng-tze-san, above and below a small shrine, from foot (1,600 feet) to summit (3,175 feet). Dense jungles; conifers on upper parts; tea cultivated; tigers present.

FUKIEN PROVINCE.

Gang-keu. Altitude 1,900 feet (July 22 to 28). Small village in southwestern Fukien, south of Shanghang and between Liung-chon-san and Ngam-chen. At the edge of a flattish valley and at the foot of a steeply rising range, part of the Leong San system. Mountain side and narrow canyons, largely with dense jungle, with trails. Pythons reported as frequent; tigers occasional.

Liung-chon-san. Altitude 2,525 feet (July 20 to 22, and 27). Small range in the Leong San system, 25 kilometers south of Shanghang, in southwestern Fukien. Summit about 3,400 feet, largely unforested; lower slopes with groves of bamboo, *Pinus* and *Cunninghamia,* with mixed forests or bushy areas in parts.

PTYCHOPTERIDÆ

PTYCHOPTERA BELLULA sp. nov. Plate 1, fig. 1.

General coloration black; halteres black, the base of stem restrictedly yellow; femora yellow, the tips narrowly and insensibly darkened; wings subhyaline, heavily patterned with brown; Rs long, about three-fifths the length of R_{4+5}; abdomen black, the proximal ends of the basal tergites yellow, most conspicuous on segment four.

Male.—Length, about 6.5 millimeters; wing, 6.2; antenna, about 3.

Female.—Length, about 7 to 7.2 millimeters; wing, 6.3 to 6.5.

Rostrum yellow; basal segment of palpi brownish yellow, the outer segments dark brown, the elongate terminal segment paler basally than at outer end. Antennæ of male of moderate length, as shown by the measurements; scape and pedicel (male) yellow, of female brownish black; basal segment of flagellum yellow, succeeding segments dark brown; in the female the antennæ are shorter. Head polished black; anterior vertex wide.

Thorax black, the dorsopleural membrane buffy. Halteres black, the base of stem restrictedly yellow. Legs with the coxæ and trochanters yellow; femora yellow, the tips narrowly and insensibly darkened, more extensively so on the forelegs; tibiæ yellowish brown to brown; tarsi brownish black. Wings (Plate 1, fig. 1) subhyaline, heavily patterned with brown, as follows: A major area in bases of cells R and M; a large quadrate area at origin of Rs; a broad band at cord, extending from R to the bend in the distal section of Cu_1, a broad band across outer forks, extending from costa to beyond the fork of M_{1+2}; an oval area at near midlength of vein M_3; wing tip paler brown; in cases, the dark area at cord confluent with that at origin of Rs; veins brown, slightly darker in the clouded areas. Macrotrichia of cells abundant, indicated in the figure by stippling. Venation: Rs long, about three-fifths R_{4+5}; fork of M_{1+2} about one-half as deep as that of vein R_{4+5}.

Abdominal tergites black, in the male with bases of segments two to four yellow, becoming more extensive on the outer segments, especially the fourth; in the female, abdomen chiefly darkened, except for the basal half of the fourth segment; outer segments, including hypopygium, black, the appendages of the latter a little paler; basal sternites yellow, the subterminal segments black.

Habitat.—China (Kiangsi).

Holotype, male, Hong San, altitude 2,925 feet, June 30, 1936 (*Gressitt*). Allotopotype, female, altitude 3,000 feet, June 28, 1936. Paratopotypes, 2 females, altitude 3,000 to 3,160 feet, June 27 to 28, 1936.

Ptychoptera bellula is very different from the other described regional species having Rs elongate, such as *P. clitellaria* Alexander, of western China, and *P. daimio* Alexander, of northern Japan, especially in the small size and conspicuous wing pattern. In the latter respect, the present fly somewhat resembles *P. japonica* Alexander, of Japan, but is readily told by the short antennæ and venation, as the length of Rs.

PTYCHOPTERA JAVENSIS sp. nov. Plate 1, fig. 2.

Head deep blue; mesonotal præscutum opalescent, the ground color black with three light castaneous stripes; scutellum black; postnotum and pleura uniformly reddish yellow; femora yellow, the tips very narrowly and abruptly black; wings pale yellowish subhyaline, with narrow brown bands at cord and across the outer forks; Rs short, less than r-m; abdomen yellow, the tergites narrowly ringed caudally with brownish black; hypopygium large and complicated, yellow.

Male.—Length, about 9 millimeters; wing, 8.5; antenna, about 5.5.

Rostrum brownish yellow; palpi pale brown, the outer segments dark brown. Antennæ of male relatively elongate, exceeding one-half the length of body; scape, pedicel, and base of first flagellar segment, yellow, the remainder of organ black; flagellar segments long-cylindrical, with a short dense pubescence and relatively short, unilaterally arranged, black verticils. Head deep blue.

Mesonotal præscutum opalescent, the ground color black, the three usual stripes light castaneous, the laterals confluent with the similarly colored scutal lobes; scutellum small, black; mediotergite entirely light castaneous brown to obscure reddish yellow. Pleura and pleurotergite uniformly reddish yellow. Halteres blackened, the base of stem restrictedly yellow. Legs with the coxæ and trochanters yellow; femora yellow, the tips very narrowly but abruptly black, the amount subequal on all legs; tibiæ and basitarsi testaceous-yellow, the tips narrowly darkened, especially of the latter; remainder of tarsi black. Wings (Plate 1, fig. 2) pale yellowish subhyaline, the prearcular and costal regions deeper yellow; a narrow brown crossband along cord, extending from R to the bend of the distal section of Cu_1; a second band across the outer forks, from R_2 to beyond midlength of vein M_2; wing tip in outer radial field restrictedly and vaguely darkened; veins dark, yellow in the flavous areas, including the basal portions of veins Cu_1 and Cu_2. Abundant macrotrichia in outer cells (indicated in the figure by stippling), in outer end of cell R and basal half of cell R_5 appearing as a linear series at near midwidth of the cells. Venation: Rs short, less than r-m.

Abdomen yellow, the tergites narrowly ringed caudally with brownish black; subterminal segments more uniformly blackened; hypopygium yellow, large, and very complicated in a structure.

Habitat.—East Java.

Holotype, male, Soember Brantas, Mount Ardjano, altitude 6,000 feet, January 1936 (*Walsh*).

Ptychoptera javensis is most closely allied to *P. annandalei* Brunetti, of Burma, *P. formosensis* Alexander, of Formosa, and *P. sumatrensis* Alexander, of southern Sumatra, differing from all in the coloration of the body and in the structure of the male hypopygium. The species is of unusual interest in that it adds the family Ptychopteridæ to the known dipterous fauna of Java and in that it provides the most easterly record of any species in Asia. Whether any member of the family will be found to the east of Wallace's Line, in Wallacea or Australasia, remains in question.

TIPULIDÆ

TIPULINÆ

DOLICHOPEZA (SINOROPEZA) PAUCISETOSA sp. nov. Plate 1, fig. 3.

General coloration brownish black to black, the præscutum with three polished, more brown, stripes; wings with a strong brown tinge, cells C and Sc a little darker; stigma dark brown; very sparse macrotrichia in extreme outer ends of cells R_3 and R_5; Sc_2 ending about opposite fork of the short oblique Rs; abdomen, including genitalia, black.

Female.—Length, about 9 millimeters; wing, 12 to 12.2.

Rostrum brownish black; palpi black. Antennæ with scape and pedicel brownish yellow; flagellum black; flagellar segments cylindrical, with short inconspicuous verticils. Head brownish black; anterior vertex wide.

Mesonotum almost uniformly black or brownish black, the præscutum with three polished, more brownish, stripes; disc of mediotergite with long, coarse, black setæ. Pleura brownish black. Halteres black, the stem a trifle paler. Legs long and slender, black throughout. Wings (Plate 1, fig. 3) with a strong brown tinge, cells C and Sc a trifle darker; stigma long-oval, dark brown; cord, extreme wing tip, and certain of the longitudinal veins narrowly and vaguely seamed with brown; veins dark. Very sparse macrotrichia in outer ends of cells R_3 and R_5 (shown in the figure by stippling). Venation: Sc_2 ending about opposite the fork of the short oblique Rs; free tip of Sc_2 lying some distance before the short spur of vein R_{1+2}; R_1 in direct longitudinal alignment with $Sc_2 + R_1$; petiole of cell M_1 a little shorter than that of cell M_2.

Abdomen, including the genitalia, black. Ovipositor with the valves fleshy and obtuse, with long setæ.

Habitat.—China (Kiangsi).

Holotype, female, Hong San, altitude 3,160 feet, June 27, 1936 (*Gressitt*). Paratopotype, female, altitude 3,150 feet, June 27, 1936.

The only other species of the subgenus having macrotrichia in the cells of the wing is the subgenotype, *Dolichopeza (Sinoropeza) pluricoma* Alexander, of western China. This differs conspicuously in the smaller size, distinct wing pattern, and coloration of the legs, and in the abundant macrotrichia in the outer cells of the wing. In this latter species Rs is longer, less transverse, and about one-half as long as vein R_{2+3}; in the present fly Rs is very short, not exceeding one-third the length of R_{2+3}.

DOLICHOPEZA (NESOPEZA) FABELLA sp. nov. Plate 1, fig. 4.

General coloration of mesonotum dark brown; pleura chiefly testaceous-yellow, the pleurotergite and ventral pleurites darkened; femora brownish yellow, tibiæ and tarsi white; wings tinged with brownish, the tip darker; stigma oval, dark brown, preceded and followed by extensive whitish areas; restricted macrotrichia in cells R_3 to 2d M_2 inclusive; Rs longer than m-cu; abdomen dark brown, tergite two with a conspicuous white area on sides at near midlength; sternites brownish black, narrowly ringed with whitish.

Sex?—Wing, 7 millimeters.

Rostrum and palpi dark. Antennæ elongate, if bent backward extending to opposite the end of the second abdominal segment or beyond scape, pedicel and base of first flagellar segment brownish yellow, the remainder of organ brownish black; flagellar segments long-cylindrical, with coarse erect setæ but without conspicuous longer differentiated verticils; from the length of the antennæ it seems virtually certain that the type is a male. Head brown, the center of vertex with a narrow darker vitta; anterior vertex wide.

Mesonotum uniformly dark brown, without markings, only the humeral region of præscutum vaguely brightened. Pleura chiefly testaceous-yellow, the propleura, ventral sternopleurite, and meron abruptly dark brown; pleurotergite dark. Halteres elongate, dark brown, the base of stem restrictedly pale. Legs with the fore coxæ darkened, remaining coxæ and all trochanters yellow; femora brownish yellow, the tips very narrowly to scarcely darkened; tibiæ snowy white, the tips very narrowly darkened; tarsi white. Wings (Plate 1, fig. 4) with a weak brown tinge, the tip darker; stigma oval, dark brown, preceded and followed by extensive whitish areas; cord vaguely clouded with darker; veins dark brown. Restricted macrotrichia in cells at wing tip, including R_3 to 2d M_2. Venation: Sc_2 ending just before fork of Rs; free tip of Sc_2 a short distance before level of R_2 but with no trace of R_{1+2}; Rs arcuated, longer than R_{2+3}; vein M before m-cu strongly arcuated; m-cu more than one-half its length before the fork of M; cell 2d A narrow.

Abdomen broken at midlength; dark brown, tergite 2 with a conspicuous whitened area on sides at near midlength; basal sternites brownish black, narrowly ringed with whitish.

Habitat.—China (Kwangtung).

Holotype, Sex?, Tai-yong, altitude 2,075 feet, August 6, 1936 (*Gressitt*).

The nearest described ally of the present fly is *Dolichopeza* (*Nesopeza*) *pallidithorax* de Meijere (Java), which is similarly a small species having macrotrichia in the distal wing cells. The present fly differs in the coloration of the body and legs and in the details of venation, as the shorter, more arcuated Rs and the position of m-cu closer to the fork of M.

LIMONIINÆ

LIMONIINI

LIMONIA (DICRANOMYIA) PACIFERA sp. nov. Plate 1, fig. 5; Plate 2, fig. 25.

Belongs to the *morio* group; size very small (wing, male, 4 millimeters or less); abdomen bicolorous, the segments brownish black basally, with narrower yellow caudal margins; male hypopygium with the tergal lobes broad; apex of dorsal dististyle simple and acute; ventral dististyle compressed, mitten-shaped; mesal-apical lobe of gonapophysis short and stout.

Male.—Length, about 3.5 millimeters; wing, 3.8 to 4.

Female.—Length, about 4 to 5 millimeters; wing, 4 to 5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, strongly narrowed to short-petiolate at the distal end, the verticils considerably longer than the segments. Front and anterior vertex brilliant silvery white; posterior portions of head black; anterior vertex broad, exceeding three times the diameter of the scape.

Pronotum black, heavily light gray pruinose. Mesonotum polished black, the median area of scutum and base of scutellum weakly dusted. Pleura heavily dusted with gray, the sternopleurite polished black. Halteres with the stem obscure yellow, the knob black. Legs with the fore and middle coxæ black, posterior coxæ obscure yellow; trochanters yellow; femora brown, the fore pair darker, brownish black; tibiæ brown; tarsi passing into black. Wings (Plate 1, fig. 5) with a strong brownish tinge, the prearcular and costal portions somewhat more yellowish, best indicated by a brightening of the veins in these fields; stigma oval, darker brown than the ground; veins brown, except as above indicated. Venation: Sc_1 ending opposite or just before origin of Rs, Sc_2 far from its tip; free tip of Sc_2 opposite R_2, or as figured for the holotype specimen, lying a short distance proximad and with a short spur of R_{1+2} preserved; m-cu oblique, at or close to fork of M.

Abdomen chiefly bicolorous, yellow, the bases of the segments extensively brownish black, broader and more extensive on the intermediate segments; hypopygium of male and subterminal segments in female black. Male hypopygium (Plate 2, fig. 25) with the tergite, *9t*, deeply emarginate, the lateral lobes broad, only a little narrower than the median notch; apices of lobes with long coarse setæ. Dorsal dististyle, *dd*, with the apex simple, acute. Ventral dististyle, *vd*, small, compressed, mitten-shaped, gradually narrowed to the apex; in the unique male, on slide mount, there appears to be a small peglike spine on outer margin before apex (as figured). Gonapophysis, *g*, with mesal-apical lobe blackened, short and stout.

Habitat.—China (Kwangtung, Kiangsi).

Holotype, male, Tsin-leong-san, Kwangtung, altitude 2,750 feet, June 6, 1936 (*Gressitt*). Allotype, female, Hong San, Kiangsi, altitude 3,400 feet, June 29, 1936. Paratopotype, female, with the holotype, altitude 2,800 feet, June 5, 1936.

This fly is readily told from other described members of the *morio* group by the small size and structure of the male hypopygium, especially the broad tergal lobes, simple apex of the dorsal dististyle and short apical lobe of gonapophysis. As indicated, I am not entirely certain that a rostral spine is present; if so, it is much smaller than usual and lies far distad.

LIMONIA (DICRANOMYIA) DEPAUPERATA (Alexander).

Dicranomyia depauperata ALEXANDER, Entomological Magazine, Kyoto, Japan 3 (1919) 122.

Wide-spread in eastern Asia. Hong San, Kiangsi, altitude 5,000 feet, June 23, 1936 (*Gressitt*). In different specimens from various parts of the range of this fly there is some variation in the relative lengths of the rostral spines of the male hypopygium.

LIMONIA (DICRANOMYIA) SORDIDA (Brunetti).

Dicranomyia sordida BRUNETTI, Fauna Brit. India, Dipt. Nematocera (1912) 382–384.

Widely distributed in southern and eastern Asia. Males and females, Tsin-leong-san, Kwangtung, altitude 2,115 to 2,750 feet, June 3 and 4, 1936 (*Gressitt*). Hong San, Kiangsi, altitude 3,400 to 3,500 feet, June 29, 1936 (*Gressitt*).

LIMONIA (DICRANOMYIA) FULLAWAYI (Alexander).

Dicranomyia fullawayi ALEXANDER, Canad. Ent. 47 (1915) 79, 80.

Widely distributed in eastern Asia, as far west as Szechwan, western China. Males, Hong San, Kiangsi, altitude 2,500 feet, July 15, 1936 (*Gressitt*).

LIMONIA (DICRANOMYIA) RECTIDENS Alexander.

Limonia (*Dicranomyia*) *rectidens* ALEXANDER, Philip. Journ. Sci. 54 (1934) 323, 324.

Known hitherto only from western China. One male, Hong San, Kiangsi, altitude 2,750 feet, June 24, 1936 (*Gressitt*).

LIMONIA (THRYPTICOMYIA) UNISETOSA Alexander.

Thrypticomyia arcuata ALEXANDER, Trans. American Ent. Soc. 46 (1920) 4 (name preoccupied).

Limonia (*Thrypticomyia*) *unisetosa* ALEXANDER, Philip. Journ. Sci. 40 (1929) 248.

Widely distributed in Japan and Formosa. One male, Yimna-san, Kwangtung, altitude 1,800 feet, June 14, 1936 (*Gressitt*).

LIMONIA (EUGLOCHINA) DIGNITOSA Alexander.

Limonia (Euglochina) dignitosa ALEXANDER, Philip. Journ. Sci. 44 (1931) 351.

Known only from Szechwan, western China. One male, Tai-au-hong, Kiangsi, altitude 1,725 feet, July 6, 1936 (*Gressitt*). One female, Hong San, Kiangsi, altitude 3,500 feet, June 29, 1936 (*Gressitt*).

Differs from the type material chiefly in the shorter, more quadrate cell 1st M_2. In all specimens vein Cu_2 is well-preserved, approximately equal in length to vein Sc.

LIMONIA (ALEXANDRIARIA) ATAYAL Alexander.

Limonia (Alexandriaria) atayal ALEXANDER, Philip. Journ. Sci. 40 (1929) 529.

Described from Formosa. One female, Liung-chon-san, Fukien, altitude 2,550 feet, July 20, 1936 (Gressitt).

LIMONIA (RHIPIDIA) TRIARMATA Alexander.

Limonia (Rhipidia) triarmata ALEXANDER, Philip. Journ. Sci. 43 (1930) 514, 515.

Known from Formosa and western China. Males and females, Hong San, Kiangsi, altitude 3,400 feet, June 29, 1936 (*Gressitt*).

LIMONIA (GERANOMYIA) SPARSIGUTTATA sp. nov. Plate 1, fig. 6; Plate 2, fig. 26.

General coloration brown, the præscutum with three somewhat darker stripes; pleura yellow, with an ill-defined brown longitudinal stripe; wings weakly tinged with gray, sparsely patterned with brown, including very small spots at the supernumerary crossvein in cell Sc, origin of Rs and fork of Sc; larger clouds at stigma and tip of vein R_3; cell 1st M_2 subequal in length to longest vein beyond it; m-cu shortly before fork of M; male hypopygium with the rostral spines of ventral dististyle short, straight, arising from a common tubercle.

Male.—Length, excluding rostrum, about 4.3 millimeters; wing, 5; rostrum, 2.

Rostrum about one-half the length of body, brownish black. Antennæ with scape and pedicel black; flagellum broken. Head black; posterior vertex with a narrow median silvery vitta.

Pronotum yellow, darkened laterally. Mesonotal præscutum with a broad, central, medium brown stripe and less distinct lateral vittæ, these stripes faintly differentiated by very slightly darker posterior interspaces; median stripe narrower at anterior end than behind, on its cephalic margin with indications of a capillary dark vitta; scutum testaceous medially, the lobes brown; scutellum brown, the caudal margin slightly yellow; a very delicate, median, dark vitta occupies the scutum and base of scutellum; postnotum darker brown, the mediotergite with a very sparse bloom. Pleura yellow, with an ill-defined brown longitudinal stripe extending from the cervical region to the base of abdomen, becoming wider on the pleurotergite. Halteres darkened, the base of stem yellow. Legs with the coxæ and trochanters yellow; remainder of legs brown, darker outwardly. Wings (Plate 1, fig. 6) with a weak grayish tinge, very sparsely patterned with pale brown, including the stigma; very small spots at the supernumerary crossvein in cell Sc, origin of Rs, fork of Sc, and tip of vein R_3; posterior cord and outer end of cell 1st M_2 very narrowly and insensibly seamed; veins pale brown. Venation: Sc long, Sc_1 ending only a short distance before outer end of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 long, equal to vein M_{1+2} beyond it; m-cu a short distance before fork of M.

Abdominal tergites dark brown; basal sternites light yellow. Male hypopygium (Plate 2, fig. 26) with the caudal margin of the tergite, *9t*, gently emarginate. Ventral dististyle, *vd*, elongate, much more extensive than the basistyle, *b*; rostral prolongation unusually short and deep, with two short straight spines arising from a small common tubercle, one from the summit, the other near the base of tubercle. Gonapophysis, *g*, with mesal-apical lobe acute at tip, the lateral margin microscopically serrulate.

Habitat.—China (Fukien).

Holotype, male, Liung-chon-san, altitude 2,550 feet, July 21, 1936 (*Gressitt*).

Limonia (*Geranomyia*) *sparsiguttata* is most closely related to *L.* (*G.*) *kiangsiana* Alexander (northern Kiangsi, China), differing especially in the coloration of the body and wings and in the details of structure of the male hypopygium, as the beak of the rostral prolongation.

LIMONIA (GERANOMYIA) SPECTATA sp. nov. Plate 1, fig. 7.

General coloration of mesonotum plumbeous-gray, the posterior interspaces of præscutum and the scutal lobes with more blackish lines; femora dark brown, the bases and tips restrictedly paler; wings with a brown tinge, restrictedly patterned with darker brown, including a series of five costal areas; dark spot at fork of Sc close to that at origin of Rs, the distance between the two not much greater than the diameter of either; Sc relatively short, Sc_1 ending nearly opposite midlength of Rs; cell 2d A of moderate width.

Female.—Length, excluding rostrum, about 7 millimeters; wing, 7; rostrum, about 2.8.

Rostrum black, relatively short. Antennæ black throughout; flagellar segments subglobular to short-oval, with inconspicuous verticils. Head blackish, variegated medially with gray.

Mesonotal præscutum almost uniform plumbeous-gray, with scarcely evident markings; in certain lights the posterior interspaces appear as slightly blackened lines, as in *atrostriata* and *kiangsiana*; scutum similarly plumbeous, each lobe with a linear black line near mesal edge and a shorter dark dash near lateral portion; posterior sclerites of notum dark plumbeous-gray, the ventral sclerites a little paler. Halteres with stem brownish yellow, the knob darker. Legs with the coxæ and trochanters obscure yellow; femora dark brown, the bases restrictedly obscure yellow, the tips narrowly and vaguely pale; tibiæ and tarsi brownish yellow, the outer tarsal segments darker. Wings (Plate 1, fig. 7) with a brownish tinge, restrictedly patterned with darker brown, as follows: Supernumerary crossvein in cell Sc; origin of Rs and fork of Sc; stigma and end of vein R_3; cord and outer end of cell 1st M_2 more narrowly seamed with brown; dark areas in costal cell more distinct than in *subradialis*, that at fork of Sc closer to Rs than to the stigma; veins pale brown, somewhat darker in the clouded areas. Venation: Sc relatively short, Sc_1 ending opposite or just beyond midlength of Rs; cell 1st M_2 about equal in length to vein M_{1+2} beyond it; m-cu at fork of M; cell 2d A of moderate width.

Abdomen dark brown, sparsely pruinose; caudal margins of the intermediate tergites vaguely paler.

Habitat.—China (Kwangtung).

Holotype, female, Tsin-leong-san, altitude 2,750 feet, June 3, 1936 (*Gressitt*).

The nearest allied species is *Limonia* (*Geranomyia*) *kiangsiana* Alexander (northern Kiangsi, China), which is generally similar in coloration of the body and wings, differing in the venation and arrangement of the dark costal areas, with the spot at fork of Sc lying farther distad, shortly before the outer end of Rs.

LIMONIA (GERANOMYIA) FREMIDA sp. nov.

General coloration of præscutum reddish, with three conspicuous brownish black stripes, the interspaces pale; head brownish black, the front and vertex with a narrow silvery median vitta; femora obscure yellow to brownish yellow; wings pale yellow, with brown areas, including about six costal markings; base of cell R darkened; conspicuous dark seams along cord and outer end of cell 1st M_2; m-cu at fork of M; cell 1st M_2 somewhat longer than vein M_{1+2} beyond it; abdomen with intermediate tergites brownish yellow, the outer segments darker.

Female.—Length, excluding rostrum, about 8 millimeters; wing, 7; rostrum, about 3.

Rostrum black, the divergent tips of the labial palpi short. Antennæ black, the scape brown, sparsely pruinose; flagellar segments oval to subcylindrical, with inconspicuous verticils. Head with front, anterior vertex, and a narrow median vitta on posterior vertex silvery, the remainder of posterior vertex brownish black.

Pronotum dark brown, the scutellum obscure yellow medially. Mesonotal præscutum with the ground color reddish, with three conspicuous brownish black stripes, the median one narrow and nearly obsolete in front, becoming obsolete before suture; interspaces of the ground color; scutal lobes brownish black, the remainder of scutum obscure reddish brown; scutellum reddish brown, darker medially at base; postnotum brownish black, heavily gray pruinose. Pleura chiefly obscure brownish yellow, the dorsal and posterior pleurites somewhat darker. Halteres with a weak tinge, the base of stem restrictedly pale. Legs with the coxæ and trochanters pale yellow; femora obscure yellow to brownish yellow; tibiæ and tarsi pale brown to darker brown, the outer segments of the latter black. Wings with the ground color pale yellow, rather heavily variegated with brown, as follows: about six costal and subcostal areas, the first near arculus in cell Sc and base of R; second at supernumerary crossvein in cell Sc, large and circular in outlines, reaching the costal vein in front and nearly to vein M behind; third area at origin of Rs, extending from vein C almost to vein M, somewhat wider behind; fourth area at fork of Sc; fifth area stigmal; sixth marking at end of vein R_3; broad dark seams along cord and outer end of cell 1st M_2; a small spot near basal third of cell R_3 immediately behind the stigma and a small interpolated area in cell C between the second and third major costal darkenings; veins yellowish brown, darker in the clouded areas. Venation: Sc_1 ending about opposite three-fourths the length of Rs, Sc_2 at its tip; m-cu at fork of M; cell 1st M_2 somewhat longer than vein M_{1+2} beyond it.

Abdomen with the basal segment dark brown, the succeeding tergites brownish yellow, at near midlength of the organ passing into dark brown; basal sternites yellow, darker on sides; subterminal segments dark.

Habitat.—China (Kwangtung).

Holotype, female, Tsin-leong-san, altitude 2,750 feet, June 3, 1936 (*Gressitt*).

Limonia (*Geranomyia*) *fremida* somewhat resembles *L.* (*G.*) *subradialis* sp. nov., differing in the pattern of the wings and general coloration of the body. The wing pattern is much as in *L.* (*G.*) *spectata* sp. nov., but the coloration of the thorax is quite different. The darkening in the base of cell R is not found in the species listed above.

LIMONIA (GERANOMYIA) SUBRADIALIS sp. nov. Plate 1, fig. 8; Plate 2, fig. 27.

General coloration of præscutum reddish brown, with three brownish black stripes; head dark gray, with a median silvery gray stripe; knobs of halteres weakly darkened; legs yellow, the tips of femora and tibiæ narrowly darkened; wings yellowish gray, with a very restricted brown pattern, chiefly costal in distribution; Sc long, Sc_1 ending about opposite five-sixths the length of Rs; m-cu at fork of M; male hypopygium with the ninth tergite deeply notched medially; rostral prolongation of ventral dististyle compressed, at base laterally with two strong black spines from conspicuous basal tubercles; gonapophyses with mesal-apical lobe elongate.

Male.—Length, excluding rostrum, about 6 to 6.2 millimeters; wing, 6 to 6.3; rostrum, about 2.7 to 2.9.

Female.—Length, excluding rostrum, about 7 millimeters; wing, 6.9 to 7; rostrum, about 2.2 to 2.3.

Rostrum black throughout, shorter in female than in male, the recurved tips of the labial palpi short and inconspicuous in the female, somewhat longer in the male. Antennæ black throughout. Anterior vertex and a central vitta on posterior vertex narrowly silvery, the remainder dark gray.

Pronotum dark brown medially, paler on sides. Mesonotal præscutum reddish brown, with three brownish black stripes, the median one narrowed in front and not quite attaining the cephalic portion of the sclerite; surface of præscutum weakly pruinose, especially behind; scutal lobes darkened, the median area dark but restrictedly pale on either side of the midline; scutellum dark brown medially at base, broadly brownish yellow on margin; postnotum heavily gray pruinose. Pleura chiefly obscure yellow, the surface more or less pruinose, especially on the pteropleurite and pleurotergite, the remainder less distinctly so; sternopleurite chiefly pale. Halteres pale, the knobs weakly darkened. Legs with the coxæ and trochanters pale; remainder of legs yellow, the femora and tibiæ with apices narrowly darkened; terminal tarsal segments black. Wings (Plate 1, fig. 8) yellowish gray, with a very restricted brown pattern, distributed as follows: At h; supernumerary crossvein in cell Sc; origin and fork of Rs; fork of Sc; stigma; tip of vein R_3, the areas much smaller than the interspaces; cord and outer end of cell 1st M_2 very narrowly seamed with brown; veins yellow, darker in the infuscated areas. Costal fringe of male relatively long and conspicuous, of female shorter. Venation: Sc long, Sc_1 ending opposite five-sixths the length of Rs, Sc_2 at its tip; cell 1st M_2 subequal to vein M_{1+2} beyond it; m-cu at fork of M.

Abdominal tergites and hypopygium brown, the basal sternites yellow. Male hypopygium (Plate 2, fig. 27) with the ninth tergite, *9t*, deeply notched medially. Dorsal dististyle, *dd*, a nearly straight rod, the tip strongly curved. Ventral dististyle, *vd*, large and fleshy; rostral prolongation yellow, compressed, pendant; rostral spines placed on side of prolongation at base, each from a strong basal tubercle, the outer tubercle a little smaller. Gonapophyses, *g*, with mesal-apical lobe elongate.

Habitat.—China (Kwangtung).

Holotype, male, Tsin-leong-san, altitude 2,115 feet, June 2, 1936 (*Gressitt*). Allotopotype, female, altitude 2,750 feet, June 3, 1936. Paratopotypes, several of both sexes, altitude 2,700 to 2,800 feet, June 2 to 3, 1936.

Limonia (*Geranomyia*) *subradialis* is most nearly allied to *L.* (*G.*) *radialis* Alexander, differing most conspicuously in the very different male hypopygium, notably the gonapophyses.

LIMONIA (GERANOMYIA) TENUISPINOSA Alexander.

Limonia (*Geranomyia*) *tenuispinosa* ALEXANDER, Philip. Journ. Sci. 40 (1929) 329, 330.

Described from Chekiang Province, eastern China. Male, Yim-na-san, Kwangtung, altitude 2,115 feet, June 15, 1936 (*Gres-*

sitt). Female, Hong San, Kiangsi, altitude 2,750 feet, June 24, 1936 (*Gressitt*). Male, Liung-chon-san, Fukien, altitude 2,550 feet, July 21, 1936 (*Gressitt*).

LIMONIA (GERANOMYIA) APICIFASCIATA Alexander.

Limonia (*Geranomyia*) *apicifasciata* ALEXANDER, Philip. Journ. Sci. 43 (1930) 516, 517.

Described from Formosa. Males, Tsin-leong-san, Kwangtung, altitude 2,750 to 2,800 feet, June 3 and 4, 1936 (*Gressitt*).

LIMONIA (GERANOMYIA) GRACILISPINOSA sp. nov. Plate 1, fig. 9; Plate 2, fig. 28.

Size small (wing, male, 4.5 millimeters); general coloration plumbeous gray, the præscutum with three darker gray stripes; rostrum elongate, approximately one-half the remainder of body; knobs of halteres dark brown; legs brownish black, the femoral bases obscure yellow; wings subhyaline, the stigma oval, brown; Sc long, Sc_1 ending shortly before fork of Rs; cell 1st M_2 long, about equal to the longest vein beyond it; m-cu about one-third its length before fork of M; abdomen brownish black to black, the basal sternites yellow; male hypopygium with the rostral spines very long, arising from a long common tubercle, one placed at summit of tubercle, the other on the face at near three-fourths the length.

Male.—Length, excluding rostrum, about 4 millimeters; wing, 4.5; rostrum, about 2.

Rostrum elongate, black; tips of labial palpi long, curved; palpi black. Antennæ black throughout; flagellar segments oval, the outer ones not lengthened; terminal segment subequal to the penultimate, pointed at tip; verticils appressed, relatively short and inconspicuous. Head black, pruinose, compressed and distorted in the unique type.

Mesonotum dark plumbeous gray, the præscutum with three darker gray stripes, the scutal lobes with similarly darkened centers. Pleura gray pruinous. Halteres with stem yellow, knob dark brown. Legs with the fore coxæ black, sparsely pruinose; remaining coxæ and all trochanters yellow; remainder of legs brownish black, the femoral bases obscure yellow. Wings (Plate 1, fig. 9) subhyaline or very faintly tinged with darker, unmarked except for the oval brown stigma; cell Sc uniformly infumed; veins brown. Venation: Sc long, Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 nearly in transverse alignment; cell 1st M_2 long, about equal to the longest vein beyond it; m-cu about one-third its length before the fork of M.

Abdominal tergites brownish black to black; basal sternites yellow; outer segments, including hypopygium, uniformly darkened. Male hypopygium (Plate 2, fig. 28) with the caudal margin of the tergite, *9t*, gently emarginate. Dorsal dististyle, *dd*, a slender, strongly curved rod, the tip acute. Ventral dististyle, *vd*, relatively long and narrow, its area much exceeding that of basistyle; rostral prolongation slender, before apex bearing a very long cylindrical tubercle that terminates in two long black spines, one arising from summit of tubercle, the other on face at near three-fourths the length. Gonapophyses, *g*, with the mesal-apical lobe long and slender, acute, the area of curvature bearing a pale flange.

Habitat.—China (Kwangtung).

Holotype, male. Tsin-leong-san, altitude 2,750 feet, June 4, 1936 (*Gressitt*).

Limonia (*Geranomyia*) *gracilispinosa* is very distinct from other species with unpatterned wings in the gray coloration of the body and especially in the very distinct structure of the male hypopygium. The latter organ is most generally similar to that of *L.* (*G.*) *apicifasciata* Alexander, which is otherwise an entirely different fly.

LIMONIA (GERANOMYIA) CONTRITA sp. nov. Plate 1, fig. 10.

General coloration dark brown, the præscutum with three confluent brown stripes, the lateral portions obscure yellow; wings uniformly tinged with brown, unmarked except for the oval darker brown stigma; Sc long, Sc_1 ending about opposite four-fifths the length of Rs; basal section of R_{4+5} short, not exceeding one-third the length of Rs; cell 2d A narrow; abdominal tergites dark brown.

Female.—Length, excluding rostrum, about 6 millimeters; wing, 6.2; rostrum, about 2.1.

Rostrum relatively short, black throughout. Antennæ black throughout; flagellar segments oval to subcylindrical, with inconspicuous verticils. Head with front, anterior vertex, and a median line on posterior vertex silvery, the remainder of vertex blackish, the sides more pruinose.

Pronotum conspicuously whitened. Mesonotal præscutum obscure yellow, chiefly covered by three confluent dark-brown stripes, the ground restricted to the broad humeral and lateral portions; posterior sclerites of notum darkened. Pleura chiefly pale, distorted in type. Halteres dusky. Legs with the coxæ and trochanters yellow; remainder of legs dark brown. Wings

(Plate 1, fig. 10) uniformly tinged with brown, unmarked except for the oval, darker brown stigma; veins dark brown. Venation: Sc long, Sc_1 ending about opposite four-fifths the length of Rs, Sc_2 at its tip; basal section of R_{4+5} short, not exceeding one-third Rs; cell 2nd A narrow.

Abdominal tergites dark brown, the basal sternites more yellowish.

Habitat.—China (Kwangtung).

Holotype, female, Tsin-leong-san, altitude 2,750 feet, June 6, 1936 (*Gressitt*).

The most similar regional species is *Limonia* (*Geranomyia*) *fletcheri* (Edwards), wide-spread in eastern and southern Asia. This latter fly has the coloration of the wings and body much the same but is entirely distinct in the venation, as the shorter Sc, ending at or near two-thirds the length of Rs; long basal section of vein R_{4+5}, which is one-half or more the length of Rs, and in the broad cell 2d A. The stigmal area in *fletcheri* is much smaller than in the present fly.

LIMONIA (LIMONIA) MACHIDAI (Alexander).

Dicranomyia machidai ALEXANDER, Ann. Ent. Soc. America **14** (1921) 113.

Limnobia pusilla LACKSCHEWITZ, Ann. Naturh. Mus. Wien **42** (1928) 232, 233.

Very widely distributed in temperate Eurasia. One male, Hong San, Kiangsi, altitude 2,800 feet, June 30, 1936 (*Gressitt*).

LIMONIA (LIBNOTES) HASSENANA Alexander.

Limonia (*Libnotes*) *hassenana* ALEXANDER, Philip. Journ. Sci. **43** (1930) 514.

Known hitherto only from Hassensan, Formosa, at moderate altitudes. Two females, Hong San, Kiangsi, altitude 2,750 to 5,100 feet, June 23 to 30, 1936 (*Gressitt*).

ANTOCHA (ANTOCHA) BIFIDA Alexander.

Antocha (*Antocha*) *bifida* ALEXANDER, Philip. Journ. Sci. **24** (1924) 564–566.

One of the most widely distributed of all known members of the genus, occurring throughout the major islands of Japan, in Formosa and in China as far west as Szechwan. To this date it had not been recorded from eastern China. Several specimens, Yim-na-san, Kwangtung, altitude 1,800 feet, June 11 to 14, 1936 (*Gressitt*).

HELIUS (HELIUS) HÆMORRHOIDALIS sp. nov. Plate 1, fig. 11; Plate 2, fig. 29.

General coloration reddish brown; rostrum about equal in length to remainder of head; antennæ short, black; head light gray, anterior vertex narrow; knobs of halteres orange; legs long and slender, femora brownish yellow; tibiæ and tarsi yellow; wings grayish subhyaline, the wing tip distinctly infumed; stigma oval, dark brown; branches of Rs divergent, cell R_2 at margin about one half as extensive as cell R_3; m-cu at or close to fork of M; abdominal tergites and hypopygium orange, sternites strikingly bicolorous, black, with about the distal third of the segments orange; male hypopygium with the outer dististyle bearing two erect spines on outer margin before apex to produce a tridentate appearance.

Male.—Length, about 6 to 6.5 millimeters; wing, 5 to 6.

Female.—Length, about 6.5 millimeters; wing, 6.

Rostrum piceous, subequal in length to remainder of head; palpi black. Antennæ short, only about as long as the head, black throughout; flagellar segments subglobular, the outer segments more elongate. Head light gray; anterior vertex in both sexes reduced to a linear strip that is only about one-half as wide as the diameter of the scape.

Pronotum brown medially, paler on sides. Mesonotum chiefly reddish brown, the præscutum darker medially. Pleura reddish, the sternopleurite and anepisternum more darkened. Halteres dusky, the knobs orange. Legs with the coxæ reddish brown; trochanters obscure yellow; remainder of legs long and slender; femora brownish yellow, a little darker outwardly; tibiæ and tarsi yellow. Wings (Plate 1, fig. 11) grayish subhyaline, the tip distinctly infumed; stigma oval, dark brown; prearcular and costal regions clearer yellow; veins brown, more luteous in the yellow portions. Costal fringe relatively short. Venation: Sc long, Sc_1 ending a short distance before outer end of Rs, Sc_2 near its tip; branches of Rs divergent, cell R_2 at margin only about one-half as extensive as cell R_3; m-cu at or shortly beyond fork of M.

Abdominal tergites and hypopygium orange; sternites strikingly bicolored, black, with about the distal third of the individual segments abruptly orange. Male hypopygium (Plate 2, fig. 29) with the basistyle, *b*, unmodified. Outer dististyle, *od*, relatively short and stout, at apex produced into a decurved spine; before tip on outer margin with two erect spines or with a single strongly bifid one. Inner dististyle, *id*, longer, moderately dilated at base. Gonapophyses, *g*, appearing as very flattened compressed plates, the tips broadly obtuse. Ovipositor with elongate valves.

Habitat.—China (Kiangsi, Fukien).

Holotype, male, Tai-au-hong, Kiangsi, altitude 1,720 feet, July 4, 1936 (*Gressitt*). Allotopotype, female, July 6, 1936, pinned with broken male paratopotype. Paratypes, male, Gang-keu, Fukien, altitude 1,900 feet, July 24, 1936; male, Wong-sa-shue, Kiangsi, altitude 1,750 feet, July 9, 1936 (*Gressitt*).

This very distinct species somewhat resembles *Helius* (*Helius*) *anæmicus* Alexander, but is very different from all species hitherto described. The coloration of the abdominal sternites and the structure of the outer dististyle of the male hypopygium are distinctive features.

HELIUS (HELIUS) ACIFERUS sp. nov. Plate 1, fig. 12; Plate 2, fig. 30.

General coloration of mesonotal præscutum reddish brown, with a darker brown median stripe; antennæ (male) elongate, nearly as long as the body; posterior sclerites of mesonotum and the pleura darkened; knobs of halteres dark brown; wings tinged with dusky, stigma dark brown; small darkened clouds at origin of Rs and along cord; male hypopygium with the basistyle bearing two lobes on mesal face; outer dististyle a blackened rod, at apex produced into a simple acute point.

Male.—Length, about 5 to 5.5 millimeters; wing, 5 to 5.8; antenna, about 5.

Female.—Length, about 7 to 7.5 millimeters; wing, 6 to 6.2.

Rostrum black, about equal in length to remainder of head; palpi black. Antennæ (male) unusually elongate, nearly as long as the entire body, black throughout; flagellar segments long-cylindrical, with a dense erect pubescence. Head dark gray; anterior vertex narrow.

Pronotum dark brown. Mesonotal præscutum reddish brown with a darker brown median stripe; lateral stripes only feebly indicated; posterior sclerites of notum brownish black to black, the median scutal area a little brightened. Pleura extensively dark brown to brownish black. Halteres with the stem yellow, the knob dark brown. Legs with the fore coxæ darkened, the remaining coxæ testaceous to yellow; trochanters yellow; remainder of legs yellow. Wings (Plate 1, fig. 12) relatively narrow, tinged with dusky; stigma oval, relatively dark brown; a small dark cloud at origin of Rs and a similarly darkened seam along cord; veins brown. Venation: Sc long, Sc_1 ending nearly opposite fork of Rs, Sc_2 at its tip; Rs relatively elongate, in cases angulated and short-spurred at origin; anterior branch of Rs long, only feebly diverging from the posterior branch; cell R_2 at margin more extensive than cell R_3; m-cu variable in position, from opposite the fork of M to about one-half its length beyond this fork.

Abdomen dark brown, the sternites concolorous or somewhat paler yellowish brown, the segments unicolorous. Male hypopygium (Plate 2, fig. 30) with the basistyle, *b*, complicated by outgrowths on mesal face, including a slender lobe tufted with long setæ placed at near midlength of style and a stouter, more distal lobe that terminates in a few short spines. Outer dististyle, *od*, blackened, gently curved, gradually narrowed to the simple acute point. Inner dististyle, *id*, pale, broad at base, the lower margin with several strong setæ. Ovipositor with elongate valves.

Habitat.—China (Kiangsi).

Holotype, male, Tai-au-hong, altitude 1,700 feet, July 5, 1936 (*Gressitt*). Allotype, female, Hong San, altitude 3,400 feet, June 29, 1936. Paratypes, one male, two females, with the allotype, altitude 2,725 to 3,400 feet, June 29 to 30, 1936 (*Gressitt*).

The nearest allied regional species is *Helius* (*Helius*) *oblitteratus* Alexander, of Japan, which has similarly elongate antennæ in the male sex and with the wing venation and pattern approximately the same but which differs very conspicuously in the structure of the male hypopygium.

ORIMARGA (ORIMARGA) EXASPERATA sp. nov. Plate 1, fig. 13; Plate 2, fig. 31.

General coloration blackish, sparsely pruinose; halteres dusky; legs black; wings very broad, slightly tinged with dusky, the short prearcular area whitish; sparse macrotrichia on outer ends of veins R_3, R_{4+5}, M_{1+2}, and M_3; free tip of Sc_2 lacking; R_{2+3} short, subequal in length to R_2; cephalic end of m-cu just beyond midlength of Rs; vein 2d A elongate; male hypopygium with the phallosome broad, its apex without spinous points.

Male.—Length, about 6.5 millimeters; wing, 5.

Rostrum black, sparsely pruinose; palpi black. Antennæ black throughout; flagellar segments oval; verticils inconspicuous. Head blackish gray.

Mesonotum blackish, with a sparse gray pruinosity, the præscutum with three poorly defined still darker stripes. Pleura black, sparsely pruinose. Halteres dusky. Legs with the coxæ and trochanters brownish black to dark brown; remainder of legs black, the femoral bases a trifle paler. Wings (Plate 1, fig. 13) very broad, with a slight dusky tinge, the short prearcular area whitish; veins brown. Costal fringe of moderate length; outer portion of costal vein incrassated. Macrotrichia of veins beyond cord restricted, there being a loose series of about eight on R_3, and from ten to twelve on outer ends of veins R_{4+5}, M_{1+2}, and M_3, these latter chiefly arranged in pairs. Venation: Free tip of Sc_2 lacking; R_{2+3} short subequal to R_2; basal section of R_{4+5} strongly angulated before midlength; cephalic end of m-cu just beyond midlength of Rs; vein 2d A elongate.

Abdomen black, the sternites a trifle paler; hypopygium somewhat brightened. Male hypopygium (Plate 2, fig. 31) with the outer dististyle, *od*, unusually stout, at tip suddenly narrowed into a short point. Inner dististyle, *id*, before apex bent into a right angle, the apex slender. Interbase a slender, pale, straight rod. Phallosome, *p*, broad, at apex without conspicuous spinous points as found in *gymnoneura*.

Habitat.—China (Kwangtung).

Holotype, male, Tsin-leong-san, altitude 2,750 feet, June 5, 1936 (*Gressitt*).

Orimarga (*Orimarga*) *exasperata* is most similar to *O.* (*O.*) *gymnoneura* Alexander, of Formosa, agreeing in the general coloration of the body, legs and wings, and in the conformation of the wings, including the short prearcular field. It differs in the details of venation, especially of the radial field, the more abundant trichia of the outer wing veins, and especially in the structure of the male hypopygium. In *O.* (*O.*) *gymnoneura*, just before the apex of the phallosome, there is a group of several sharp spines that are not present in the insect here discussed.

HEXATOMINI

PSEUDOLIMNOPHILA PROJECTA sp. nov. Plate 1, fig. 14.

General coloration medium brown; antennæ black, the outer flagellar segments elongate and provided with long verticils; wings with a uniform pale brown tinge; R_2 before fork of R_{3+4}; cell M_1 lacking; veins issuing from cell 1st M_2 relatively short; anterior arculus preserved.

Male.—Length, about 4.6 millimeters; wing, 5.4.

Rostrum light yellow; palpi black. Antennæ black throughout, relatively long and slender; outer flagellar segments becoming long-cylindrical, with conspicuous verticils; basal flagellar segments with verticils short and inconspicuous. Head dark brown.

Mesonotum almost uniformly medium brown, the scutellum a trifle more testaceous; mediotergite with central portion darkened, the broad lateral margins more brownish yellow. Pleura brownish yellow. Halteres infuscated. Legs with the coxæ and trochanters testaceous yellow; remainder of legs brown, the outer tarsal segments passing into dark brown. Wings (Plate 1, fig. 14) with a uniform pale brown tinge; stigma small, pale brown, scarcely darker than the ground color; veins brown. Costal fringe (male) of moderate length, dense. Venation: Sc of moderate length, Sc_1 ending about opposite four-fifths the length of Rs; R_{2+3+4} rather strongly arcuated; R_2 before the fork of R_{3+4}, the distance somewhat variable in the type specimen, longest in the right wing, as figured; veins issuing from cell 1st M_2 relatively short, the longest not twice the length of the cell; cell M_1 lacking; anterior arculus preserved.

Abdominal tergites dark brown, the sternites more yellowish brown, their caudal margins narrowly yellow; hypopygium chiefly pale brownish yellow.

Habitat.—China (Kwangtung).

Holotype, male, Mei-hsien, altitude 715 feet, July 18, 1936 (*Gressitt*).

Pseudolimnophila projecta is readily told from allied regional species, such as *P. descripta* Alexander (Formosa) by the venation, as the short cell R_3 and the length of the veins beyond cell 1st M_2. In the present fly, Sc is shorter and Rs shorter and more arcuated than in allied forms in which cell M_1 is lacking.

HEXATOMA (ERIOCERA) QUADRIATRATA sp. nov. Plate 1, fig. 15.

Belongs to the *rubrescens* group; general coloration of body dark plumbeous-gray, the sides of præscutum and scutum with velvety black areas; trochanters and femora light yellow, the remainder of legs a trifle darker; wings with a strong brown suffusion, the prearcular and costal regions more saturated; stigma small, dark brown; R_{1+2} and R_2 subequal; R_{2+3+4} and R_{2+3} in longitudinal alignment and subequal, more than twice as long as the basal section of R_5; cell M_1 about twice its petiole; m-cu at or before midlength of cell 1st M_2.

Female.—Length, about 15 to 16 millimeters; wing, 13 to 13.5.

Rostrum black, sparsely pruinose; palpi black. Antennæ black throughout, 8-segmented (female); flagellar segments cylindrical, with abundant setæ, those of basal two flagellar segments chiefly unilateral in distribution. Head dark gray; anterior vertex relatively narrow, the low simple tubercle correspondingly narrowed; setæ of head relatively sparse, on posterior portion shortened and reduced in number.

Mesonotum almost uniformly dark plumbeous-gray, the lateral margin of præscutum before suture and of the scutal lobes behind the suture extensively velvety black; mesonotum glabrous. Pleura dark plumbeous-gray; dorsopleural membrane dusky. Halteres dark brown, the extreme base of stem brightened. Legs with the coxæ brownish black; trochanters and femora light yellow; tibiæ and tarsi a trifle more brownish yellow. Wings (Plate 1, fig. 15) with a strong brown suffusion, the prearcular and costal portions more saturated brown; cell Sc a little more yellowish, especially on proximal portion; stigma small and narrow, dark brown; vague, scarcely evident, dark seams along cord and outer end of cell 1st M_2; veins darker brown than the ground. Longitudinal veins beyond cord with abundant macrotrichia. Venation: Sc_1 ending nearly opposite fork of R_{2+3+4}; R_{1+2} and R_2 subequal; R_{2+3+4} and R_{2+3} in longitudinal alignment and subequal in length, either more than twice as long as basal section of R_5; cell M_1 deep, from one and one-half to two times its petiole; m-cu at or just before midlength of cell 1st M_2.

Abdomen dark plumbeous; dorsal shield of ovipositor deep reddish brown; cerci moderately long, basal half darkened, distal portion more slender, gently upcurved, yellow.

Habitat.—China (Kiangsi).

Holotype, female, Tai-au-hong, altitude 1,725 feet, July 6, 1936 (*Gressitt*). Paratopotype, female, Wong-sa-shue, altitude 1,750 feet, July 9, 1936.

The present fly differs rather conspicuously from other members of the *rubrescens* group in the coloration of the body, wings, and legs, as well as in the details of venation. By Edwards's key to the Old World species of the subgenus [2] the fly runs to couplet 29 where it can be traced no further, in having the combination of five posterior cells and being equipped with velvety black spots on the sides of the mesonotum.

[2] Ann. & Mag. Nat. Hist. IX 8 (1921) 70–78.

HEXATOMA (ERIOCERA) DAVIDI (Alexander).

Eriocera davidi ALEXANDER, Bull. Mus. Hist. Nat. Paris 1922 (1922) 295, 296.

One male, Tai-au-hong, Kiangsi, altitude 1,725 feet, July 6, 1936 (*Gressitt*). This specimen has the white discal area of wings much reduced, being narrow and involving cells R, M, and posterior edge of R_1; besides the primary white area, there are several small pale dashes on either side of this fascia. Antennæ (male) 8-segmented; claws toothed.

HEXATOMA (ERIOCERA) OBLIQUA (Alexander).

Eriocera obliqua ALEXANDER, Proc. Hawaiian Ent. Soc. 5 (1923) 255, 256.

Known hitherto only from Macao. One female, Hong San, Kiangsi, altitude 2,500 feet, July 15, 1936 (*Gressitt*). The present specimen agrees closely with the type except that the ground color of the wings is more intensely black and unfaded; Rs a little shorter; basal section of R_5 about one-half longer than R_{2+3+4}; Sc a little longer, Sc_1 ending shortly beyond level of fork of R_{2+3+4}. Antennæ (female) 11-segmented; claws simple.

HEXATOMA (ERIOCERA) CHRYSOMELA (Edwards).

Eriocera chrysomela EDWARDS, Ann. & Mag. Nat. Hist. IX 8 (1921) 88, 89.

Described from Hong Kong, China. One female, Hong San, Kiangsi, altitude 1,425 feet, July 10, 1936 (*Gressitt*). One female, Liung-chon-san, Fukien, altitude 2,540 feet, July 21, 1936 (*Gressitt*).

ERIOPTERINI

TEUCHOLABIS (TEUCHOLABIS) KIANGSIENSIS sp. nov. Plate 1, fig. 16.

Female.—Length, about 7.5 to 8 millimeters; wing, 5.5 to 6.

Most closely allied to *T.* (*T.*) *iriomotensis* Alexander, of the southern Loochoo Islands, differing especially in the patterned wings. The fly differs from *iriomotensis* in the following regards:

Posterior portion of head not pruinose. Median region of præscutum before suture extensively yellow. Sternopleurite not or scarcely darkened. Legs with the tibiæ yellowish brown, narrowly blackened at either end. Wings (Plate 1, fig. 16) distinctly patterned; whitish subhyaline, with brown areas arranged as follows: Cell Sc; a small spot at origin of Rs; stigma and a broad confluent seam along cord; outer end of cell 1st M_2 similarly seamed; small marginal clouds at end of anterior branch of Rs and of 2d A. Venation: Sc_2 more removed from tip of Sc_1, placed nearer the origin of Rs than to the tip of Sc_1. Ovipositor with bases of cerci blackened, only the tips dark horn-colored.

Habitat.—China (Kiangsi).

Holotype, female, Hong San, altitude 2,750 feet, June 24, 1936 (*Gressitt*). Paratopotypes, females, altitude 3,150 feet, June 27, 1936.

GYMNASTES (GYMNASTES) SHIRAKII (Alexander).

Paratropeza (*Gymnastes*) *shirakii* ALEXANDER, Ann. Ent. Soc. America 13 (1920) 254.

Described from high altitudes in Formosa. Additional records: Formosa: Urai, April 20, 1922 (*K. Takeuchi*). Southeastern China: Hong San, Kiangsi, altitude 2,750 to 3,500 feet, June 25 to 30, 1936 (*Gressitt*), several specimens.

GONOMYIA (LIPOPHLEPS) INQUISITA sp. nov. Plate 1, fig. 17.

Belongs to the *nubeculosa* group; general coloration dark brown, pruinose; knobs of halteres dark brown; femora brownish yellow, with a broad, brownish black, subterminal ring, preceded and followed by narrow yellowish annuli; wings strongly darkened, variegated by china white and darker brown areas; cells R and M uniformly infumed; Sc_1 and Sc_2 both beyond origin of Rs; vein R_4 short, about one-half as long as R_{2+3+4}; cell 1st M_2 subequal to vein M_3 beyond it; abdomen brownish black, the segments narrowly ringed caudally with whitish.

Female.—Length, about 5.8 millimeters; wing, 4.2.

Rostrum and palpi black. Antennæ with the scape and pedicel brown on ventral faces, yellow above; flagellum dark brown; flagellar segments with a dense erect white pubescence. Head yellow, the center of the vertex darkened.

Pronotum and lateral pretergites very pale yellow. Mesonotum brownish gray, the posterior margin of scutellum broadly pale yellow. Pleura dark brown, with a conspicuous, white, longitudinal stripe extending from and including the fore coxæ, passing above the remaining coxæ to base of abdomen; dorsopleural region chiefly yellow. Halteres with stem yellowish white, the knob chiefly dark brown. Legs with the fore coxæ as described above, its extreme base darkened; remaining coxæ brown; trochanters yellow; femora yellow, slightly more brownish yellow outwardly, with a broad brownish black subterminal ring, preceded and followed by narrower yellow rings, each of the latter about one-half as wide as the darkened annulus; tibiæ and basitarsi yellow, outer tarsal segments black. Wings (Plate 1, fig. 17) with the ground color strongly darkened, variegated by china white and darker brown areas; the white includes the prearcular and costal regions, together with the wing tip; cells R and M uniformly of the ground color; dark-brown areas small, at arculus, origin of Rs, stigma, and along cord; more restricted darkenings at tips of veins R_3, R_4, R_5, M_3, M_4 and Cu_1; veins brown, paler in the whitened areas, darker along the cord. Costal fringe unusually long and conspicuous for the female sex. Venation: Sc relatively long, both Sc_1 and Sc_2 lying beyond origin of Rs; R_3 short and erect, about two-thirds as long as m; R_4 short, about one-half the length of R_{2+3+4}; cell 1st M_2 subequal to vein M_3 beyond it.

Abdomen brownish black, the segments narrowly ringed caudally with whitish, a little more conspicuously so on the tergites. Ovipositor with the basal shield obscure yellow, narrowly darkened at base.

Habitat.—China (Kiangsi).

Holotype, female Wong-sa-shue, altitude 1,750 feet, July 8, 1936 (*Gressitt*).

Related to *Gonomyia* (*Lipophleps*) *conquisita* Alexander, *G.* (*L.*) *nubeculosa* de Meijere, and *G.* (*L.*) *pallidisignata* Alexander. The various members of the group are separated in the female sex by characters of wing pattern and venation, as to whether the basal cells are variegated on their proximal portions, as in *pallidisignata;* by venation, especially the length of Sc, the relative proportions of veins R_{2+3+4} and R_4, and the length of cell 1st M_2, proportional to vein M_3 beyond it. The leg pattern, especially the coloration and width of the darkened femoral rings, furnish important characters; in *conquisita,* this dark annulus is pale and narrow. The present fly differs from the others in the longer Sc, which projects distinctly beyond the origin of Rs.

GONOMYIA (LIPOPHLEPS) SUBANXIA sp. nov. Plate 1, fig. 18; Plate 2, fig. 32.

Belongs to the *skusei* group; general coloration of mesonotum dark brown, the posterior margin of scutellum broadly yellow; head gray; pleurotergite and metapleura chiefly yellowish white; halteres and legs darkened; wings broad, tinged with dusky, the stigma a little darker; Sc_1 ending beyond midlength of Rs; abdominal tergites dark brown; male hypopygium with the dististyle fleshy; phallosome pale, the apex of ædeagus subacute.

Male.—Length, about 3.8 to 4 millimeters; wing, 3.8 to 4.

Rostrum yellow; palpi black. Antennæ black; flagellar segments cylindrical, with an abundant erect pubescence. Head gray.

Pronotum and anterior lateral pretergites light yellow. Mesonotal præscutum and scutal lobes almost uniformly dark brown, the surface very sparsely pruinose; median area of scutum in front and posterior lateral portions of scutal lobes yellow; scutellum darkened medially at base, the posterior margin broadly obscure yellow; mediotergite brownish black, the anterior lateral margins restrictedly yellow. Pleura chiefly dark brown, the dorsopleural region yellow; pleurotergite and metapleura chiefly pale yellowish white. Halteres dark brown, the extreme base of stem pale, the knob a trifle brightened. Legs brownish black throughout. Wings (Plate 1, fig. 18) broad, with a strong dusky tinge, the elongate stigmal area a little darker; prearcular and costal regions more whitish; veins brown. Venation: Sc long, Sc_1 extending to beyond midlength of Rs, Sc_2 a short distance from its tip; branches of Rs long, the anterior one paralleling R_1 for most of its length; m-cu just before fork of M.

Abdomen dark brown, the sternites and hypopygium a trifle brighter. Male hypopygium (Plate 2, fig. 32) with the outer lobe of basistyle, *b*, slender; a single dististyle, *d*, fleshy, nearly equal in size and shape to the lobe of the basistyle. Phallosome, *p*, complex, without heavily sclerotized or blackened points, the apex of ædeagus subacute, gradually narrowed to the tip.

Habitat.—China (Kwangtung).

Holotype, male, Yim-na-san, altitude 2,115 feet, June 15, 1936 (*Gressitt*). Paratopotype, male. Paratype, male, Mei-hsien, altitude 715 feet, May 31, 1936 (*Gressitt*).

The nearest ally is *Gonomyia* (*Lipophleps*) *anxia* Alexander, of western Sumatra, which has the hypopygium of this same general structure. In the latter species the wings are conspicuously narrower, Sc shorter and the apex of the ædeagus very narrow, a slender falcate blade. There are several species of the *skusei* group in the Philippines but all of these are more distantly allied. In Japan, Formosa, and China, only a single additional species, *G.* (*L.*) *sauteri* Alexander, has been described to this date, and this is entirely distinct from the present fly in the structure of the male hypopygium.

GONOMYIA (LIPOPHLEPS) ATROX sp. nov. Plate 1, fig. 19; Plate 3, fig. 33.

General coloration blackish gray; head yellow, the central portion of posterior vertex brownish black; pleura black, with a longitudinal yellowish white stripe; knobs of halteres extensively darkened; femora yellow, with a broad brownish black subterminal annulus, preceded and followed by narrow, light yellow rings; wings clouded with brown and pale, the costal border yellow; Sc short; male hypopygium with the outer dististyle a powerful black rod, at base on mesal face with two long, strongly curved, black hooks.

Male.—Length, about 3 millimeters; wing, 3.2.

Rostrum and palpi black. Antennæ with the scape and pedicel black on lower or ventral face, yellow above; flagellum black, the basal segment brightened. Head light yellow, the central portion of posterior vertex extensively brownish black; postgenæ infuscated.

Pronotum and anterior lateral pretergites light yellow. Mesonotum black, sparsely gray pruinose; scutellum with posterior border obscure yellow. Pleura black, with a relatively narrow, yellowish white, longitudinal stripe, extending from fore coxæ to base of abdomen; dorsal pleurotergite and pteropleurite yellowish brown. Halteres yellow, the knobs extensively darkened. Legs with the fore coxæ obscure yellow, remaining coxæ testaceous brown; trochanters obscure yellow; femora brownish yellow with a broad dark brown or brownish black subterminal annulus, preceded and followed by much narrower, clear yellow rings, the latter at the tip of the segment; tibiæ yellow, the extreme base and tip darkened; tarsi brownish yellow, passing into black. Wings (Plate 1, fig. 19) with the ground color brown, variegated by clearer areas, chiefly before and beyond stigma, before cord and as smaller markings in certain of the other cells; costal border of wing narrowly light yellow; veins pale brown, a little darker in the clouded areas. Venation: Sc relatively short, the distance on costa between Sc_1 and origin of Rs only a little less than the length of the latter; m-cu at fork of M.

Abdomen brownish black, the incisures of the segments pale; hypopygium dark. Male hypopygium (Plate 3, fig. 33) with the outer dististyle, *od*, a powerful black rod, nearly straight, at base on mesal face with two long, strongly curved, black hooks; mesal face of style at near one-third the length with an acute erect spine; beyond this point the style slightly constricted and the mesal face microscopically roughened. Inner dististyle a small simple lobe, pointed at outer end, provided with long setæ, at apex with two long pale fasciculate bristles. Phallosome, *p*, complex, consisting of a broadly depressed plate, the caudal margin terminating in four short black spinous points, the outer pair from cylindrical lobes. Distad of the phallosome, as figured, lie other massive structures and a strongly curved crook, the end of which is shown.

Habitat.—China (Kiangsi).

Holotype, male, Hong San, altitude 3,000 feet, June 26, 1936 (*Gressitt*).

Gonomyia (*Lipophleps*) *atrox* is very distinct from allied regional forms in the structure of the male hypopygium, which is very different from all other species known to me.

IDIOCERA (IDIOCERA) TERANISHII (Alexander).

Gonomyia (*Ptilostena*) *teranishii* ALEXANDER, Ann. Ent. Soc. America 14 (1921) 118, 119.

Described from Morioka, Honshiu, Japan. The following Chinese records are now available:

Hang-chow, Chekiang, April 28, 1924 (*Suenson*); Liung-chonsan, Fukien, altitude 2,550 feet, July 20, 1936 (*Gressitt*); Mount Omei, Szechwan, altitude 4,000 feet, July 14, 1931 (*Franck*); Boat on the Min River, Szechwan, April 30, 1933 (*Franck*).

It should be noted that the subgeneric name *Idiocera* has been retained for those species of *Gonomyia* in which the anterior arculus of the wings is entire.

IDIOCERA (PTILOSTENODES) UNIPLAGIATA sp. nov. Plate 1, fig. 20; Plate 3, fig. 34.

Small (wing 4 millimeters or less); posterior vertex polished black; mesonotum black, variegated with yellow on the scutum and scutellum; mediotergite yellow medially, the sides darkened; pleura yellow, with a single major black area on anepisternum; halteres black; legs dark brown to brownish black, the femoral bases narrowly obscure yellow; wings subhyaline, m-cu at or close to fork of M; abdominal tergites black, sternites yellow to brownish yellow.

Male.—Length, about 3.2 to 3.3 millimeters; wing, 3.7 to 3.8.

Female.—Length, about 4 millimeters; wing, 4.

Rostrum yellow; outer palpal segments infuscated. Antennæ with scape obscure yellow; pedicel and flagellum black; flagellar segments oval, the longest verticils a little exceeding the segments. Head with the front and orbits yellow; anterior vertex infuscated; posterior vertex and occiput polished black.

Pronotum yellow, narrowly infuscated medially. Mesonotal præscutum chiefly covered by a polished black discal area, the humeral region restrictedly pale; scutum polished black on the lobes and across the median area, leaving obscure yellow areas behind the suture and along the posterior borders of the lobes; scutellum black medially, obscure yellow on posterior portion, parascutella black; mediotergite with central portion yellow, the sides darkened; pleurotergite darkened, especially behind. Pleura obscure yellow, with a major black area occupying the anepisternum. Halteres black. Legs with the coxæ obscure yellow, the fore coxæ a trifle darkened; trochanters yellow; remainder of legs dark brown or brownish black, the femoral bases narrowly obscure yellow, somewhat more extensively so on the fore pair; posterior femora slightly paler in color than the middle or fore pairs. Wings (Plate 1, fig. 20) subhyaline or with a faint gray tinge; veins slender, brown. Macrotrichia on all veins beyond cord, on anterior branch of Rs restricted to a central series of about ten, on the distal section of Cu_1 occurring on outer half of vein. Venation: Sc_1 ending opposite or just before origin of Rs, Sc_2 at midlength of the distance between arculus and origin of Rs; anterior branch of Rs bent strongly cephalad at anterior end so cell R_4 at margin is considerably wider than cell R_2; m-cu at or immediately before fork of M.

Abdominal tergites black; sternites yellow to brownish yellow; hypopygium yellow. Male hypopygium (Plate 3, fig. 34) with three dististyles; median style, *md,* bifid, with glabrous blades, the stem with abundant setæ; inner style, *id,* a flattened spatulate blade, with coarse setæ. Ædeagus gradually narrowed outwardly, terminating in a slender apical point.

Habitat.—China (Kiangsi).

Holotype, male, Tai-au-hong, altitude 1,700 feet, July 5, 1936 (*Gressitt*). Allotopotype, female. Paratopotype, male.

Idiocera (*Ptilostenodes*) *uniplagiata* is readily told from the other described species of the subgenus by the position of m-cu at or very close to the fork of M. The fly is more generally similar to the Philippine *I.* (*P.*) *ptilostenella* (Alexander) than to the Formosan and western Chinese species.

GNOPHOMYIA (GNOPHOMYIA) DEJECTA Alexander.

Gnophomyia dejecta ALEXANDER, Philip. Journ. Sci. 40 (1929) 542, 543.

Known from various stations in Formosa. Male, Hong San, Kiangsi, altitude 3,000 feet, June 25, 1936 (*Gressitt*). Both sexes, Liung-chon-san, Fukien, altitude 2,550 feet, July 20 and 21, 1936 (*Gressitt*).

CRYPTOLABIS (BÆOURA) ANGUSTILOBATA sp. nov. Plate 1, fig. 21; Plate 3, fig. 35.

Belongs to the *trichopoda* group; general coloration black; head dark gray; wings with a weak brown tinge, the costal region more whitened; femora brownish yellow, the tips narrowly darkened; legs with long conspicuous erect setæ; male hypopygium with the tergite broad, each lateral angle produced caudad into a narrow glabrous lobe, the caudal margin between these lobes truncated.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.6 to 5.

Female.—Length, about 4 millimeters; wing, 5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments passing through oval into long-oval and cylindrical, with elongate verticils. Head dark gray.

Pronotum and mesonotum black, the anterior lateral pretergites very restrictedly and vaguely brightened; posterior margin of scutellum a trifle paler. Pleura black, sparsely pruinose, especially on posterior sclerites. Halteres brownish black, the base of stem restrictedly brightened. Legs with the coxæ and trochanters dark brown; remainder of legs brownish yellow, the tips of the femora and tibiæ narrowly darkened; terminal tarsal segments infuscated; legs with long, conspicuous, erect setæ. Wings (Plate 1, fig. 21) with a weak brown tinge, the costal region more whitened; stigma small and poorly indicated; veins and macrotrichia dark. Venation: Petiole of cell M_3 a little longer than m-cu; cell 2d A relatively narrow.

Abdomen, including hypopygium and ovipositor, dark brown. Male hypopygium (Plate 3, fig. 35) with the tergite, *9t*, broad, each lateral angle produced caudad into a narrow glabrous lobe, its tip obtuse, the caudal margin between these lobes truncated. Dististyle, *d*, relatively narrow, gently curved to the subacute tip; before apex on lower margin with about two small spines. What is here interpreted as being modified gonapophyses terminate in a semicircular pale lobe that is provided with four or five conspicuous setæ. Eighth sternite, *8s*, with apex darkened and slightly produced into an obtuse lobe.

Habitat.—China (Kwangtung).

Holotype, male, Yim-na-san, altitude 1,800 feet, June 11, 1936 (*Gressitt*). Allotopotype, female, with the type. Paratopotypes, one male, one female, June 10 to 14, 1936.

Cryptolabis (*Bæoura*) *angustilobata* is readily told from all regional allied species, as *C.* (*B.*) *trichopoda* Alexander (Formosa), *C.* (*B.*) *lævilobata* Alexander (Formosa), *C.* (*B.*) *setosipes* Alexander (Hainan), and *C.* (*B.*) *consona* Alexander (Hainan), by the structure of the male hypopygium, especially of the tergite, dististyle, and gonapophyses.

MOLOPHILUS INJUSTUS sp. nov. Plate 1, fig. 22; Plate 3, fig. 36.

Belongs to the *gracilis* group, *assamensis* subgroup; general coloration dark brownish gray; antennæ (male) elongate, nodulose; halteres with dark-brown knobs; femora chiefly dark brown, the bases narrowly obscure yellow, the posterior femora chiefly yellow with about the distal third darkened; wings with a weak dusky tinge; R_{2+3} longer than R_{4+5}; male hypopygium with the dorsal lobe of basistyle exceeding the dististyle in length, provided with long coarse setæ; inner dististyle entirely darkened.

Male.—Length, about 3.5 millimeters; wing, 4; antenna, about 3.2.

Rostrum gray; palpi black. Antennæ (male) elongate, nearly as long as the body, black throughout; flagellar segments fusiform, about equally narrowed at both ends, each segment with a group of long erect setæ on the enlarged portion, these setæ about equal in length to the segments. Head gray.

Mesonotum dark brownish gray; pseudosutural foveæ black; scutellum and mediotergite concealed by mounting medium. Pleura brownish gray. Halteres with stem obscure yellow, the knob dark brown. Legs with the coxæ dark; trochanters obscure yellow; femora chiefly dark brown, the bases of fore and middle pairs restrictedly brightened; posterior femora yellow with the distal third or less darkened; tibiæ yellowish brown to brown; the tips darker; tarsi dark brown to black. Wings (Plate 1, fig. 22) with a weak dusky tinge; veins pale brown; macrotrichia a trifle darker. Venation: R_{2+3} longer than R_{4+5}, R_2 lying distad of level of r-m; petiole of cell M_3 about three times m-cu; vein 2d A relatively short, ending before m-cu.

Abdomen, including hypopygium, brownish black. Male hypopygium (Plate 3, fig. 36) with the dorsal lobe, *db*, of basistyle elongate, relatively stout, the apex narrowed and glabrous;

ventral lobe shorter, with long, coarse, erect to retrorse setæ; a slender, fingerlike lobule on dorsomesal end, this provided at apex with a group of long setæ, not distributed along face as in *kempi.* Outer dististyle, *od,* sinuous to the acute apex, the surface microscopically roughened; inner dististyle, *id,* nearly as long, near base with a few coarse setæ, thence narrowed to an acute spinous point. Ædeagus, *a,* with lateral wings or flanges.

Habitat.—China (Kwangtung).

Holotype, male, Tsin-leong-san, altitude 2,750 feet, June 6, 1936 (*Gressitt*).

The nearest ally is *Molophilus kempi* Alexander (eastern Himalayas) which differs especially in the larger size, different coloration of the body and legs, and in the details of structure of the male hypopygium. There are several species of the *assamensis* subgroup in the Philippines and northern India, but none had hitherto been discovered in China or Japan.

STYRINGOMYIA SPATHULATA sp. nov. Plate 1, fig. 23; Plate 3, figs. 37 to 39.

Belongs to the *armata* group; male hypopygium with the median tergal lobe elongate, weakly spatulate, narrowest at near midlength; ninth sternite relatively narrow at apex, the two major setæ placed one on either side of midline; spines of basistyle terete or only weakly flattened, one arising from a conspicuous basal tubercle; dististyle with a long blackened spine at base of inner arm.

Male.—Length, about 7 millimeters; wing, 4.8 to 5.

Female.—Length, about 6 millimeters; wing, 4.

Rostrum brownish black; palpi dark brown, the terminal segment a little paler at outer end; flagellum chiefly pale. Head pale testaceous brown, the bristles of anterior vertex flattened and proclinate.

Mesonotum chiefly testaceous-brown, vaguely patterned with darker, including a central spot and narrow lateral borders on the pronotum. Dorsal pleura darkened, the ventral portion yellow. Halteres dusky. Legs with the femoral and tibial dark rings relatively vague and diffuse, slightly interrupted on lower surface. Wings (Plate 1, fig. 23) narrow, subhyaline, sparsely patterned with brown, including restricted seams on anterior cord, m-cu, outer end of cell 1st M_2, and distal end of vein 2d A; veins brown, darker in the clouded areas, the more basal and the costal veins paler. Costal fringe long and conspicuous. Venation: Anterior branch of Rs suberect; 2d M_2 short-petiolate; vein 2d A curved rather gently into wing margin.

Abdominal tergites yellowish brown, the extreme lateral and caudal margins of the individual segments a trifle darker; sternites slightly more testaceous. Male hypopygium with the median lobe of tergite (Plate 3, fig. 37, 9*t*) elongate, weakly spatulate, being narrowed at near midlength, the surface with abundant erect setulæ. Ninth sternite (Plate 3, fig. 37, 9*s*) with the apex relatively narrow, obtuse, the major setæ of moderate length, placed one on either side of the midline, the distance between their punctures about one-fourth the length of the seta itself. Basistyle (Plate 3, fig. 38, *b*) with two modified setæ, one subsessile, the other arising from a slender tubercle that is more than one-half the length of the seta itself, the latter strongly curved; setæ terete, not strongly flattened as in *armata*. Dististyle (Plate 3, fig. 39, *d*) with the outer arm bearing two very unequal setæ, the longest nearly one-half the length of the arm; along face of arm with a scattered series of about twelve small erect setæ; at base of arm a trifle group of about twenty-five black peglike spines; middle arm of style as figured; inner arm with its outer lobe high, the beak portion terminating in a compact group of about ten black spines; base of arm bearing a curved blackened spine.

Habitat.—Central Java.

Holotype, male, Nglirip, Djati forests, altitude 300 feet, January, 1936 (*Walsh*). Allotopotype, female, pinned with type. Paratopotypes, 3 males and females, with types.

The nearest allies of the present fly are *Styringomyia acuta* Edwards (Borneo) and *S. armata* Edwards (Sumatra, Borneo, Philippines), which have the bisetose basistyle of the group but differ in several details of the male hypopygium. The present fly is closest to *armata*, differing especially in the shape and structure of the modified setæ of the basistyle and the structure of the dististyle, especially the long curved spine at base of the inner arm. I have identified as *armata* specimens from Mindanao, and these differ from the present fly, not merely in the structures described, but also in the number and arrangement of the peglike blackened spines on the outer and middle arms of the dististyle. All three species are rather closely allied among themselves, but all seem to represent valid species rather than races.

STYRINGOMYIA PENDULA sp. nov. Plate 1, fig. 24; Plate 3, figs. 40, 41.

General coloration yellow, variegated with darker; head grayish white above, the posterior genæ infuscated; mesonotum variegated grayish white and brownish black; brown rings on femora and tibiæ broad and clear cut; wings whitish subhyaline, with dark seams on anterior cord, m-cu and outer end of cell 1st M_2; a conspicuous brown seam on basal half of vein Cu; anterior branch of Rs oblique, originating opposite r-m; male hypopygium with a single modified seta on basistyle; dististyle with its inner arm produced into a slender pendulous process that terminates in a long acute spine, along the margin with about six black points.

Male.—Length, about 7.5 to 7.8 millimeters; wing, 4.8 to 5.

Female.—Length, about 6 to 7 millimeters; wing, 4.2 to 4.3.

Rostrum and palpi brownish black. Antennæ with scape blackened beneath, yellow above; pedicel brownish black; flagellum chiefly pale, the more basal segments obscure yellow. Head grayish white above, the postgenæ infuscated; setæ of head stout but not flattened, chiefly proclinate.

Mesonotum variegated with grayish white and brownish black, forming a complex pattern on præscutum; central portion of scutellum almost white; setæ of thorax strong but simple. Pleura darkened dorsally, abruptly yellow on ventral portions. Halteres dusky. Legs with the usual yellow and dark-brown pattern, the brown rings complete and conspicuous. Wings (Plate 1, fig. 24) narrow, whitish subhyaline, sparsely patterned with brown, as follows: Anterior cord; m-cu and outer end of cell 1st M_2; a conspicuous seam on vein Cu, involving basal half of first section; distal third of vein 2d A darkened. Costal fringe long and conspicuous, erect. Venation: Anterior branch of Rs moderately oblique, originating opposite r-m; cell 2d M_2 very short-petiolate to broadly sessile; vein 2d A bent into margin at a moderate curve.

Abdominal tergites obscure yellow, with a vague darker median stripe; sternites light yellow, the lateral margins narrowly darkened; hypopygium yellow. Male hypopygium with the tergite (Plate 3, fig. 40, 9*t*) relatively narrow and pointed at apex; ninth sternite with apex glabrous, truncated, with the major setæ relatively short, about equal in length to the distance between them; on margin, on either side of the midline, with a microscopic spinous point. Basistyle (Plate 3, fig. 41, *b*) with a single modified bristle. Dististyle (Plate 3, fig. 41, *d*) as shown, the outer arm, *od,* dusky, with two unequal setæ at and near tip; middle arm, *md*, with very numerous and complex groups of black spines; inner arm, *id*, produced into an acute sclerotized beak and bearing a long sinuous process that terminates in a slender point, the margin bearing about six black points.

Habitat.—Central Java.

Holotype male, Nglirip, Djati forests, altitude 300 feet, January, 1936 (*Walsh*). Allotopotype, female, pinned with type. Paratopotypes, both sexes.

The nearest ally of the present fly appears to be *Styringomyia soembana* Edwards (Soemba Islands), which differs chiefly in the coloration of the head and thorax and in the details of structure of the male hypopygium. The distinctly darkened seam along vein Cu is found in certain African species, such as *S. lineaticeps* Edwards and *S. marshalli* Edwards, but is not found in the regional allies of the present insect.

STYRINGOMYIA SEPARATA Alexander.

Styringomyia separata ALEXANDER, Philip. Journ. Sci. 56 (1935) 368, 369.

Described from northern Formosa. Several specimens, Hong San, Kiangsi, altitude 2,750 to 3,500 feet, June 24 to 29, 1936 (*Gressitt*).

TOXORHINA (CERATOCHEILUS) TAIWANICOLA (Alexander).

Ceratocheilus taiwanicola ALEXANDER, Philip. Journ. Sci. 22 (1923) 475, 476.

The species is wide-spread in the mountains of Formosa and is herewith recorded from southeastern China.

FORMOSA, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*), Fudieda, altitude 4,700 feet, August 13, 1933 (*Issiki*). CHINA, Hong San, Kiangsi, altitude 2,750 feet, June 25, 1936 (*Gressitt*).

ERRATUM

Due to a regrettable oversight certain of the illustrations for Parts XXXI [Philip. Journ. Sci. 60 (1936) 323] and XXXII [Philip. Journ. Sci. 61 (1936) 113] of this series have been transposed. Plate 1 at the end of Part XXXI belongs to Part XXXII, and Plate 1 at the end of Part XXXII belongs to Part XXXI. The author has kindly corrected this error in all the reprints distributed by him.—EDITOR.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b* basistyle; *d*, dististyle; *db*, dorsal lobe of basistyle; *dd*, dorsal dististyle; *g*, gonapophysis; *id*, inner dististyle; *md*, middle dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Ptychoptera bellula* sp. nov.; venation.
2. *Ptychoptera javensis* sp. nov.; venation.
3. *Dolichopeza (Sinoropeza) paucisetosa* sp. nov.; venation.
4. *Dolichopeza (Nesopeza) fabella* sp. nov.; venation.
5. *Limonia (Dicranomyia) pacifera* sp. nov.; venation.
6. *Limonia (Geranomyia) sparsiguttata* sp. nov.; venation.
7. *Limonia (Geranomyia) spectata* sp. nov.; venation.
8. *Limonia (Geranomyia) subradialis* sp. nov.; venation.
9. *Limonia (Geranomyia) gracilispinosa* sp. nov.; venation.
10. *Limonia (Geranomyia) contrita* sp. nov.; venation.
11. *Helius (Helius) hæmorrhoidalis* sp. nov.; venation.
12. *Helius (Helius) aciferus* sp. nov.; venation.
13. *Orimarga (Orimarga) exasperata* sp. nov.; venation.
14. *Pseudolimnophila projecta* sp. nov.; venation.
15. *Hexatoma (Eriocera) quadriatrata* sp. nov.; venation.
16. *Teucholabis (Teucholabis) kiangsiensis* sp. nov.; venation.
17. *Gonomyia (Lipophleps) inquisita* sp. nov.; venation.
18. *Gonomyia (Lipophleps) subanxia* sp. nov.; venation.
19. *Gonomyia (Lipophleps) atrox* sp. nov.; venation.
20. *Idiocera (Ptilostenodes) uniplagiata* sp. nov.; venation.
21. *Cryptolabis (Bæoura) angustilobata* sp. nov.; venation.
22. *Molophilus injustus* sp. nov.; venation.
23. *Styringomyia spathulata* sp. nov.; venation.
24. *Styringomyia pendula* sp. nov.; venation.

PLATE 2

FIG. 25. *Limonia (Dicranomyia) pacifera* sp. nov.; male hypopygium.
26. *Limonia (Geranomyia) sparsiguttata* sp. nov.; male hypopygium.
27. *Limonia (Geranomyia) subradialis* sp. nov.; male hypopygium.
28. *Limonia (Geranomyia) gracilispinosa* sp. nov.; male hypopygium.
29. *Helius (Helius) hæmorrhoidalis* sp. nov.; male hypopygium.
30. *Helius (Helius) aciferus* sp. nov.; male hypopygium.
31. *Orimarga (Orimarga) exasperata* sp. nov.; male hypopygium.
32. *Gonomyia (Lipophleps) subanxia* sp. nov.; male hypopygium.

PLATE 3

FIG. 33. *Gonomyia (Lipophleps) atrox* sp. nov.; male hypopygium.
34. *Idiocera (Ptilostenodes) uniplagiata* sp. nov.; male hypopygium.

FIG. 35. *Cryptolabis* (*Bæoura*) *angustilobata* sp. nov.; male hypopygium.
36. *Molophilus injustus* sp. nov.; male hypopygium.
37. *Styringomyia spathulata* sp. nov.; male hypopygium, tergite and sternite.
38. *Styringomyia spathulata* sp. nov.; male hypopygium, apex of basistyle.
39. *Styringomyia spathulata* sp. nov.; male hypopygium, styli.
40. *Styringomyia pendula* sp. nov.; male hypopygium, tergite and sternite.
41. *Styringomyia pendula* sp. nov.; male hypopygium, styli.

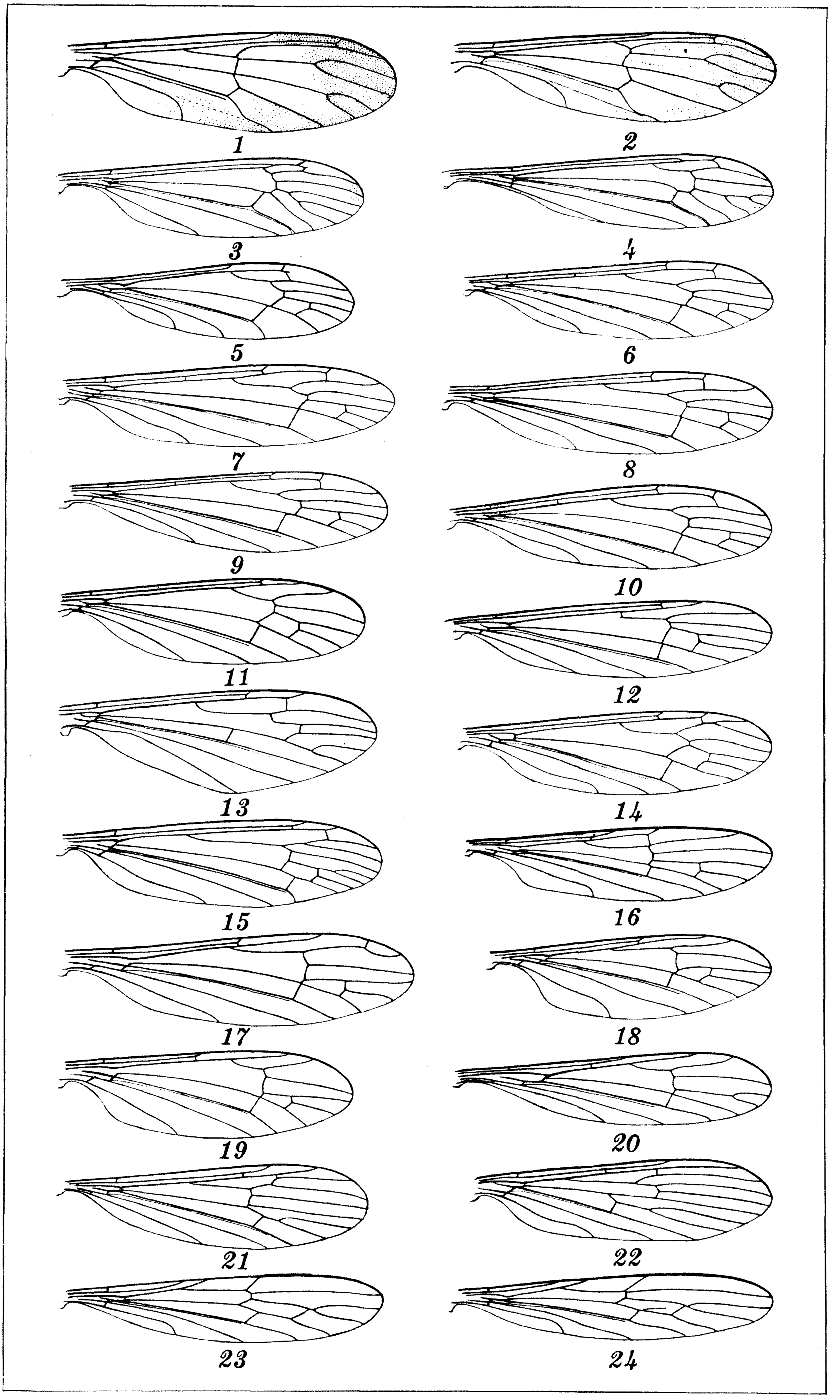

PLATE 1.

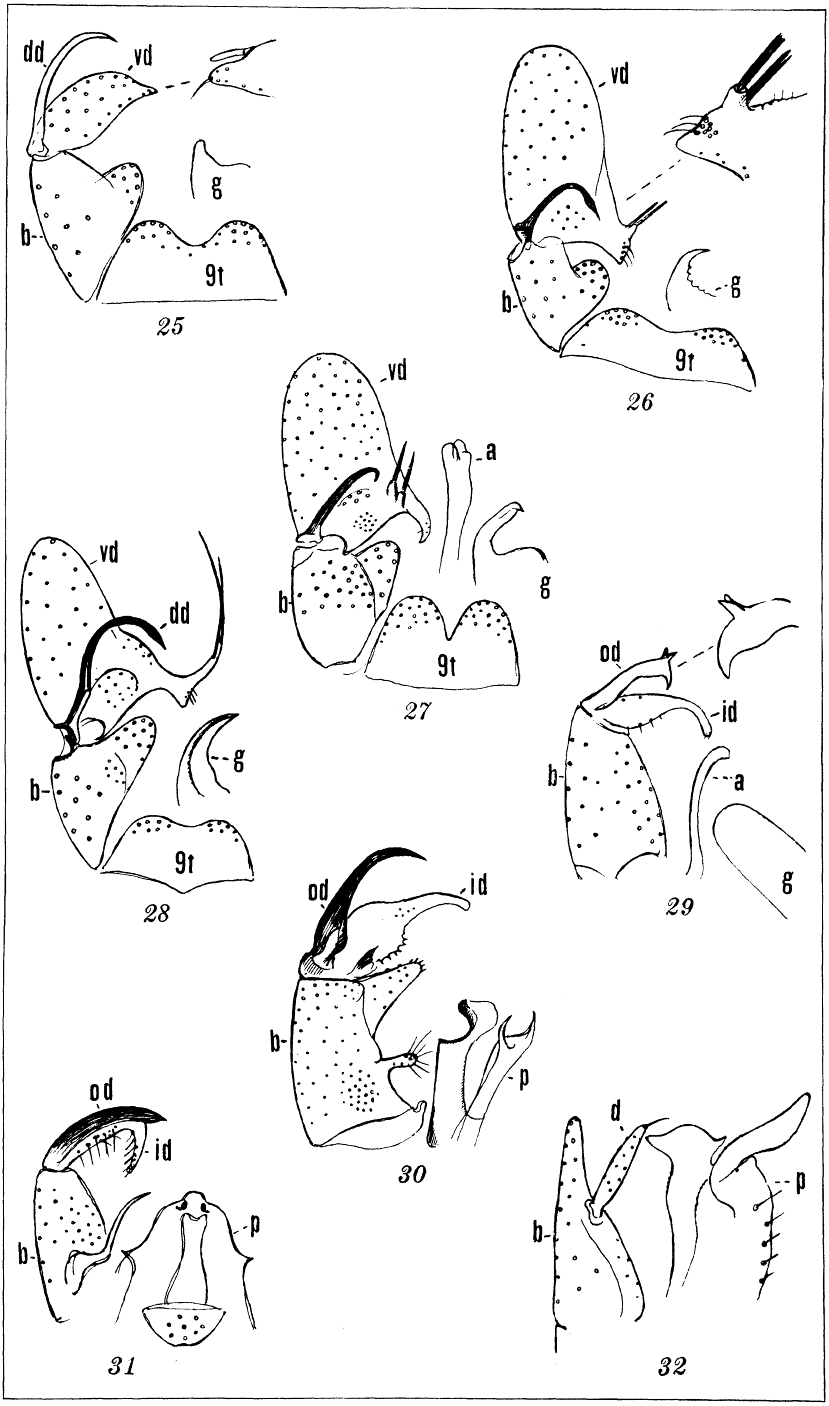
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PLATE 2.

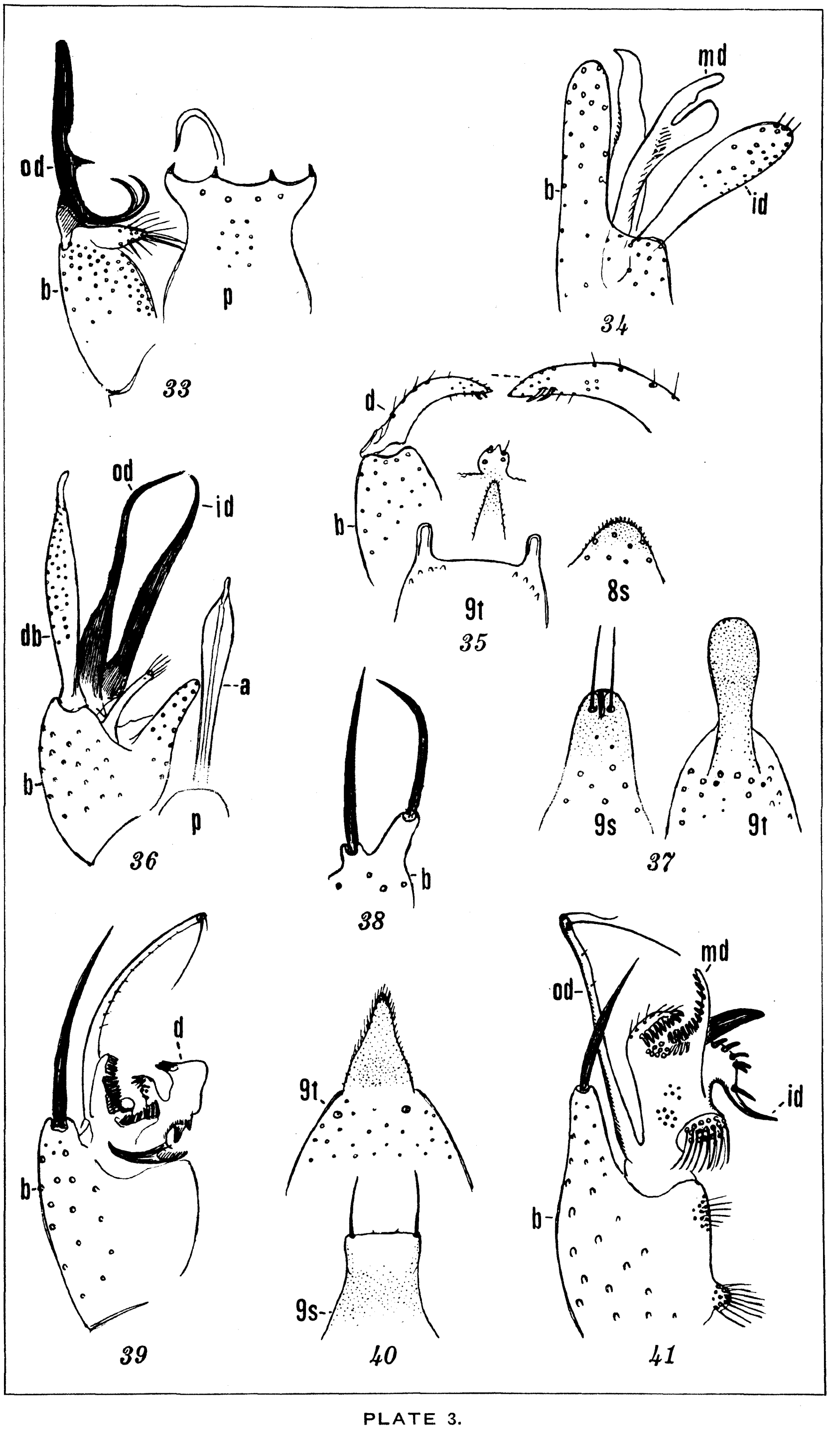
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PLATE 3.

EFFECT OF DECORTICATION ON THE CONSTITUENTS OF PHILIPPINE GINGER

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Ginger for export purposes may be either the dried undecorticated or the decorticated rhizome of the plant known botanically as *Zingiber officinale* Rosc. This plant is indigenous to the East Indies, but is now cultivated in many tropical countries.

In the work of Marañon and Caguicla[1] on Philippine ginger an attempt was made to ascertain whether this product could meet the requirements for ginger imported into the United States. A number of samples were analyzed, and it was found that many of them did not exactly conform to the United States standards. Some had less than the required amount of starch (42 per cent) while others contained more than the maximum quantity allowed for ash (7 per cent). Since the rhizomes analyzed were not peeled, we thought that decorticating them would alter their chemical composition sufficiently to meet the requirements of the United States standards. Accordingly a number of ginger samples, both decorticated and undecorticated, were analyzed. The results are recorded in this paper.

EXPERIMENTAL PROCEDURE

The ginger rhizomes used in this investigation were purchased in the Manila markets. They were first washed with water to free them from adhering particles of soil. The whole rhizome ("hand") was then split longitudinally into approximately equal halves. One half of the "hand" was peeled, or decorticated, by means of a scalpel, essentially according to the method described by Joachim.[2] The skin of the rhizome was merely scraped, and care was taken not to cut deeply and destroy the subepidermal cells, for these cells contain much of the oil that gives ginger its characteristic aroma.

The decorticated portions of the rhizomes were again washed and then dried in the sun. The other half of the "hand," which

[1] Philip. Journ. Sci. 58 (1935) 171.

[2] Trop. Agri. 83 No. 4 (1934) 214.

was not peeled, was also dried in the sun. After drying, the unpeeled and decorticated portions of each sample were ground and placed in glass stoppered bottles.

Twenty-two samples were analyzed in accordance with the directions given in the official methods for spices and other condiments.[3]

According to the United States Food and Drugs Act[4] dried ginger imported into the United States should conform to the requirements given in Table 1.

TABLE 1.—*Requirements for ginger imported into the United States.*

Constituent.	Per cent.
Starch	42 or more
Crude fiber	8 or less
Lime (CaO)	1 or less
Cold-water extract	12 or more
Total ash	7 or less
Ash insoluble in HCl	2 or less
Ash soluble in cold water	2 or more

The results of our analyses are given in Table 2. Comparing the data for both the decorticated and undecorticated rhizomes, we note that, by decortication, the chemical composition was, in general, changed in the following respects:

1. The amount of starch was increased very appreciably.
2. The crude fiber and the ash content were lowered considerably.
3. The ash soluble in water was reduced slightly.
4. Changes in the other constituents were not consistent.

Our experimental findings confirm our previous observations that, compared to foreign ginger, Philippine ginger is characteristically high in crude fiber, ash, and extractive matter (soluble in ether and alcohol) but rather low in starch content.

Decortication caused the composition of the ginger rhizome to approach more nearly the United States requirements. We found, however, that when the starch content was too low or the ash rather high, decortication did not produce sufficient change in these particular constituents to make the ginger conform to the United States standards.

[3] Methods of Analysis of the Association of Official Agricultural Chemists. 4th ed. (1935) 445.

[4] Dunn's Food and Drug Laws 1 (1927–1928) 132.

TABLE 2.—*Analysis of undecorticated and decorticated ginger rhizomes.*[a]

Sample.	Condition of sample.	Moisture.	Cold-water extract.	Alcoholic extract.	Ether extract.	Crude fiber.	Starch.	Calcium oxide.	Ash.		
									Total.	Soluble in water.	Insoluble in HCl.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Undecorticated	7.43	18.06	6.53	6.19	8.02	50.28	0.46	7.38	6.75	0.21
1A	Decorticated	8.18	14.85	4.56	5.67	5.11	54.80	0.25	6.65	6.26	0.31
2	Undecorticated	10.11	17.40	7.13	7.57	7.50	44.46	0.42	9.18	7.16	0.50
2A	Decorticated	9.23	16.70	6.02	7.49	5.73	47.18	0.35	8.18	6.93	0.54
4	Undecorticated	9.11	16.00	6.40	7.04	7.14	44.77	0.33	7.88	6.85	0.56
4A	Decorticated	6.52	15.10	5.29	6.26	5.26	51.61	0.20	6.92	5.86	0.59
5	Undecorticated	9.14	17.12	9.90	8.21	7.43	38.82	0.38	8.20	6.18	0.58
5A	Decorticated	9.27	16.71	9.42	7.91	5.00	46.37	0.21	7.00	5.83	0.65
6	Undecorticated	15.40	20.52	11.90	7.38	7.37	32.85	0.39	8.24	7.00	0.95
6A	Decorticated	13.06	24.45	12.27	7.68	5.39	36.27	0.46	8.17	6.99	0.86
7	Undecorticated	12.40	21.57	14.68	8.97	9.00	24.09	0.63	10.08	8.13	1.54
7A	Decorticated	16.13	20.92	16.50	6.85	7.84	29.99	0.64	8.87	7.45	1.20
8	Undecorticated	12.77	18.65	14.50	7.98	9.39	28.62	0.51	9.66	6.87	2.05
8A	Decorticated	15.03	18.20	15.30	8.31	7.30	31.70	0.66	8.46	6.47	1.42
9	Undecorticated	10.01	17.50	14.95	12.95	8.01	39.45	0.45	7.91	5.66	1.13
9A	Decorticated	14.39	17.33	15.45	10.15	6.85	48.37	0.46	6.95	5.19	0.85
10	Undecorticated	12.88	18.98	12.02	11.53	12.41	25.93	0.64	10.29	7.43	1.83
10A	Decorticated	12.68	19.35	13.67	13.72	8.94	31.70	0.62	9.25	6.93	1.91
11	Undecorticated	11.80	22.32	12.98	11.21	12.10	26.77	0.74	11.33	8.61	2.29
11A	Decorticated	12.36	23.35	17.01	13.58	10.29	28.91	0.95	9.41	7.53	1.73
12	Undecorticated	10.65	23.80	17.45	12.32	9.38	34.98	0.57	7.44	5.33	1.38
12A	Decorticated	10.24	24.72	18.17	11.48	7.71	42.18	0.61	6.15	5.13	0.89

[a] Percentages based on sun-dried samples. Each specimen of ginger was divided into two samples one of which was decorticated.

In order to produce Philippine ginger suitable for export it appears that the rootstock should be selected carefully for cultivation. Repeated cultivation and selection, as determined by analysis, should eventually produce a local ginger of satisfactory quality.

SUMMARY

By decortication the starch content of Philippine ginger was, in general, increased 14.9 per cent, while the ash was reduced 11.2 and the crude fiber 22.8 per cent.

Decortication also gave somewhat less water-soluble ash.

The effect of decortication on other constituents in the ginger rhizome did not give consistent results.

When the undecorticated ginger rhizome had an unusually low starch content or a rather high ash content, decortication did not produce sufficient change in these particular constituents to make the ginger conform to the United States standards.

PHYSIOLOGICAL ANATOMY OF THE LEAVES OF CUCURBITACEÆ

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ELEVEN PLATES

Although the anatomy of the stem and root of the Cucurbitaceæ has been sufficiently investigated, the physiological anatomy of their leaves has not yet been fully studied. Since the publication of Solereder's Handbook of the systematic anatomy of the dicotyledons, systematists have tried to utilize the facts of anatomy for purposes of classification. Investigation on the Cucurbitaceæ may be traced as far back as the middle of the eighteenth century, but much important research has been done on this group of plants during the latter part of the eighteenth and the early nineteenth centuries. Among early investigations may be mentioned the work of G. H. Kohl (1889) on the genera *Lagenaria* and *Momordica.* Martinet (1872), Vesque (1875), Eichler (1876), De Bary (1877), Weiss (1880), Arthur (1881), and other workers made valuable contributions, from both the morphological and the anatomical point of view. In 1881 Penzig first studied the cystoliths in the leaves of Cucurbitaceæ in *Momordica charantia* Linn. and *Momordica echinata* Spreng.[1] A. Fischer (1883), Uhlworm (1883), H. Molisch (1888), G. O. Müller (1889), Haberlandt (1889), Strasburger (1891), and Tognini (1894) have studied the family from different aspects. In 1896 and subsequently A. Yasuda published a few original papers on some of the Japanese species of the Cucurbitaceæ, in which he attempted to classify this family on the basis of the arrangement of the vascular bundles on the midribs of the leaves. Zimmerman in his recent monograph made an elaborate study of the morphology, anatomy, and physiology of the African Cucurbitaceæ. Roland Holroyd in 1924 published a paper on the origin of the wood and bast vessels in the bundle in the Cucurbitaceæ. Holroyd states that, due to continued cambial activity, the mass of internal phloëm in the Cucurbitaceæ is

[1] Bot. Zentralblt. 8 (1881).

gradually enlarged to form the well-known bicollateral bundle. Grace Barkley in 1927 investigated the differentiation of vascular bundles in *Trichosanthes anguina* Linn., a species common in India.

Little work has been done, however, on the leaves of the Cucurbitaceæ; the few species that have been investigated are mostly confined to Europe, Africa, and Japan.

The presence of bicollateral bundles and other anomalous internal structures in this group, and its important economic and medicinal properties, have made it interesting for further investigation. In the present paper I have attempted to investigate the anatomical peculiarities of the leaves of cucurbitaceous species common in, and in the neighborhood of, Calcutta, India.

MATERIALS AND METHODS

The species studied, all of which are cultivated principally for their edible fruits, were the following:

Trichosanthes dioica Roxb.; Sans. *patola;* Hind. *parvar, pavul;* Beng. *patol.*
Trichosanthes anguina Linn.; Sans. *chichinda;* Hind. *chachanda;* Beng. *chichinga.*
Lagenaria vulgaris Seringe; Sans. *alabu, kututumby* (bitter variety) Hind. *kadu, lauki;* Beng. *lau.*
Luffa ægyptiaca Mill.; Sans. *ghia turai;* Hind. *purul;* Beng. *dhundul.*
Luffa acutangula Roxb.; Sans. *jhingaka;* Hind. *turai;* Beng. *jhinga.*
Benincasa cerifera Savi.; Hind. *gol kaddu, kudimah, kondha;* Beng. *kumra, chalkumra.*
Momordica cochinchinensis Spreng.; Sans. *karkataka;* Hind. *kakrol;* Beng. *kakrol.*
Momordica charantia Linn.; Hind. *sushavi, karela;* Beng. *karala, uchhya;* two seasonal varieties found in Bengal.
Cucumis melo Linn. var. *momordica;* Hind. *phut, phunt;* Beng. *phuti.*
Cucumis sativus Linn.; Hind. *khira;* Beng. *sasa.*
Cephalandra indica Naud.; Hind. *bimb;* Beng. *telakucha.*
Cucurbita pepo DC.; Beng. *kumra;* Hind. *safed kumra.*

Fresh material was used in most cases, in others, material preserved in 5 per cent formalin. Fine hand sections lightly stained in Delafield's hæmatoxylin and mounted in glycerine (from 10 per cent to 50 per cent) were found suitable for the examination of the cell contents. Sections stained properly in saffranin and hæmatoxylin for differentiation of tissue were used whenever required.

GENERAL ANATOMY OF THE LEAVES

Weiss determined that in the Cucurbitaceæ all bundles in the stem are leaf-trace bundles. In the petiole, at the points where the veins branch off from the main bundles, the internal phloëm unites with the external, and hence the bundles in the leaf are longer bicollaterally.

The mesophyll tissue in the Cucurbitaceæ consists of both spongy and palisade parenchyma. The palisade tissue may consist of one or two layers, but the spongy tissue is generally three to seven cells thick.

TABLE 1.—*Number of layers of palisade and spongy cells, and average measurements in breadth of palisade and spongy tissues and lower and upper epidermis.*

Species.	Number of layers.		Average measurements.			
	Cells.		Tissue, in breadth.		Epidermis, in breadth.	
	Palisade.	Spongy.	Palisade.	Spongy.	Lower.	Upper.
			μ	μ	μ	μ
Trichosanthes anguina	1–2	2–5	63	30	25	35
Trichosanthes dioica	1–2	2–6	68	36	25	36
Luffa ægyptiaca	2	2	120	145	18	35
Lagenaria vulgaris	1	6	66	105	30	45
Luffa acutangula	2	2	160	155	21	42
Benincasa cerifera	1	3	85	96	77	52
Momordica cochinchinensis	2	2–6	36	35	23	42
Momordica charantia	2	2–4	26	25	13	22
Cucumis melo var. *momordica*	2	3–6	25	32	46	38
Cucumis sativus	2	2–7	24	48	36	52

SPECIAL STRUCTURES

(*a*) *Extrafloral nectaries.*—Extrafloral or extranuptial nectaries are common in most species of the Cucurbitaceæ. For the investigation of the general morphology and the physiological anatomy of the glands the following species were used: *Cephalandra indica* Naud., *Luffa acutangula* Roxb., *Luffa ægyptiaca* Mill., *Lagenaria vulgaris* Ser., *Cucurbita pepo* DC.

In *Cephalandra indica* there are a few dotlike glistening glands on the dorsal surface of the leaf, usually at the base on both sides of the midrib. A few more glands are scattered on the remaining parts of the lamina. They are never found on the leaf margin. They show no connection with the veins, as is the case with some other genera of the Cucurbitaceæ (Plate 1, fig. 3). In the early stages these glands consist of a few epidermal cells arranged in a circle below which there is ordinary mesophyll tissue. In a longitudinal section the gland is semicircular in appearance, its flat side being either continuous with the lower epidermis of the leaf or slightly depressed. It is surrounded by a layer of semicircularly arranged suberized thick-walled cells, except on the epidermal side, the cells of which are rather thin-walled and nonlignified (Plate 3, fig. 11). The suberized tissue so arranged in a semicircle is termed superficial tissue. It is stained red by saffranin. Professor Zimmerman has observed a similar gland in *Fagraea fragans*. The superficial tissues have been regarded by some workers as having a certain resemblance to the endodermis. The cells within these superficial tissues are thin-walled, comparatively smaller, and devoid of chlorophyll. They essentially contain sugar in solution with water and other secretory substances. The superficial chain of cells in turn is surrounded by colorless patches of mesophyllous tissue with tracheidal ends. They may be termed supply patches, as they seem to supply the glands with secretory fluid. The liquid passes up to the tracheidal ends by transpiration and root pressure through cell to cell osmosis, but how this liquid passes from these patches to the glands proper through the mesophyllous cells is a question. The space between the tracheidal ends and the gland may be charged with high osmotic pressure, as sufficient amounts of osmotically active substance, that is, sugar in solution with water, has been found in these spaces. A membrane protects the outer flat end of the gland from the influence of the external environment. This membrane is permeable to the osmotic solution. The osmotic theory of the escape of fluid from these extranuptial nectaries is verified by the fact that the cells are charged with sufficient quantities of sugar solution. That other physico-chemical or biological phenomena do not take part in the escape of fluid cannot be confidently stated until this phenomenon has been subjected to further study.

Average length of glands, 560 μ; breadth, 122.

Thickness of the superficial cells forming the convex side, 22 μ.

In *Luffa acutangula* and *L. ægyptiaca* the morphological appearance of the leaf is closely allied, and the internal structure of the nectaries is more or less similar. In both the extranuptial nectaries are confined to either sides of the principal veins on the abaxial leaf surface. The nectaries are more crowded at the base of the lamina (Plate 1, fig. 1). A few glands are scattered on the remaining part of the lamina. In *L. ægyptiaca* the glands are less numerous and less distinct than in *L. acutangula*. The glands in these species agree with those of *Cephalandra indica*, except in the following respects: (*a*) they are smaller, (*b*) they protrude outward from the general level of the epidermal surface, (*c*) the superficial cells are more convex but less suberized, (*d*) they are not surrounded by semicircular tracheidal patches.

A group of irregularly crowded mesophyllous cells of special form surround the gland and often have drops of sugar solution on them. A few tracheidal ends are scattered on the mesophyllous cells away from the superficial tissue.

Luffa acutangula, average length of gland, 528 μ; breadth, 80.

L. ægyptiaca, average length of gland, 320 μ; breadth, 112.

In *Lagenaria vulgaris* there are only two large lateral glands on the base of the leaf, at the junction of the blade and the petiole. The whole lamina is free from any other nectary except the vein ends of the leaf tooth, which are swollen and glandular in appearance. A few glands are also found on the margin of the leaf along with the tooth glands, and sometimes the tooth glands and marginal glands are jointed together (Plate 2, fig. 8). A longitudinal section of the gland shows the following internal structures: (*a*) A layer of thick-walled rectangular outer cells, (*b*) prominent suberized superficial cells, wavy to irregular in appearance, encircling a mass of reserve cells, (*c*) away from the superficial tissue, wavy or semiwavy parenchymatous tissue congregated together around the superficial layer of cells, covering a considerable area of the gland. These supply tissues often contain watery drops with abundant sugar in solution (Plate 3, fig. 10). The area further away from the supply tissue contains a number of tracheids (bundle ends). The tracheids no doubt are the channels through which secretory fluid escapes. While the glands are young they do not secrete nectar, but as they mature, the reserve cells disorganize and form a passage for the translocation of fluid outside the plant body (Plate 3, fig. 10).

On a sunny day fluid escapes profusely, and the secretion is often sucked by butterflies, moths, ants, and other insects.

The leaves of *Cucurbita pepo*, unlike those of other Cucurbitaceæ, have club-shaped glands covered with short hairs and attached with the veinlets on the lower surface (Plate 5, fig. 29). The extrafloral nectaries are peculiar in appearance. In a longitudinal section the glands, like those of other species, show a suberized superficial layer of cells at the end of the club-shaped gland, covering a small area. The tip of the gland is cup-shaped or semicircularly curved; its concave side lies toward, and the convex side away from, the gland; a few tracheidal strands run near about the superficial cells straight-away from the veins. The gland of this species is simpler in internal structure than in those mentioned above, as it merely contains a layer of curved superficial cells enclosing a few reserve cells. No specialized supply patches of mesophyllous tissue are present.

Different theories have been advanced regarding the function of these extrafloral or extranuptial nectaries. "According to Belt, Delphino and others these organs serve to attract protective ants" (Haberlandt). These nectaries occur on the leaves or on other vegetative organs, like bracts. Their position on the leaves and leaflike organs varies in different species. They are similar in structure to the floral nectaries, although they perform slightly different functions. They remain active for a longer period than floral nectaries. That the escape of watery liquid depends upon osmotic suction has been experimentally proved by Wilson (Haberlandt). Osmotic action is induced by the presence of sugar in the nectaries. The secretion of nectar probably contributes to the maintenance of the body temperature of the plant, and may also help in the exudation of waste products otherwise injurious to the plant body, and, last but not least, allures ants against injurious pests. There is a striking relationship in all the glands of the species examined. In every case there is a layer of superficial tissue of cells enclosing a mass of reserve cells, and a tracheidal arrangement in the form of patches or strands.

(*b*) *Cystoliths in the leaf of Momordica.*—The present investigation is based on the three species of *Momordica;* namely, *Momordica charantia* Linn., *Momordica cochinchinensis* Spreng., and *Momordica dioica* Roxb. The material was usually examined in a fresh condition, and mounted in 5 per cent glycerine whenever required.

In 1881 Penzig, studying the occurrence of cystoliths in the leaves of *Momordica charantia* and "*Momordica echinata* Wall.," [2] observed that the cystoliths are arranged in groups of two, three, or many. Penzig's observations on the occurrence of cystoliths only in the enlarged epidermal cells of the lower epidermis of the leaf have been confirmed by my own observations, but his results with regard to the occurrence in *M. charantia* of cystoliths mostly in groups of three to five do not coincide with my own findings. In the Indian species examined I have found about 60 per cent of the cystoliths arranged in groups of two; cystoliths in groups of three, four, and five to seven have

[2] According to Radlkofer, the latter plant is not *M. echinata* Wall.= *Echinocystis lobata* Torr. and Gray, but another species of *Momordica.*

also been met with in *Momordica charantia,* but groups from five to seven are rare and generally do not exceed 1 per cent. The cystoliths are uniformly distributed on the lower surface of the leaf. They do not occur in the petiole and they have no connection with veins or veinlets. The stalks of the cystolith are very short. The cystolith groups are all attached with the stalks and arise from a common center. The epidermal cells that encase the cystolith groups are much enlarged, being sometimes ten times as large as the ordinary epidermal cells. The calcium carbonate in the form of small globules strongly impregnates a cellulose skeleton. When the deposit of calcium carbonate ($Ca\ CO_3$) is dissolved by diluted hydrochloric acid (HCl diluted) the skeleton shows concentric stratification (Plate 5, fig. 27). That the skeleton is made up of cellulose is shown by the following chemical reactions: (*a*) It dissolves in cupra ammonia; (*b*) it swells and finally dissolves in concentrated sulphuric acid; (*c*) it stains blue with iodine and sulphuric acid.

Measured.	Length. μ	Breadth. μ	Point of contact. μ
Single group	25–32	25–32	12–14
Double group	55–75	32–44	20–24
Triple group	60–74	32–36	20–30

The cystoliths of the Indian *Momordica cochinchinensis* Spreng. do not seem to have been worked out by any previous worker. In this species they are arranged in groups of two to four, and, as in *Momordica charantia,* they are uniformly distributed on the lower surface of the leaf. No cystolith is found in this species arranged singly or in groups of more than four. The following percentage of distribution of the cystolith groups is approximately correct: Single, nil; double, 50 per cent; triple, 25 per cent; groups of four, 25 per cent.

The cystoliths are encased within enlarged epidermal cells of the lower surface of the leaf. There are as many of these enlarged epidermal cells as there are cystolith groups; that is, each epidermal cell encases a single cystolith group. Due to this abnormal growth of the epidermal cells the cystoliths are pushed to a considerable depth of the mesophyll, so that in a transverse section they often seem to arise from the mesophyllous tissue of the leaf.

Unlike the case in *Momordica charantia,* the cystoliths of *Momordica cochinchinensis* have no definite structure. They are irregularly branched and hence heteroplanous. Due to this irregular branching they show no definite shape (Plate 4, figs.

15 to 17). At the beginning of their formation they are more or less definitely oval, like those of *Momordica charantia,* but as they grow older they invariably branch off and develop into various fantastic structures. Calcium carbonate is strongly impregnated over a stratified branched cellulose skeleton. The cystoliths are either sessile or very shortly stalked. Their number in a square centimeter varies from 1,000 to 1,600, and in an entire leaf there may be as many as 100,000.

Length of cystoliths in groups of 2 to 4, 60 to 75 μ; breadth, 35 to 42; breadth of the point of contact, 12 to 14.

The cystoliths in the leaf of *Momordica dioica* are more or less similar to those in *Momordica charantia,* differing from the latter only in the slightly irregular shape of the cellulose skeleton impregnated with calcium carbonate.

The great number of cystoliths in a single leaf gives an idea of the enormous quantity of calcium carbonate in a single plant of *Momordica.* Calcium carbonate is an excretory product. During the process of metabolism a large quantity of lime otherwise useless to the plant body is deposited in the leaves. The plant on which cystoliths are found must therefore require a sufficient amount of lime for its life process. According to Haberlandt the deposit of calcium carbonate may be redissolved and utilized by the plant when it is in need of calcium food.

The rigidity of the definition of cystoliths, as having a stalk and a body of cellulose on which carbonate of lime is impregnated in the form of globules, and which have been compared by some authors with grape bunches or mulberry clusters, should not be maintained, as in *Momordica cochinchinensis* are found cystoliths having no stalk or a very small (invisible) one, and a body of most irregular structures. Zimmerman has examined a similar type of cystoliths in *Momordica rostrata* Zimmerman.

(*c*) *Cystolithlike structures or pseudocystoliths.*—Deposits of calcium carbonate forming definite cystolith structures are larger, but numerous other small deposits, or cells impregnated with them, have also been observed. In the basal cells of the hairs of *M. cochinchinensis* they are often met with. These groups of cystoliths are smaller than those appearing on the lamina, and have no definite stalk, nor are they encased within netlike cells; hence the term "pseudocystoliths" (Plate 4, fig. 18). In *Cephalandra indica* some of the upper epidermal cells are strongly impregnated with calcium carbonate. These deposits of calcium carbonate are arranged in separate groups which assume the dotted appearance on the adaxial surface of the leaf. Held against light, they look like oil dots. Here the deposit is peculiarly on the upper surface of the leaf. The cells of the upper epidermis on which these deposits occur are somewhat enlarged, and the whole group of cells is sometimes completely impregnated with lime and shows free deposits of calcium carbonate (Plate 6, fig. 48).

(*d*) *Crystals in Momordica.*—Calcium oxalate crystals in the leaves of Cucurbitaceæ have not been sufficiently studied; in fact Professor Solereder remarks that he has never met with calcium oxalate crystals in the leaves of Cucurbitaceæ. Professor Zimmerman mentioned calcium oxalate in few species of *Momordica, Gerrardanthus, Luffa,* and *Physedra.*

The genus *Momordica* exhibits all over its body enormous deposits of calcium in the form of salts deposited in the plant body, as calcium carbonate in the form of cystoliths and as calcium oxalate in the form of crystals. Of these two different calcarious salts the former is largely confined to the leaves (lamina), and the latter is more or less confined to the stem and the petiole.

For the investigation of crystals only two species of *Momordica* have been examined, *M. charantia* and *M. cochinchinensis.* All specimens were collected from a locality near Calcutta, examined in a fresh condition, and mounted in 5 per cent glycerine.

Abundant crystals of calcium oxalate have been found in the petiole of both species. Most of the crystals are solitary. They are of rhombohydral types, belonging to the monoclinic system. Numerous other derivations of the monoclinic system in the form of twin or clustered crystals have also been found in abundance. Twin crystals (star-shaped) and combinations of the monoclinic and tetragonal systems with crystals of other different structures making complex or composite forms have been observed in the petiole of *Momordica charantia.* The twin crystals are mostly in the petiole, though a few may be found in the stem. The star crystals of *Momordica charantia* differ from those of *Momordica cochinchinensis* in having more projected and prominent star ends. The crystals in *Momordica cochinchinensis* are less numerous and smaller than in *M. charantia.* They are completely absent in the roots. In the stem the monoclinic crystals are most perfect and distinct, and larger. They are scattered throughout the ground tissue, though mostly confined to the cortical parenchymatous cells. They are absent in the epidermal cells and scarcely found in the vascular bundles.

If we trace the crystals from the petiole through the midrib to the leaf blade we find that their size gradually diminishes and the shapes loose their prominence, so much so that they are not distinguishable even under the high-powered lens of the microscope; hence the term "dust crystals" has been applied to them. These crystals are traceable up to half of the midrib but not beyond.

Momordica charantia, star-shaped crystals, 18 to 24 μ; tetragonal, 9 to 18.

Momordica cochinchinensis, star-shaped crystals, 9 to 12 μ; tetragonal, 7 to 10.

Crystals in the form of raphides and sphæraphides are not found in these species.

It is to be remembered that large amounts of calcium oxalate are manufactured in these plants as products of metabolism. Professor Haberlandt remarks that oxalic acid is formed in the plant body as a result of a variety of metabolic processes, particularly in connection with protein synthesis; but this substance is poisonous to the protoplasm and is accordingly rendered innocuous by combination with calcium to form the very insoluble oxalate of the metal. Calcium must therefore be present in the plant itself in large quantities. According to some workers this oxalate of lime, which is an excretory product, is redissolved by the plant once again when it is in need of calcium.

STOMATA AND HYDATHODES

Epidermal cells.—In general the epidermal cells are very wavy, but the cells on the adaxial surface of the leaf are less wavy than at the abaxial. Due to unequal thickening of the cell walls of the epidermal cells in *Lagenaria vulgaris* they have a dotted appearance, which is particularly marked when the leaf is in a fresh condition. Epidermal cells around the base of the hairs on *Cucurbita pepo,* and *Cucumis sativus* are very crowded.

The stomata in the Cucurbitaceæ show no peculiarity in structure. They are of very regular form, consisting of two identical guard cells of ordinary type. The epidermal cell all around the stoma show no peculiarity or congregation. The guard cells of the stomata contain 8 to 15 chloroplasts.

The average length of the stomata thus varies from 22 to 27 μ, the breadth from 12 to 18, and the pore length from 12 to 16.

TABLE 2.—*Average measurements of the stomata of Cucurbitaceæ based on five readings.*

Species.	Length.	Breadth.	Length of pore.
	μ	μ	μ
Luffa ægyptiaca	22	17	12
Trichosanthes dioica	26	18	15
Cephalandra indica	24	18	11.5
Lageneria vulgaris	27	18	16
Cucurbita pepo	16	12	15
Luffa acutangula	22	15	12
Momordica charantia	22	15	13
Momordica cochinchinensis	25	18	15
Trichosanthes anguina	24	15	14

Hydathodes.—Hydathodes of different structures are present on the leaves of Cucurbitaceæ; there are in fact abundant devices for exudation on these leaves; namely, (*a*) epithem type of hydathodes, (*b*) ordinary stomata which have ceased to perform their normal function and are transformed for water exudation, and (*c*) the trichomatous hydathodes.

Leaf apices or leaf teeth in many cases show hydathodal structures. The epithem type of hydathode has been observed in *Cephalandra indica.* Here the prominent leaf teeth are formed of special brown cells (Plate 1, fig. 3). On a longitudinal section they show a mass of epithem tissue in the intercellular space which the tracheids (bundle ends) penetrate, but no definite hydathode is seen at the extreme end, as found by Professor Haberlandt in *Primula chinensis.* Instead of a single hydathode at the extreme end there are a number of loose cells at the end with intercellular spaces through which water possibly escapes. The brown leaf apex in *Cephalandra* does not grow much with the growth of the leaf, so that the brown tooth ends in their early stages do not differ much in size from those in old leaves. With the growth of the leaf blade two side lobes with brown teeth are traced. Only the main teeth are specialized, the rest merely showing thickened tips.

Glandular hydathodes in the form of trichomes consisting of four cells which afterwards divide into many cells are also met with on the leaf. At first (in *Cephalandra indica*) a cell destined to become a gland divides by a transverse wall into a stalk cell and a gland cell of nearly the same size. The stalk cell in contact with the epidermis does not grow much, but the body cell which performs the function of secretion divides by a transverse wall into two and then by a vertical wall into four cells; at the four-cell stage it may divide again as in *Cephalandra indica*, where it is many-celled. The cells forming the body round off into a club-shaped structure, while the stalk is somewhat narrowed down (Plate 7, fig. 55). The cells of the glandular hair contain abundant protoplasmic substance.

The glandular hair in *Trichosanthes anguina* is peculiar. The stalk consists of a single cell and the body when mature consists of four cells forming the head. Each head cell contains a distinct nucleus around which cytoplasm is deposited, while the other portion of the cell may remain vacuolated.

In *Cucurbita pepo* there are 4 to 5 head cells (Plate 7, fig. 50). The formation of the gland is more or less like that of the above species. The hydathodes and water stomata perform the function of water exudation from the plant body. The leaf teeth of *Cucurbita pepo, Cucumis sativus, Cucumis melo*, and *Cucumis melo* var. *momordica* exhibit peculiar hydathodes at the tooth apices of the leaves. The leaf tooth is here much thickened and rounded. A fine transverse section through the tooth shows patches of thick rod-shaped epidermal cells separated from one another by a stoma (Plate 8, fig. 67). The cells of each rod at the extremity, that is, in contact with the hydathode, are the smallest. Each rod generally consists of 5 to 8 cells, and in a single tooth as many as sixteen hydathodes have been observed. That these hydathodes (aquatic stomata) are really the modified ordinary stomata is corroborated by the fact that similar respiratory cavities are found in these cases and that they are of nearly the same dimensions as the ordinary stomata.

Length of hydathodes, 21 μ; breadth, 10.5.

In a transverse section of a tooth of the species mentioned above only the side epidermal cells show hydathodes, the tip of the tooth being formed of a few loose cells.

The hydathodes here perform the function of a sieve, as water exudes out through all the aquatic stomata simultaneously. A large number of tracheids are present on the midregion of the tooth cell through which water is carried up. A layer of chlorophyll-containing cells surrounds the epidermis (Plate 8, fig. 67).

The Cucurbitaceæ are a family of the rainy season; the soil at that time contains much water and the atmosphere is almost saturated with water vapour, so the plant is likely to absorb much more water than it ordinarily requires. This circumstance explains the well-engineered hydathodal systems adopted by this family for rapid and easy discharge of water.

NONGLANDULAR HAIRS

The glandular hairs have already been described. Short or long multicellular hairs cover the adaxial and abaxial surfaces of the leaves of most Cucurbitaceæ.

On both surfaces of the leaf of *Lagenaria vulgaris* there are innumerable soft woolly hairs. The hairs on the lower surface are larger and cover the entire surface. Each hair consists of 3 to 4 cells in which protoplasm is uniformly distributed (Plate 8, figs. 65 and 66).

Two kinds of hairs are noted in *Cucurbita pepo.* Those on the upper surface are stiff, silicified, short uni-, bi-, or sometimes tricellular (Plate 9, fig. 68). The basal cells of the hairs perform the mechanical functions of resisting excessive pressure. The hairs on the lower epidermis (Plate 8, fig. 64) are longer, the basal cells supporting the hair are very strong, thick-walled, and crowded. The cytoplasmic matter is aggregated in some parts of the cell, leaving the other portions free from content.

The hairs of *Trichosanthes dioica* are strongly built and contain silica. These silica-containing hairs impart roughness to the leaf (Plate 9, fig. 70). Hairs on the leaves of *Luffa acutangula* contain in their basal cells deposits of lime crystals (calcium oxalate), which impart rigidity to the hairs (Plate 9, fig. 69).

On the upper surface of the leaf of *Cucurbita pepo* wax deposits are often met with. Wax deposited on the epidermal cells often partially or fully covers the pore of the stomata and thus prevents excessive transpiration.

PETIOLES

Lagenaria vulgaris.—Bundles 10, hollow at the base and solid at the end, with a vascular strand running through the hollow of the petiole making an angle of 45° in the anticlockwise direction from the point of attachment of the petiole with the branch.

Cucurbita pepo.—Bundles 13, arranged in a ring, sometimes one or two smaller bundles outside the ring; hollow throughout.

Luffa acutangula.—Bundles 8, arranged in a semicircle; solid throughout. The smallest bundle lies at the top.

Luffa ægyptiaca.—Bundles 9, arranged in a horseshoe structure; solid throughout.

Trichosanthes anguina.—Bundles 10, arranged in a horseshoe structure; solid throughout.

Trichosanthes dioica.—Bundles 7, arranged in a ring; solid throughout.

Benincasa cerifera.—Bundles 11 to 12, arranged in a ring; hollow throughout.

Cephalandra indica.—Bundles 7 to 8 in a ring; solid throughout (mucilaginous).

Momordica charantia.—Bundles 5, arranged in a horseshoe structure; solid throughout.

Momordica cochinchinensis.—Bundles 7, arranged in a horseshoe structure; solid throughout.

Cucumis melo.—Bundles 7 to 8, arranged more or less in a horseshoe structure. Solid throughout. The number of bundles in the petiole is never constant, varying in different parts of the same petiole.

MIDRIBS

The studies of A. Yasuda on Japanese species threw light on the systematics of the Cucurbitaceæ by his anatomical investigation of the midrib from the proximal part of the leaves. He described the following 6 types of arrangement:

1. A single vascular bundle; in *Actinostema racemosum, Schizopepon bryoniæfolius.*
2. Two vascular bundles, a large one on the middle and a smaller strand on the top; in *Melothria japonica.*
3. One large bundle and two small lateral strands; in *Gymnostema cissoides.*
4. Three vascular bundles, one large, and two small situated vertically above it; in *Benincasa cerifera, Cucumis sativus,* and *Lagenaria vulgaris.*
5. Four bundles arranged to form an almost right-angled cross, the lowest bundle being the largest; in *M. charantia,* species of *Luffa,* and *Trichosanthes.*
6. Seven vascular bundles forming a ring, the largest bundle situated below, the remaining strands above successively smaller, arranged symmetrically; in *Citrullus vulgaris* and *Cucurbita pepo.*

I have examined the midribs of 12 Indian species belonging to 8 genera and have noted some inconsistencies with the observations of Yasuda.

A single vascular bundle is not found in any of the species examined, but in *Momordica charantia* it is present in the midrib a little away from the petiole (Plate 10, fig. 72).

In *Benincasa cerifera* (Plate 11, fig. 79) three bundles are no doubt present and arranged, as described by Yasuda, all in a straight line, the lowest of them being the largest; but a fourth strand is also observed at the top of the third bundle. Yasuda's observations of the identical arrangement of vascular bundles in *Lagenaria vulgaris* (Plate 11, fig. 78) and *Cucumis sativus,* and their arrangement in a straight line, is not correct. In both

Lagenaria vulgaris and *Cucumis sativus* (Plate 11, fig. 81) there are four perfect bundles instead of three. In *Lagenaria vulgaris* the four bundles are arranged as follows: The lowest bundle largest, ring-shaped; the next two smaller bundles above it occupying a lateral position; the topmost bundle, which is the smallest, occupying a position at the head of the big basal bundle equidistant from the lateral ones (Plate 11, fig. 78). The topmost bundle in *Lagenaria* sometimes shows a compound form; that is, it is a combination of two bundles. In *Cucumis sativus* the second bundle lies vertically just above the largest one on the base, and the next two upper smaller bundles lie at the top of the intermediate one equidistant from it. *Cucumis melo* var. *momordica* shows exactly the same arrangement as *Cucumis sativus*, but the bundles at the top are very minute and look like strands.

The fifth arrangement of Yasuda, namely, four bundles arranged at right angles, the topmost the largest, as in *Momordica charantia, Luffa ægyptiaca, Luffa acutangula,* and *Trichosanthes anguina,* is quite in harmony with my observations, but in *Trichosanthes dioica* the fourth bundle at the top is not on the proximal part of the midrib.

The sixth arrangement of Yasuda, namely, seven vascular bundles forming a ring as in *Cucurbita pepo,* is correct, though occasionally an eighth bundle at the top, or sometimes 9 bundles, are also found; but whatever the number they are always arranged in a ring.

Two vascular bundles, one above the other, the lowest being the largest as is observed by Yasuda in *Melothria japonica,* are also found in *Cephalandra indica* (Plate 10, fig. 71). The arrangement of vascular bundles in *Momordica cochinchinensis* does not coincide with that of *M. charantia.* In *M. cochinchinensis* there are five bundles instead of four. The arrangement is otherwise similar to that in *M. charantia,* except that each of the two smallest bundles at the top lies above each of the intermediate lateral bundles (Plate 10, figs. 72 and 73).

Though the observation made by Yasuda on the arrangement of vascular bundles in the leaves of Cucurbitaceæ is not correct in all respects, it offers valuable suggestions for further systematic study, not only on the mere arrangement of the vascular bundles but also on the structure of the lowest, that is, the biggest bundle, which in most respects is peculiar to each genus.

The fourth bundle in *Luffa ægyptiaca, L. acutangula,* and *Lagenaria vulgaris,* seems to be the point of origin of many bundles, as the number of bundles at any portion away from the petiole is often greater.

SUGGESTED AFFINITIES

From the anatomical details of the vascular bundles of the midribs of Cucurbitaceæ it has been possible to determine phylogenetic relationships between the members of the family, if the reduction of the number of vascular bundles is considered a principal criterion from the evolutionary point of view. The genus *Trichosanthes* seems to have a striking relationship with the genus *Luffa.* Of the two species of *Trichosanthes* studied, *T. anguina* most closely resembles *Luffa,* which also has four vascular bundles that are arranged crosswise, the lowest being the largest and the topmost the smallest. From the standpoint of the reduction of vascular bundles *T. dioica* seems to be derived from *T. anguina,* the topmost bundle of the cross being absent in the former. Moreover, *T. anguina* can still be found growing wild in our locality, while *T. dioica* is never found in a wild state and has undergone wide cultivation. Of the two species of *Luffa, L. acutangula* seems to be the more primitive. Here the topmost bundle may be taken as a compound one, made up of two bundles. In *Luffa ægyptiaca* the topmost bundle is perfectly single and there seems to be a tendency of further reduction of the number of bundles, as the two bundles at the middle are found joined in the proximal part of the midrib, and may in the course of time be fused and reduced to a single bundle. *Momordica charantia* seems to be derived from *Momordica cochinchinensis.* The latter species contains five vascular bundles at the midribs, while in the former we find only four bundles at the base of the midrib. Four bundles are present only at the very beginning of the midrib, but all the three top bundles do not occur at other portions of the midrib, where only a single vascular bundle is to be seen.

Cucumis sativus seems to be more primitive than *Cucumis melo;* of the four vascular bundles of the latter species, three at the top are on the verge of extinction. *Benincasa cerifera* [3]

[3] Characters common in *Benincasa* and *Cucurbita* are: Large climbing herbs, soft hairy tendrils 2- to 4-fid in *Cucurbita* but 2-fid in *Benincasa.* Leaves cordate, 5-angular or lobed; petioles without glands. Flowers large, yellow monœcious, all solitary, without bracts. Male, calyx tube campanulate, lobes 5-linear or foliaceous; corolla campanulate, 5-lobed; stamens 3, inserted in the calyx tube. Female, calyx and corolla as in the male; ovary oblong; ovules many-horizontal; placentas 3. Fruits fleshy, large, indehiscent; seeds compressed.

Loureiro (1790), in his Flora Cochinchinensis, named it as *Cucurbita pepo* Lour. C. L. Blume (1826) in his "Bydragen tot de van Nederlandsch Indie" designated it as *Cucurbita ferinosa* Blume, and Wallich in his catalogue No. 6723 described it as *Cucurbita hispida* Wall., which from its external appearance seems to have much similarity to *Cucurbita pepo;* so much so that authors like Loureiro, Blume, and Wallich placed *Benincasa cerifera* as a species of *Cucurbita;* but the number of vascular bundles (seven) and their arrangement (in an ellipse) in *Cucurbita pepo* differ greatly from those of *Benincasa cerifera,* which has four vascular bundles lying in a straight line. This arrangement may be explained by the fact that each two side bundles at the top of *Cucurbita pepo,* except the basal one which is the largest, approach one another and finally fuse to a single bundle, and as a result there are three bundles in a straight line just above the basal bundle, the exact arrangement in *Benincasa cerifera. Benincasa* may therefore be regarded as an advanced form of *Cucurbita. Cephalandra indica,* which contains only two vascular bundles in the midrib, seems to have no relation to any of the above species. It may have branched off at a remote period from some unknown group of Cucurbitaceæ.

CONCLUSION

Most of the species of the Cucurbitaceæ examined are equipped with strikingly interesting adaptations for the discharge of superflous fluid from the plant body. The excretion of aquatic fluid seems to be very important in all these species. Hence, apart from the presence of innumerable hydathodal hairs in nearly all of them, which perform an important function for the drainage of water, various other structures in the form of glands and nectaries have developed. It is evident that cucurbitaceous plants, being mainly plants of the rainy season, absorb unusual quantities of water from the soil or from rain water, so that they require well-engineered structures for easy and rapid discharge of the excess intake of water. Therefore we find sieve and epithem types of hydathodes in addition to other devices.

Some genera of the Cucurbitaceæ, like *Momordica, Cephalandra,* and *Cucurbita,* seem to have a high calcium requirement, and for the utilization of lime food have reservoirs of calcium in the form of cystoliths and crystals, ready for immediate use. Anatomical arrangement of the midribs and petioles seems to have much importance in the classification of the family into groups, from the evolutionary as well as from the taxonomic point of view.

SUMMARY

1. Extrafloral nectaries are present in the leaves of (*a*) *Cephalandra indica* on the leaf base of the blade, (*b*) in *Luffa acutangula* and *Luffa ægyptiaca* all over the lamina, (*c*) and in *Lagenaria vulgaris* as two lateral glands on the petiole and a few at the leaf tooth.

2. All glands show the presence of sugar and have special devices for the discharge of osmotically active fluid. The glands of the Cucurbitaceæ are characterized by a superficial layer of cells that covers a group of reserve cells.

3. The presence of heterophanous branched cystoliths enclosed within enlarged lower epidermal cells of the leaf in *Momordica cochinchinensis* invalidates the definition of cystoliths generally adopted in text books, and further casts light on the formation and deposit of lime in plant cells.

4. The genus *Momordica* alone shows the presence of solitary, clustered, or twin crystals and crystal dusts of various structures.

5. Arrangement, number, and nature of vascular bundles in the midribs and petioles of cucurbitaceous leaves maintain an individuality of character in a particular genus or even in a species, so much so that they facilitate the identification of the genus from knowledge of the anatomy of the midrib and the petiole.

6. Cucurbitaceæ are equipped with facilities for the rapid drainage of superfluous water. Water stomata and hydathodes of different structures (sieve and epithem types and glandular hairs) are abundantly present.

7. The hairy coverings on the leaves of *Cucurbita pepo, Luffa acutangula,* and *Momordica cochinchinensis* are peculiar. Calcium crystals, known as pseudocystoliths, are deposited in some of the hairs.

8. On the basis of the anatomical knowledge of the leaf in the Cucurbitaceæ the relationship of the genera may be traced from the evolutionary standpoint.

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ILLUSTRATIONS

Plate 1

Fig. 1. Leaf of *Luffa acutangula,* showing the general distribution of the extrafloral nectaries over the lamina, on either sides of the prominent veins. × 0.5.

2. A part of the lower surface of the leaf of *Cucurbita pepo,* showing club-shaped glands. × 0.5.
3. Leaf of *Cephalandra indica* showing the basal position of the glands and the specialized leaf tooth. × 0.5.
4. Leaf of *Momordica charantia* showing minute dots of cystoliths. × 0.5.

Plate 2

Fig. 5. Leaf of *Trichosanthes anguina.* × 0.5.

6. Leaf of *Trichosanthes dioica.* × 0.5.
7. Young leaf of *Momordica cochinchinensis* showing innumerable cystolith dots over the lamina. × 0.5.
8. Young leaf of *Lagenaria vulgaris* with two lateral glands. × 0.5.
9. A part of the lower surface of the leaf of *Cucurbita pepo* showing the shape of the gland. × 10.

Plate 3

Fig. 10. Longitudinal section of gland at right angle to the leaf lamina of *Lagenaria vulgaris,* showing superficial layer of cells, disorganized reserved cells, supply tissue with sugar drops, and tracheidal ends. × 50.

11. Longitudinal section of gland at right angle to the lamina of *Cephalandra indica* with tracheidal patches around it. × 75.
12. Longitudinal section of gland at right angle to the lamina of *Cucurbita pepo.* × 25.
13. Longitudinal section of gland at right angle to the lamina of *Luffa acutangula* with sugar drops on the supply tissue. × 75.
14. Same as above. × 175.

Plate 4

Figs. 15 to 17. Cystoliths from the leaf of *Momordica cochinchinensis;* heteroplanous, branched and with enlarged epidermal cells encasing the cystolith groups. × 175.

Fig. 18. An epidermal hair from the leaf of *Momordica cochinchinensis,* showing pseudocystoliths in the basal cells of the hair. × 175.

Figs. 19 to 22. Two, three, four, and seven groups of cystoliths respectively in *Momordica charantia.* × 225.

PLATE 5

FIGS. 23 and 24. Double groups of cystoliths in *M. cochinchinensis.* × 220.

25 and 26. The cellulose skeleton of cystoliths from *M. cochinchinensis,* showing concentric stratification when calcium carbonate is dissolved in diluted HCl. × 220.

FIG. 27. The cellulose skeleton of the cystoliths of *M. charantia* in groups of seven when calcium carbonate is dissolved in diluted HCl. × 275.

FIGS. 28 to 30. Position of cystoliths in the enlarged epidermal cells and their mode of attachment. × 220.

PLATE 6

FIGS. 31 to 43. Various structures of crystals found in *M. charantia.* × 1,250. Figs. 30, 32, and 43 show twin (star-shaped) crystals.

44 to 48. Various structures of crystals found in *M. cochinchinensis.* × 1,250. Fig. 48 shows twin star-shaped crystals.

FIG. 49. Transverse section of the leaf of *Cephalandra indica,* showing the deposit of calcium carbonate in the upper epidermal cells. × 290. Complex crystals are shown in figs. 42 and 44 to 46.

PLATE 7

FIG. 50. A glandular hair of *Cucurbita pepo.* × 305.

FIGS. 51, 55, 57, 58, and 60. Different stages of the glandular hairs of *Trichosanthes anguina* (Cytoplasm with distinct nucleus). × 305.

FIG. 52. Net work of veins in *Trichosanthes dioica.* × 110.

FIGS. 53, 54, 55, 59, and 61. Glandular hairs of *Cephalandra indica.* × 305.

FIG. 63. A stoma from the leaf of *Cephalandra indica.* × 624.

PLATE 8

FIG. 64. Nonglandular hair from the lower surface of the leaf of *Cucurbita pepo.* × 305.

FIGS. 65 and 66. Nonglandular hairs from the lower surface of the leaf of *Lagenaria vulgaris.* × 305.

FIG. 67. Longitudinal section of the leaf tooth at right angle to the lamina of *Cucurbita pepo,* with sieve type of hydathodes. × 330. Hydathodes are arranged between bands of thickened epidermal cells.

PLATE 9

FIG. 68. Hairs from the upper surface of the leaf of *Cucurbita pepo,* with strong deposit of silica. × 260.

69. Hair from the leaf of *Luffa acutangula,* with deposit of lime. × 260.

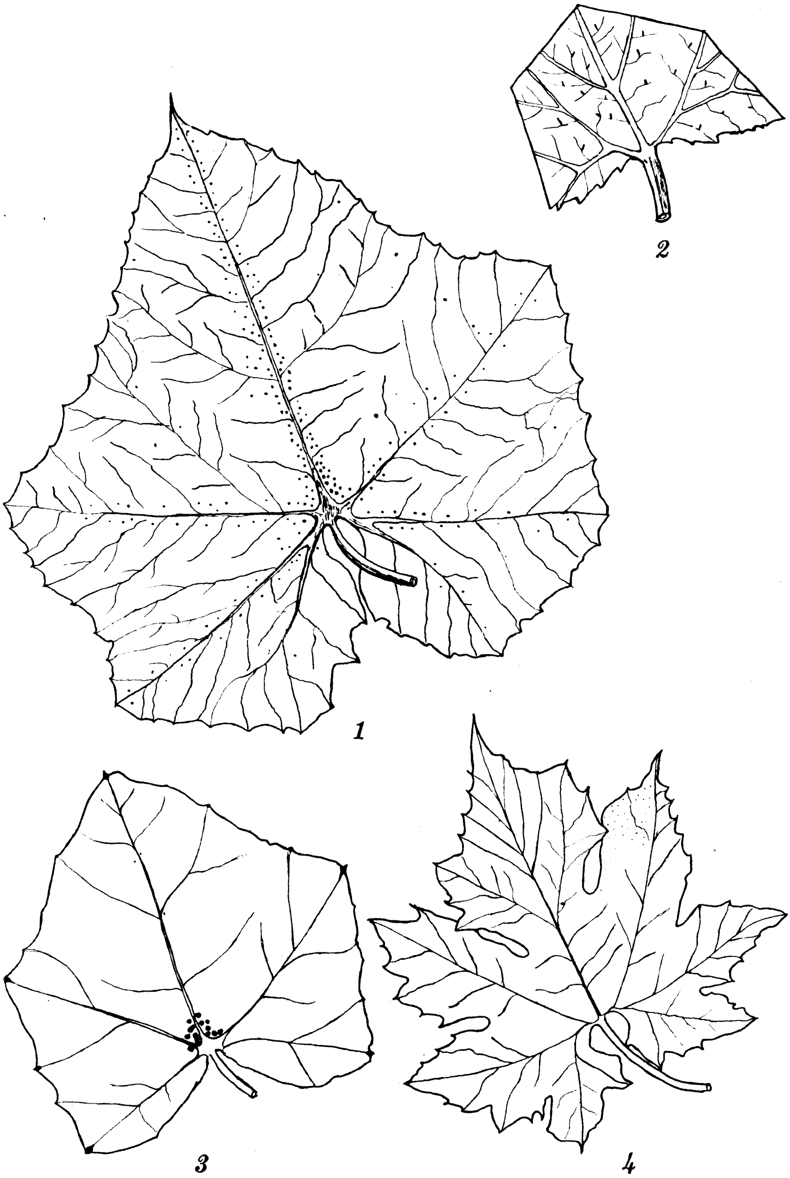
70. Hair from the leaf of *Trichosanthes dioica,* with deposit of silica. × 260. Transverse section of the midribs of the leaves of different species from the proximal part of the petioles. × 40.

PLATE 10

FIG. 71. *Cephalandra indica.*
72. *Momordica charantia.*
73. *Momordica cochinchinensis.*
74. *Luffa aegyptiaca.*
75. *Luffa acutangula.*
76. *Trichosanthes dioica.*

PLATE 11

FIG. 77. *Trichosanthes anguina.*
78. *Lagenaria vulgaris.*
79. *Benincasa cerifera.*
80. *Cucurbita pepo.*
81. *Cucumis sativus.*
82. *Cucumis melo* var. *momordica.*



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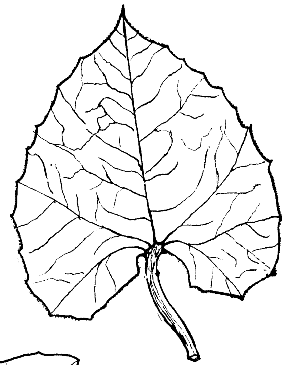

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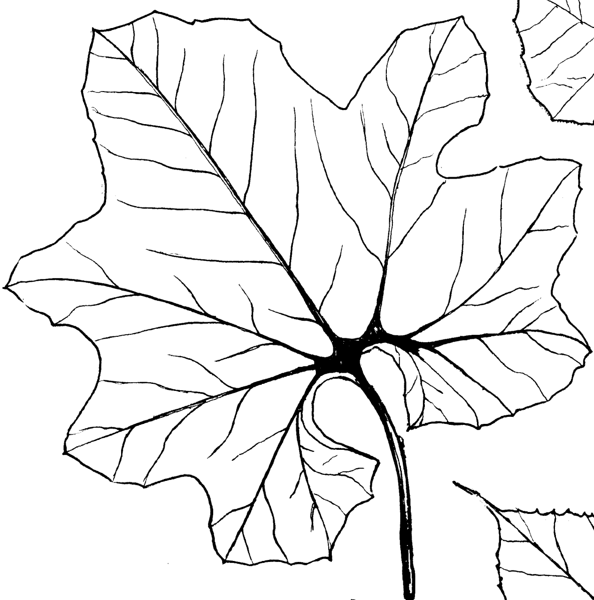

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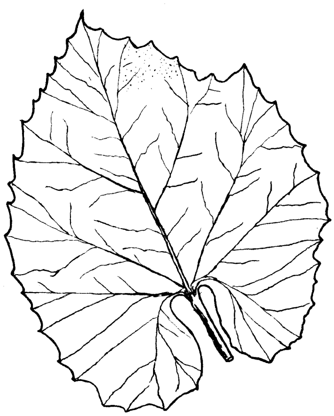

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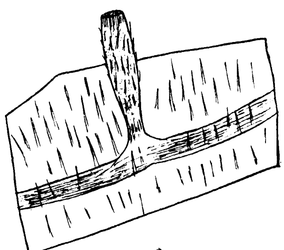

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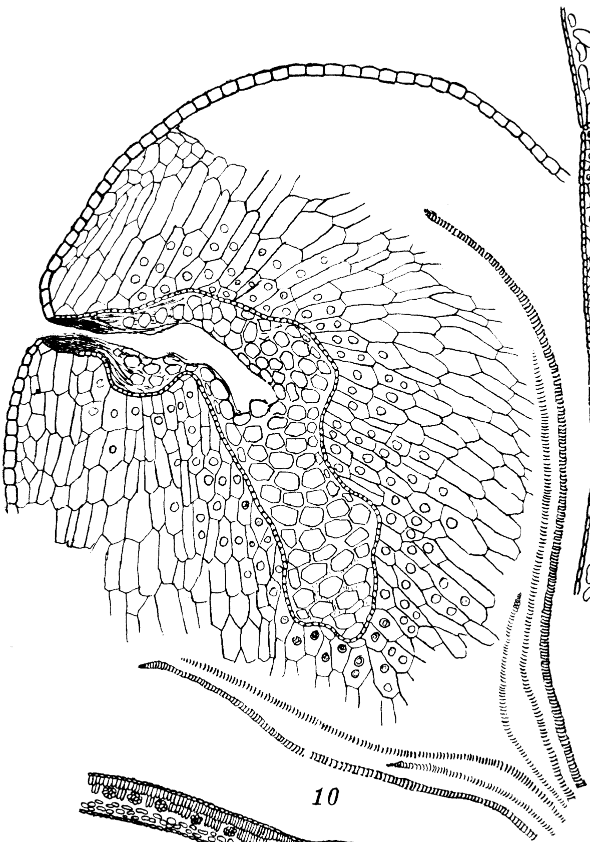

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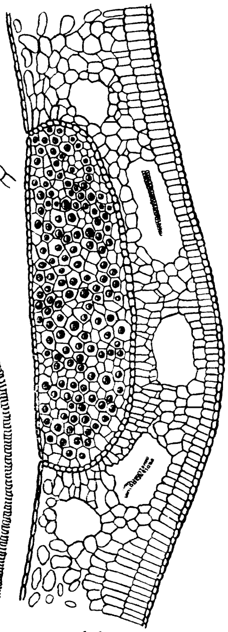

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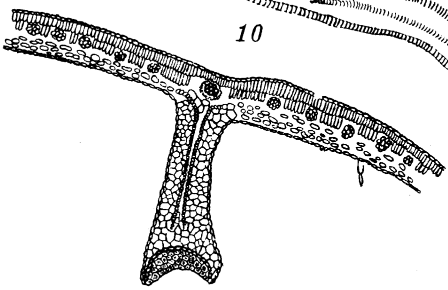

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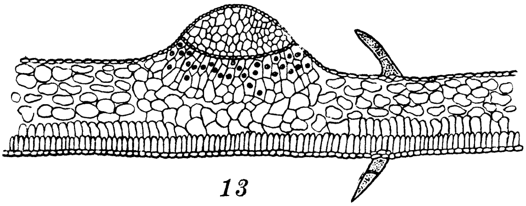

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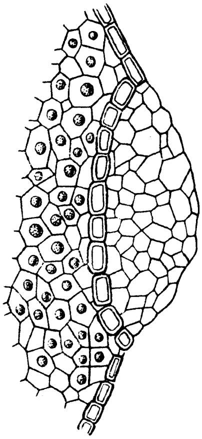

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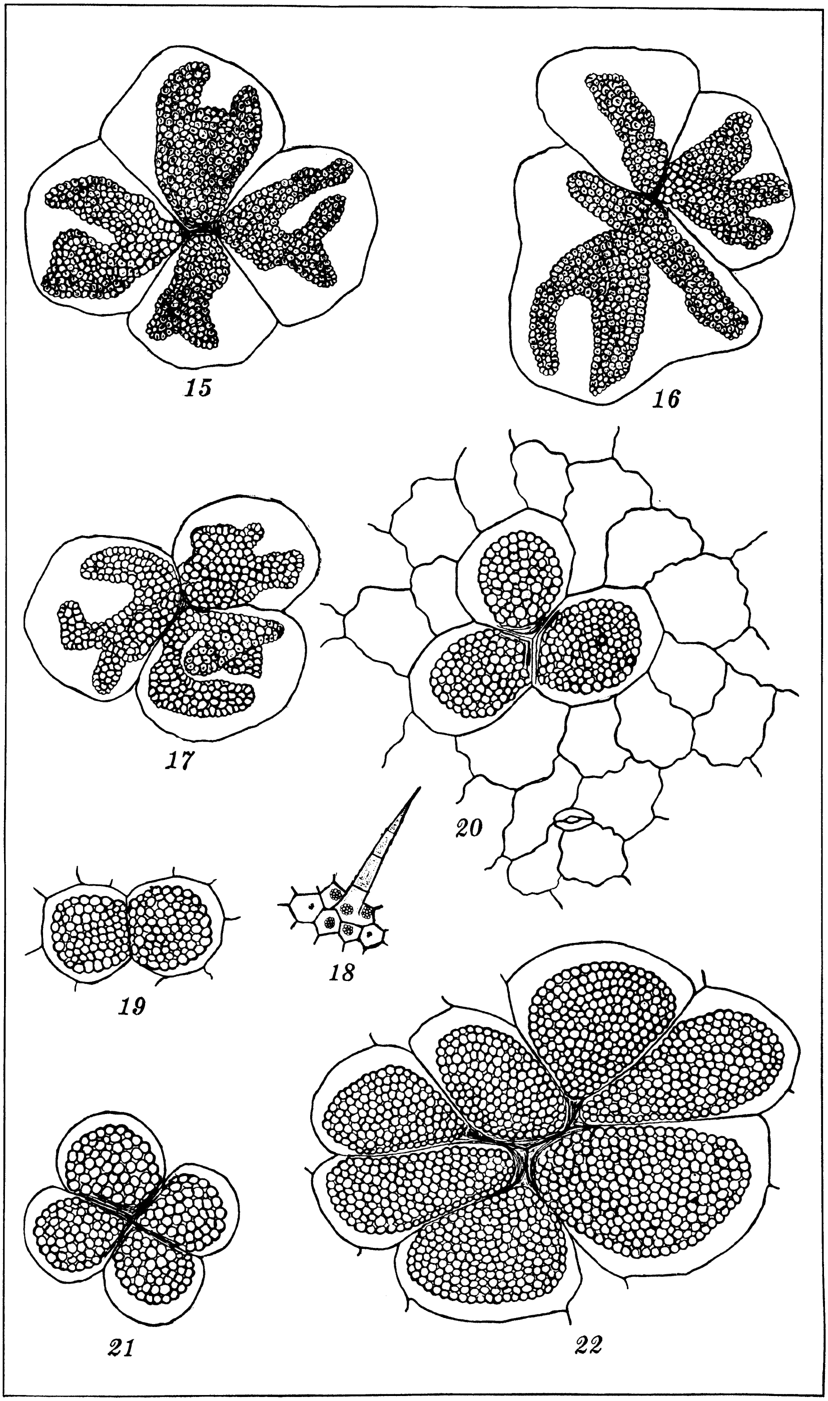

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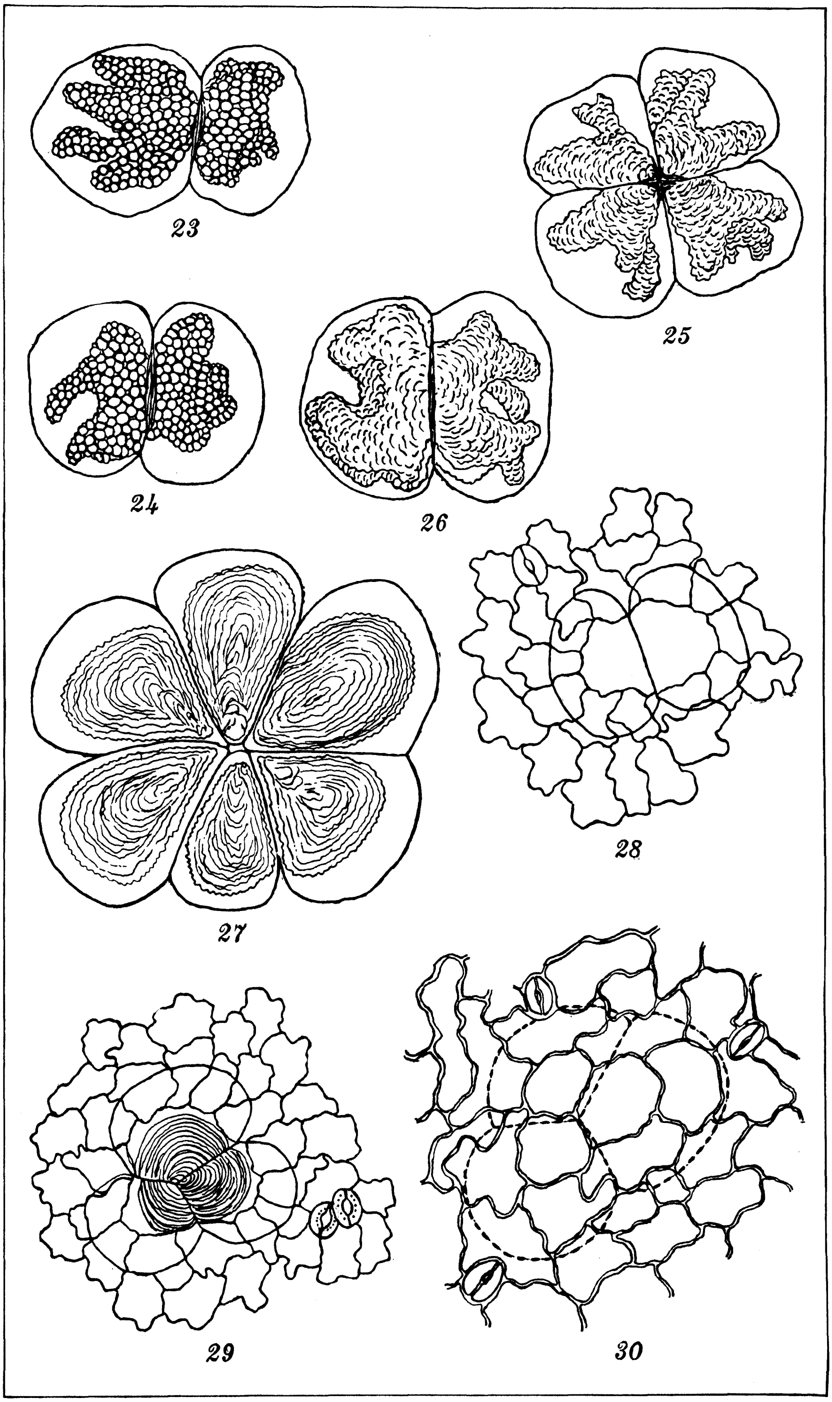

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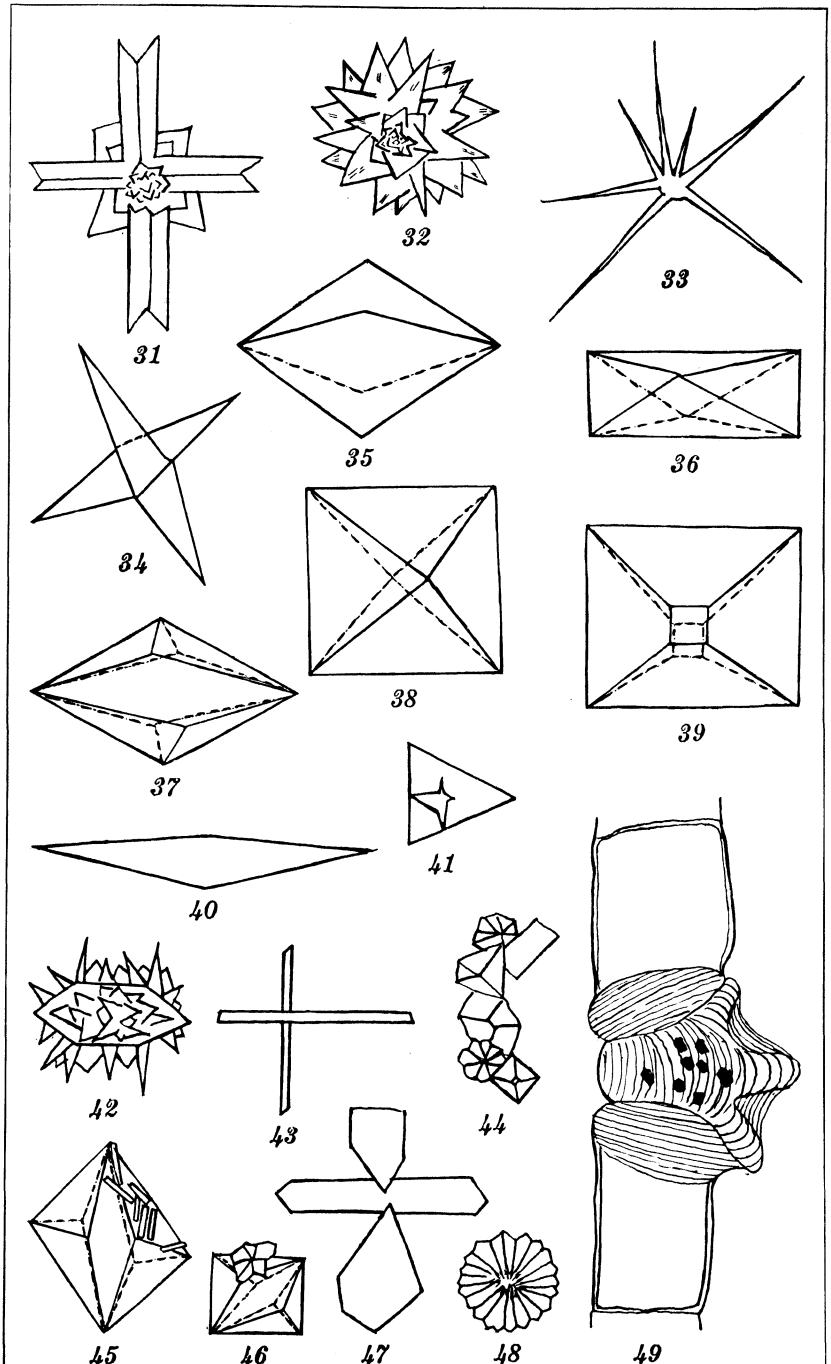

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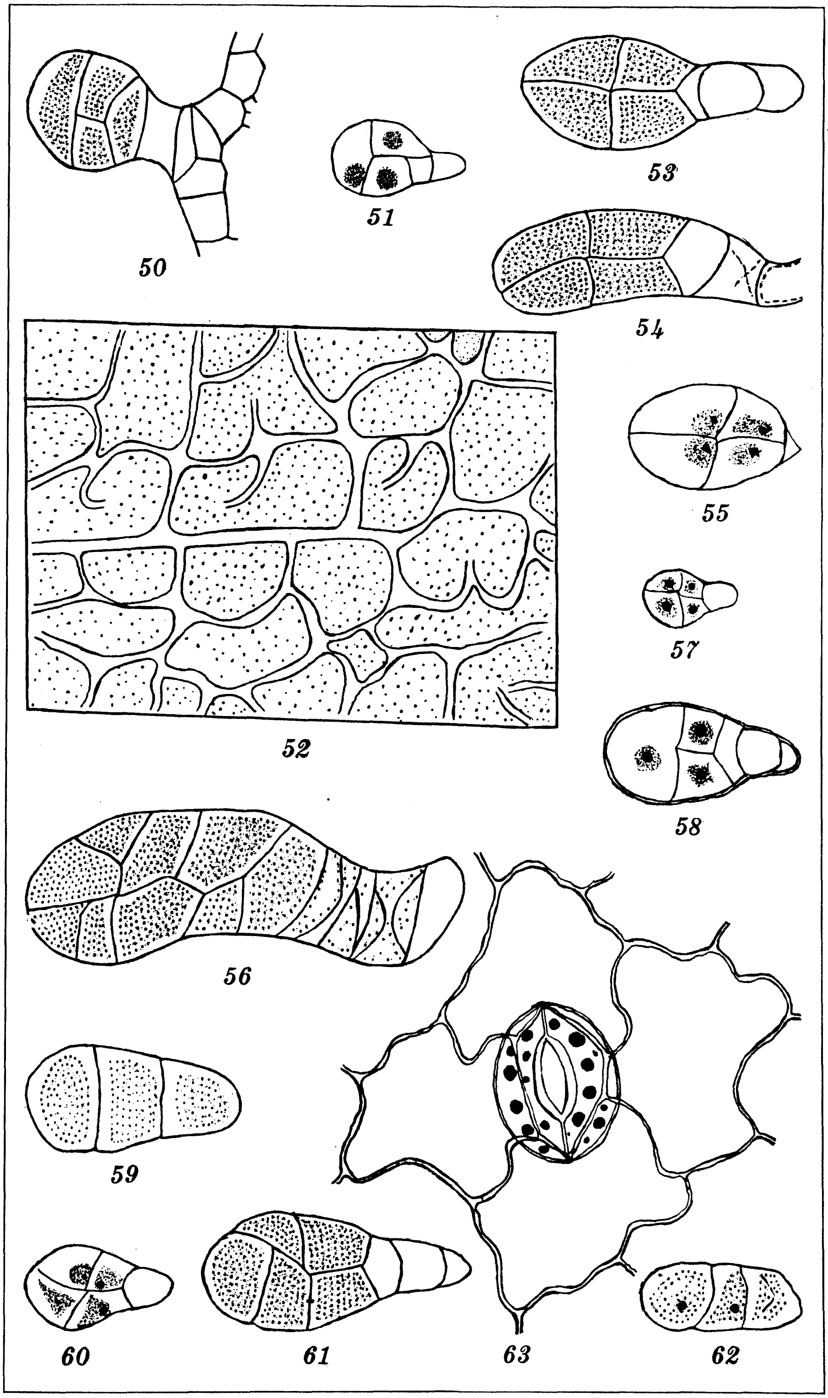

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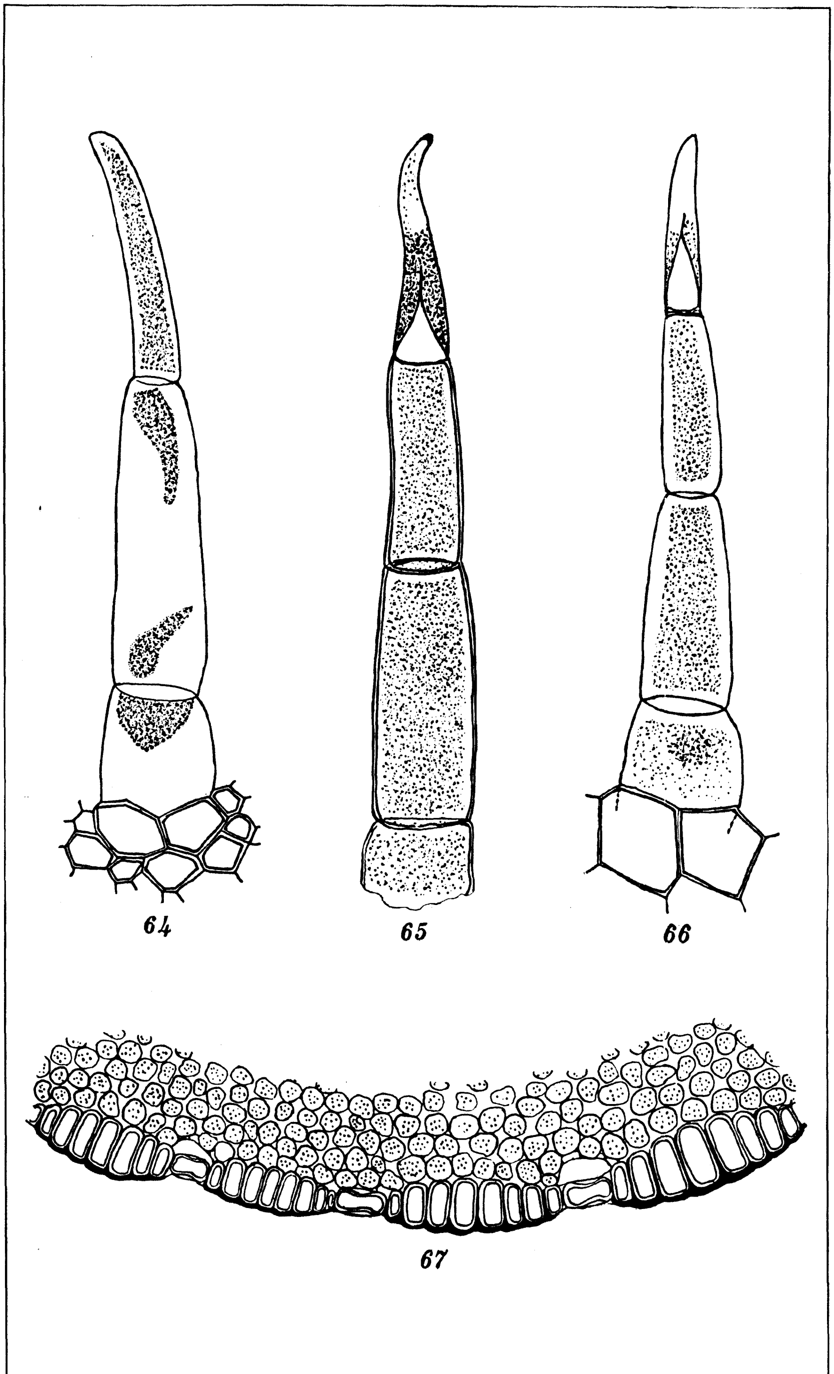

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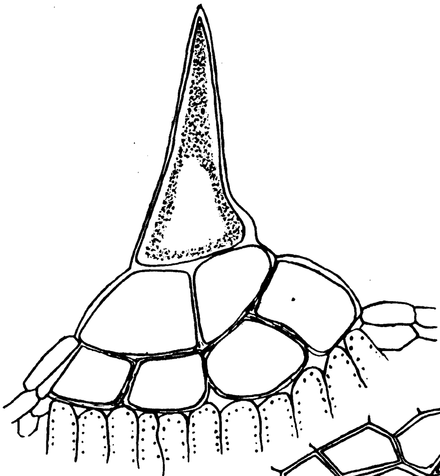

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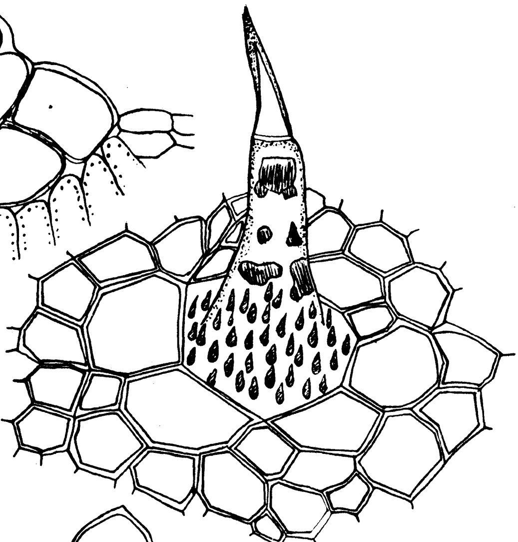

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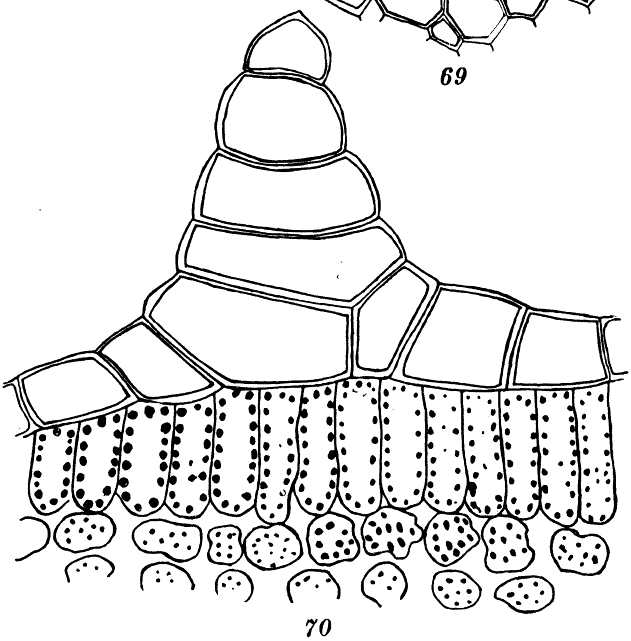

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PLATE 9.

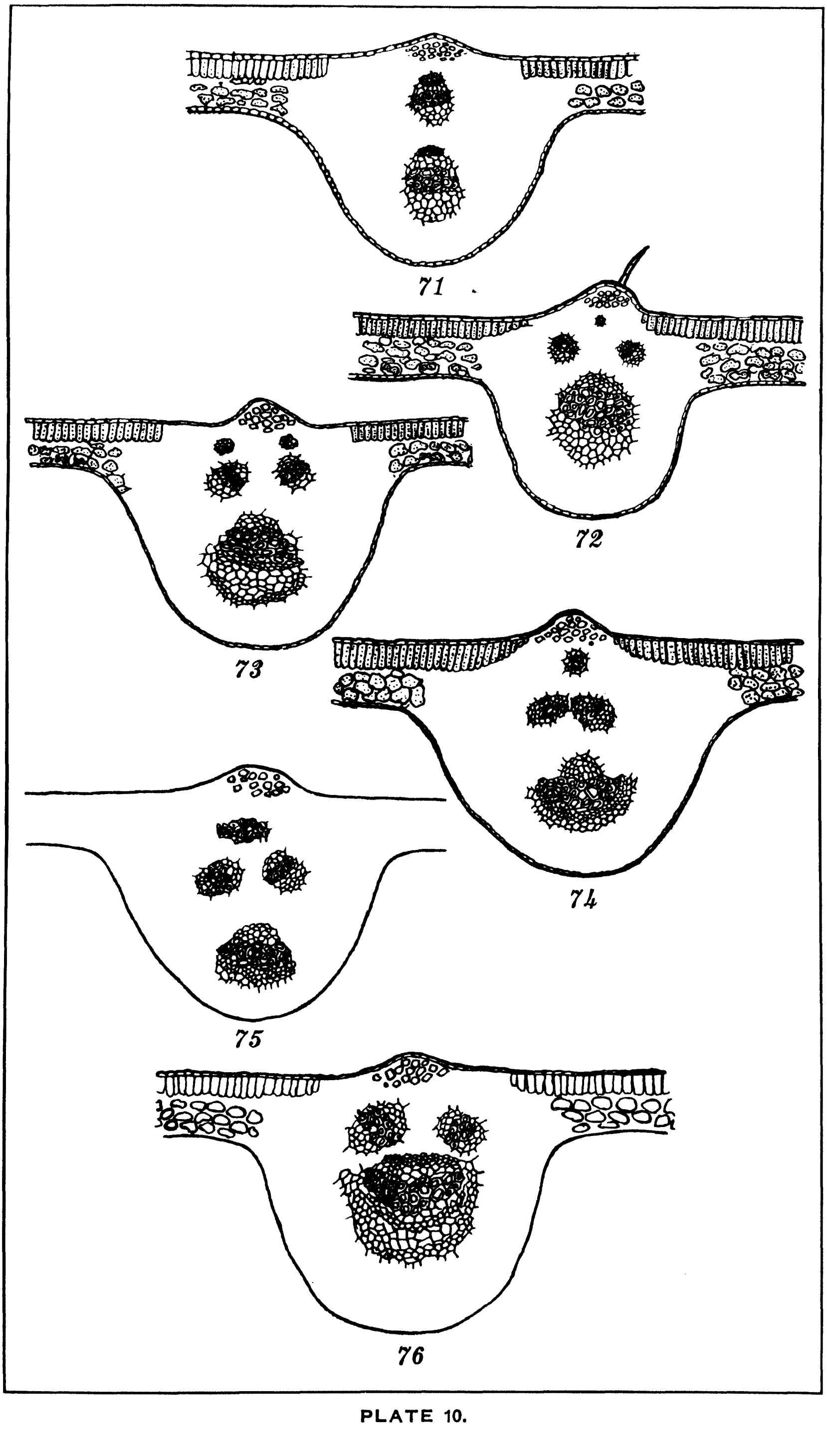

PLATE 10.

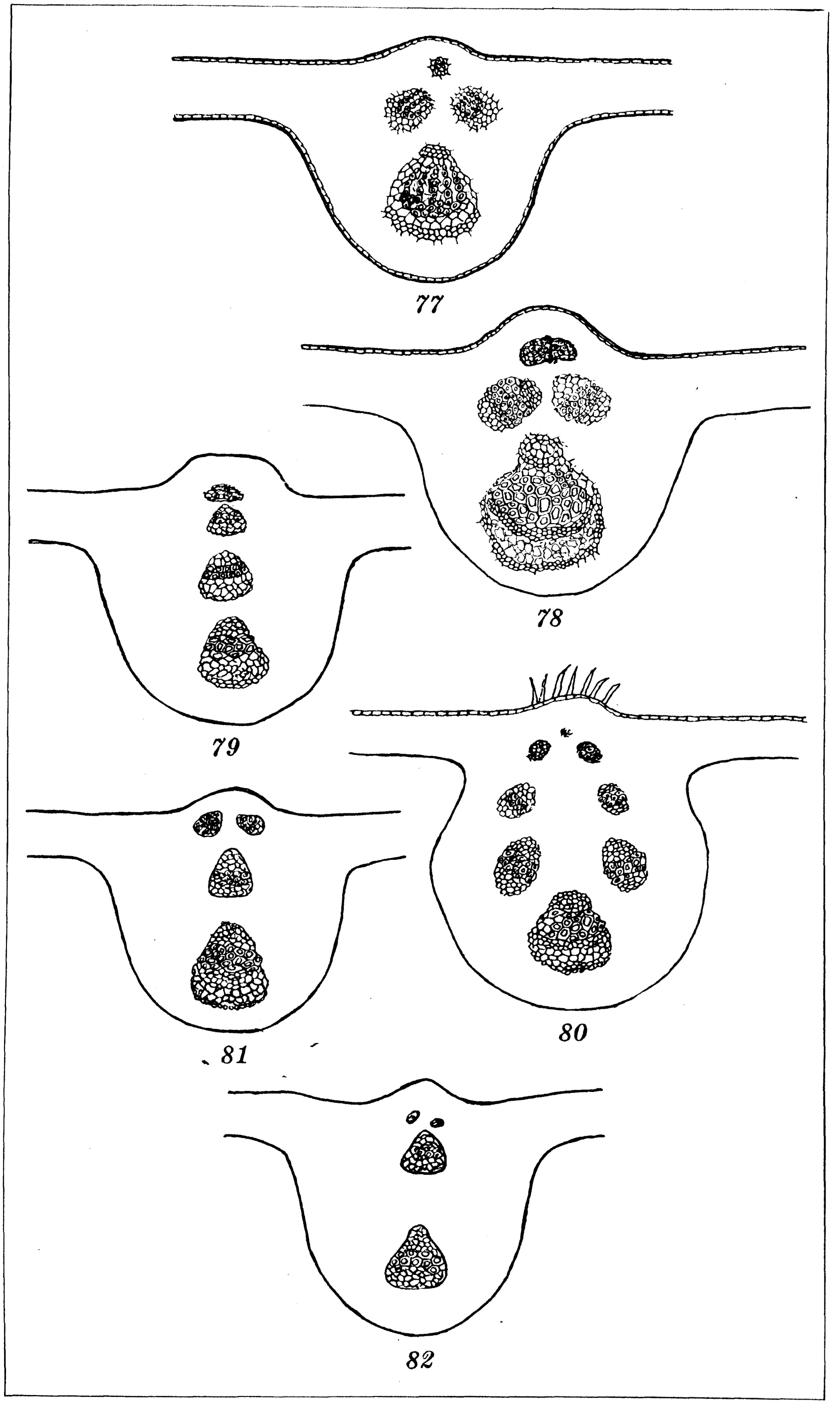

PLATE 11.

FRESH-WATER FISH FARMING IN THE PHILIPPINES

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Of the Fish and Game Administration, Bureau of Science, Manila

TEN PLATES AND ELEVEN TEXT FIGURES

INTRODUCTION

The artificial propagation of fishes is not at all unknown to the Filipinos. In the bañgos industry the small fry are cultivated to a marketable size, an undertaking that necessitates the investment of large sums of money for considerable lengths of time. Extensive mangrove swamps and fore-shore lowlands have been adapted to such purposes, in Luzon and in many of the Visayan islands. These bañgos fish farms, however, are more or less brackish-water fishponds in which an adequate supply of sea or brackish water from an adjacent tidal stream is of paramount importance.

In interior regions, to which brackish or sea water has no access, the artificial culture of fish is not carried on. Yet the absence of fresh-water fish farming in the Philippines cannot be attributed to lack of adequate sites, for the Philippines is abundantly supplied with fresh-water streams. Perhaps it is traceable more to the absence of a native edible fresh-water species that is profitable to raise in such confined spaces as are to be found in regularly-constructed fish farms. Our fresh-water fishes, as the murrel, *Ophicephalus striatus* Bloch; the climbing perch, *Anabas testudineus* (Bloch); the fresh-water catfishes, *Clarias* spp.; and the fresh-water eels, *Anguilla* spp. are all deficient in one or the other of the different characteristics essential in fishes for artificial cultivation. Even our marine species, as the milkfish, *Chanos chanos* (Forskål), and the mullets, *Mugil* spp., that could live in fresh water, are unprofitable to culture in fresh-water ponds, where the growth of algæ, the bulk of the food of these two species, is entirely inadequate to supply their needs for rapid growth.

Numerous attempts to cultivate the above-mentioned species have been total failures, not because of mismanagement or faulty technic, but because of the inability of these native fishes to thrive and multiply properly in confinement in limited bodies of water. Up to the present the supply of such fresh-water species in the market is taken from natural grounds, where no attention whatsoever is paid to their proper growth and multiplication. They are left to themselves, nature taking her own course, the survival of the fittest being the only governing law.

INTRODUCTION AND DISTRIBUTION OF IMPORTED FOOD FISHES

Because of the inadequacy of the native fresh-water fish resources, the Bureau of Science, through the Fish and Game Administration, has for several years endeavored to import foreign species, both for replenishing the natural supply of fresh-water species in our lakes and streams and for cultivation in artificial fresh-water ponds. Such species as the black bass, *Huro floridana* (Le Sueur); the carp, *Cyprinus carpio* Linnæus; the catfish, *Haustor catus* (Linnæus); and the giant goramy, *Osphronemus goramy* Lacépède have been imported at different periods for this purpose.

Black bass.—This fish was imported from Folsom, California, by A. Seale, May 4, 1907, when he brought 175 fingerlings, 7 of which died in transit. This original lot was planted in a lake near Pines Hotel and in Trinidad Lake, Baguio, Mountain Province. Table 1 is the summary of the distribution of black bass in the Philippines.

TABLE 1.—*Distribution of black bass in the Philippines.*

Date.	Locality.	Number.	Length.
	Cayman Lake, Los Baños, Laguna		
Dec. 17, 1913	Los Baños, Laguna (private pond)		
Dec. 22, 1913	Lake Lanao, Mindanao	50	
Jan. 1915	Lake near Kiangan, Ifugao		
Oct. 28, 1916	Lake Sampaloc, San Pablo, Laguna	1 tank	
Nov. 1916	Lake Lanao, Mindanao	8 cans	fry
Jan. 1925	Tributaries of Lake Lanao		

In the Philippines black bass have so far failed to spawn in the lowlands, although they have been breeding in great numbers in Baguio where the temperature is low. For this reason their cultivation has never been popular in the Islands.

Carp.—The first batch of carp was introduced from Hongkong into the Philippines in 1915, also by A. Seale, through the then Colonial Secretary, Claud Severn, for the Philippine Government, when 2,000 fry in 15 cans were requested for the Department of Mindanao and Sulu for stocking the swamp lakes of Cotabato.

The second batch was introduced by Dr. A. W. Herre from Canton, April 9, 1925. Presumably these were the Cantonese carp with proportionately large bellies.

The third batch, apparently the Formosan variety with a slenderer body, was brought by H. R. Montalban from Formosa in February, 1926. Table 2 is the summary of the distribution of carp in the Philippines.

TABLE 2.—*Distribution of carp in the Philippines.*

Date.	Locality.	Number.	Length.
Feb. 1915	Swamp lakes of Cotabato	2,000	fry
Oct. 1916	Lanao (not Lake Lanao)		
Nov. 18, 1918	Lakes Dapao and Nunungan		
June 4, 1926	Laguna de Bay, Luzon	400	
June 11, 1926	Lakes Buhi and Bato, Camarines Sur	300	
Aug. 9, 1926	Lake Baao, Camarines Sur	150	
Feb. 1927	Umingan, Pangasinan		
Mar. 30, 1927	Lake Paoay, Ilocos Norte	300	
June 5, 1927	Laguna de Bay, and Magat River, Nueva Vizcaya		
July 11, 1927	Rio Grande de Pampanga and Santa Ana, Pampanga	300	
July 4, 1928	Laguna de Bay	400	
July 7, 1928	do	400	
July 28, 1928	do		

Carp is now very numerous in Lanao and Bicol Provinces, and in Laguna Province, where it has replaced the native species to some extent. It does not require cultivation in regularly constructed farms, because it can compete with the various native species. It now forms the bulk of cheap food fish in the Bicol provinces.

Catfish.—The catfish was only very recently imported by W. Adams, who, January 10, 1935, brought from San Jose, California, 96 specimens, which varied in length from 13 to 31 centimeters and had not yet reproduced. At the time of writing these are still quartered in one of the compartments of the Bureau of Science Propagation Ponds.

Goramy.—In September, 1927, Dr. A. W. Herre arrived in Manila with a little over 700 goramy, both young and adult. These were bought from one Hadji Hanapi,[1] chief citizen of a village of the Javanese town of Pasar Minggu. The records of the Bureau of Science show that of this number, 40 were planted in Laguna de Bay, July 7, 1927, and 200 were introduced in Lake

[1] Asia 29 (1929) 210, 211, 236, 238, 239.

Bato, June 27, 1928. The remainder of this batch were quartered in the Manila Propagation Ponds, where they were observed to have spawned for the first time in the latter part of March, 1930, when fry varying from 4 to 8 centimeters in length were seen in nursery tank No. 4 (text fig. 1). From October, 1930, the distribution of goramy has been brisk, as can be seen from Table 3.

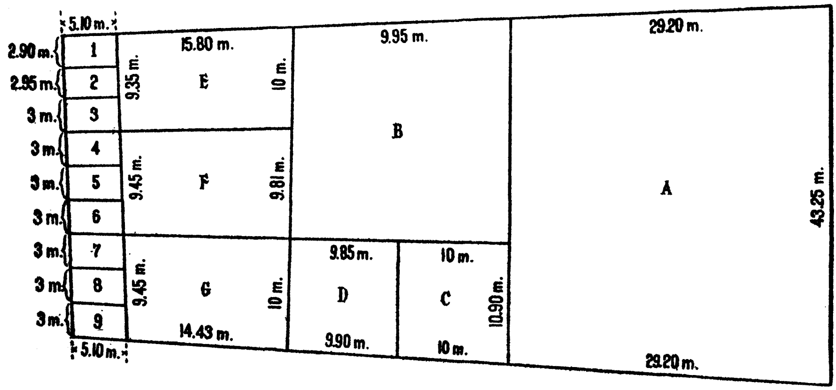

FIG. 1. Ground plan of the Manila Propagation Ponds of the Bureau of Science.

Although at the time of writing goramy have been observed to propagate in lakes and streams (Lake Bato and its inlets, Agus and Libon Rivers and their outlet, Bicol River), they are best fitted for culture in regularly constructed ponds, where their breeding and growth may be properly promoted and safeguarded. Being essentially vegetarians, they are devoid of strong and sharp dentition that may serve as a protection against the native carnivorous species. As such, they are easy preys to the predacious fishes that abound in our bodies of fresh water.

The tables show that of the different species imported, the goramy is most in demand for cultivation. This is perhaps due to the following characteristics, which make it thoroughly amenable to pond culture:

1. It is herbivorous, hence the problem of food supply is easily solved.

2. It is nonpredacious and noncannibalistic, hence the yield is not greatly reduced even under crowded conditions.

3. It readily breeds in confinement, hence there is no need of stocking the pond from year to year with new fry.

4. Its flavor and eating qualities are equal, if not superior, to that of the native species generally eaten.

TABLE 3.—*Distribution of goramy in the Philippines.*

Date.	Locality. [a]	Number.	Length.
			cm.
July 7, 1927	Laguna de Bay	40	----------
June 27, 1928	Lake Bato, Camarines Sur	200	----------
Oct. 8, 1930	Los Baños, Laguna	40	13
Nov. 7, 1930	Sorsogon, Sorsogon	15	13
Dec. 6, 1930	Los Baños, Laguna	20	13
June 17, 1931	San Jose, Nueva Ecija	3	25–31
Oct. 28, 1931	Camp Nichols, Rizal	6	15
Dec. 23, 1931	Angeles, Pampanga	57	8–31
Dec. 28, 1931	San Jose, Nueva Ecija	10	8–15
Mar. 17, 1932	Angeles, Pampanga	12	10
Apr. 9, 1932	Dalirig, Bukidnon	24	10–18
May 21, 1932	Angeles, Pampanga	12	8–10
June 11, 1932	Lagangilang, Abra	30	5–23
June 15, 1932	Dalirig, Bukidnon	15	5–10
June 25, 1932	Manila	12	3– 8
July 25, 1932	Angeles, Pampanga	117	5–41
Aug. 15, 1932	Lucban, Tayabas	24	5–10
Aug. 20, 1932	Dalirig, Bukidnon	15	5–15
Aug. 24, 1932	Mandaluyong, Rizal	20	10–15
Sept. 17, 1932	Malabon, Rizal	2	5–15
Nov. 25, 1932	Paete, Laguna	36	5–31
Nov. 27, 1932	Bangued, Abra	12	5–10
Mar. 1, 1933	Manila	4	5–10
Mar. 6, 1933	Davao Penal Colony, Davao	300	8–13
April 4, 1933	Calamba, Laguna	25	8–31
May 13, 1933	Cagayan, Misamis	20	10–15
May 27, 1933	Calamba, Laguna	25	10–31
Aug. 2, 1933	Tiaong, Tayabas	192	8–28
Aug. 12, 1933	Amboklas Bokad, Mountain Province	36	8–15
Aug. 12, 1933	Capiz, Capiz	25	10–23
Aug. 23, 1933	Cagayan, Misamis	46	8–13
Aug. 26, 1933	Manila	6	8
Sept. 9, 1933	Malolos, Bulacan	4	3– 8
Sept. 30, 1933	San Narciso, Zambales	12	10
Jan. 3, 1934	Tiaong, Tayabas	69	18–25
Jan. 6, 1934	Manila	4	10–20
Feb. 2, 1934	Sorsogon, Sorsogon	6	15
Feb. 5, 1934	Davao, Davao	13	15–20
Feb. 13, 1934	Iloilo, Iloilo	12	13
Feb. 13, 1934	Pasig, Rizal	12	10
Mar. 19, 1934	Manila	12	13
April 19, 1934	----do	24	13–20
April 25, 1934	United States (exchange)	60	13–20
July 3, 1934	Bay, Laguna	26	13–31
Aug. 10, 1934	San Nicolas, Pangasinan	12	10–13
Aug. 20, 1934	Iwahig Penal Colony, Palawan	40	13–15
Sept. 4, 1934	La Carlota, Occidental Negros	12	18
Sept. 4, 1934	Manila	2	25
Sept. 28, 1934	Pasay, Rizal	12	13–28
Sept. 29, 1934	Umingan, Pangasinan	17	8–23
Oct. 1, 1934	La Carlota, Occidental Negros	7	13–28
Oct. 2, 1934	Umingan, Pangasinan	12	13
Oct. 6, 1934	Mexico, Pampanga	65	13–41
Oct. 9, 1934	San Jacinto, Pangasinan	8	10
Oct. 9, 1934	Manila	5	18–25
Oct. 9, 1934	Bacolod, Occidental Negros	24	13–23
Oct. 30, 1934	Nangpicuan, Nueva Ecija	30	13–25
Oct. 30, 1934	Talisay, Occidental Negros	24	13–18

[a] The distribution was mostly by sale to private persons in the localities cited.

TABLE 3.—*Distribution of goramy in the Philippines*—Continued.

Date.	Locality.[a]	Number.	Length.
			cm.
Nov. 5, 1934	Dinalupihan, Bataan	28	23–31
Nov. 8, 1934	Manila	14	31–36
Nov. 12, 1934	Calasiao, Pangasinan	6	8–10
Nov. 27, 1934	Angeles, Pampanga	52	15–38
Dec. 12, 1934	Santa Rosa, Nueva Ecija	4	20–31
Dec. 17, 1934	Pilar, Bataan	24	13
Dec. 18, 1934	Talisay, Negros Occidental	12	13
Dec. 24, 1934	San Quintin, Pangasinan	12	18
Dec. 24, 1934	San Fabian, Pangasinan	6	13–20
Jan. 2, 1935	Manila	1	25
Jan. 12, 1935	Bacolod, Occidental Negros	24	13–15
Jan. 18, 1935	Sangangdaan, Rizal	12	18
Jan. 18, 1935	Pasay, Rizal	7	8
Jan. 29, 1935	Lipa, Batangas	57	8–31
Mar. 18, 1935	Macabebe, Pampanga	3	8–31
Mar. 22, 1935	Manila	1	31
Mar. 22, 1935	Maao, Occidental Negros	12	13–25
Mar. 22, 1935	Los Baños, Laguna	5	8–13
May 18, 1935	Balintawak, Rizal	30	10–43
May 20, 1935	Cotabato, Mindanao	12	13–20
May 27, 1935	Lucban, Tayabas	6	15–18
June 13, 1935	Cabuyao, Laguna	12	20–36
June 13, 1935	Pasig, Rizal	6	13–31
June 19, 1935	Pandacan, Manila	6	13–20
June 24, 1935	Cabuyao, Laguna	2	18
June 29, 1935	San Fernando, Pampanga	18	18–23
July 13, 1935	Manila	12	15–18
July 27, 1935	General Trias, Cavite	4	23
July 29, 1935	Mexico, Pampanga	4	28–31
Aug. 10, 1935	Manila	3	25
Aug. 15, 1935	Mexico, Pampanga	4	25–31
Aug. 20, 1935	Maao, Occidental Negros	12	18–31
Aug. 29, 1935	Mexico, Pampanga	39	18–56
Sept. 16, 1935	do	2	10
Oct. 30, 1935	Manila	4	3– 5
Nov. 22, 1935	Occidental Negros	12	8–10
Nov. 22, 1935	San Juan, Rizal	13	5–31
Nov. 27, 1935	Minalin, Pampanga	12	33–46
Jan. 2, 1936	Cotabato, Cotabato	24	3–13
Jan. 8, 1936	Marikina, Rizal	12	5–10
Mar. 11, 1936	Nangpicuan, Nueva Ecija	6	31–36
Mar. 16, 1936	Manila	12	5–18
Mar. 25, 1936	Floridablanca, Pampanga	8	33–46
April 23, 1936	Manila	5	5–15
	Total	2,365	

[a] The distribution was mostly by sale to private persons in the localities cited.

5. It is a hardy fish, hence mortality during the period of growth is very small.

These good qualities are slightly minimized by the fact that the goramy is not as rapid a breeder as our native species. Nevertheless it is the one species, among imported as well as endemic fishes, that meets the approval of fishpond owners in the Philippines. The description of its characteristics and the method of its culture is the purpose of the present work.

The Philippine Department of Agriculture and Commerce is at present planning to construct a series of fresh-water ponds in the interior regions, which are far from the sea and where the supply of fish is low. In Nueva Vizcaya and Isabela Provinces in Luzon, in the central portion of Panay and in the interior parts of Surigao, Agusan, Oriental and Occidental Misamis, Lanao, Cotabato, and Davao Provinces, sufficient acreage of goramy ponds may be profitably located to stabilize the fresh-water fish supply of these inland regions.

GORAMY

OSPHRONEMIDÆ

Goramy, also written gourami, gouramie, and gouramy, is the name given to a group of remarkable fresh-water labyrinthine fishes, with a deep and compressed body covered with moderate-sized scales that are regularly arranged. The small mouth is without teeth on the roof or palate. There is but one dorsal fin on the back. Characteristic of these fishes is the prolongation of the first ray of each ventral fin into a filament, which fin may consist of a spine and five soft rays or may be reduced to a single elongated ray and a rudimentary spine.

Like other labyrinthine fishes, it has a pair of labyrinthiform organs on the head, lying directly above the gill cavity, which serve as an accessory breathing apparatus, enabling the fish to absorb oxygen directly from the air and thus to survive outside of its natural habitat for some time, as well as to resist considerable pollution of the water.

Although there are many species of goramy, the majority do not attain a large enough size to be suitable for food. Most of them are of sizes that are good only for ornamental purposes, home pets with their interesting breeding habits and their pugnacity and beauty. Even in the Philippines the three-spotted goramy, *Trichogaster trichopterus* (Pallas), has been found to abound in a small crater lake in Cagayan Sulu. The giant goramy, *Osphronemus goramy* Lacépède, is the only one attaining a large size enough to make its cultivation for food profitable.

GIANT GORAMY

OSPHRONEMUS GORAMY Lacépède. Text figs. 2 and 3.

This goramy is a large fresh-water fish of Java, Madura, Sumatra, and Borneo in the Malay Archipelago. Some authorities regard it as a native of Cochin China. It has been introduced as an aquarium fish into Europe and as a valuable food fish into Mauritius, Cayenne, and Australia in 1864, into Madras in 1886, into Ceylon in 1908, and into other places, including the Philippines.

Body characteristics.—This goramy reaches a length of 183 centimeters. As in other members of the goramy family, the body is deep, in large specimens nearly twice the length of the head. The snout is much produced and the head is with a distinct concavity on its rostrodorsal profile, just in front of the eyes, but convex behind the eyes, becoming more and more so with advancing age. In the male this hump is prominent.

With age the lower jaw seems to protrude in front of the upper.

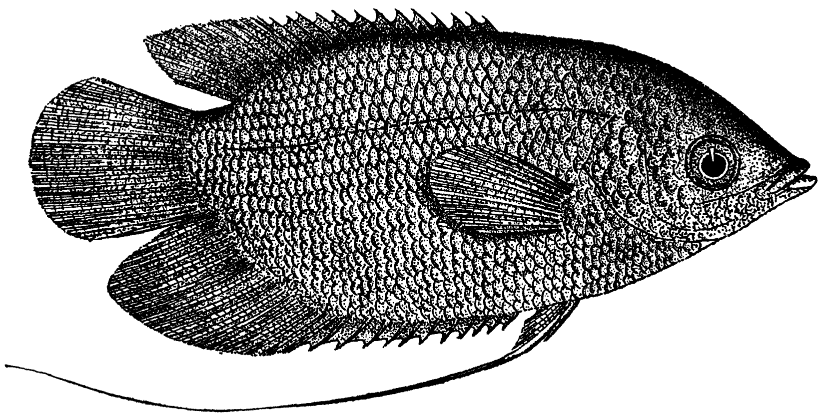

FIG 2. An adult female goramy.

The single dorsal fin has from 11 to 13 spines, and from 11 to 12 articulated rays, beginning behind the base of the pectoral fins. The very much longer anal fin has from 9 to 12 spines and from 19 to 21 branched rays. The caudal fin is rounded. The ventral fin, consisting of 5 soft rays and 1 spine is characterized by the very much elongated first ray, this being produced into a filament extending backward even beyond the end of the tail. The scales are regularly arranged and the lateral line is complete and continuous from the shoulder to the base of the caudal fin. The edge of the gill cover is smooth, without spines or serrations. The jaws are with fixed conical teeth and the roof of the mouth is toothless.

The adult is more or less grayish, olivaceous above, silvery or yellowish below, with the fins all dusky. In youth, the color in life is gray, darker on the back and head. About 10 dark brown bands cross the body, the first just behind the edge of the gill cover and the last at the base of the tail. A black circular spot is visible towards the anterior border of the caudal peduncle, a little below the lateral line and on the second to the last band. A blackish spot is present at the base of the pectoral. All fins are dusky, edged with white. The posterior two-thirds of the tail is hyaline.

Albino specimens are not infrequently met with; in these the body and fins are creamy, the belly somewhat pinkish. In youth, the body is a beautiful combination of olive and orange or gold.

The eating quality of the giant goramy is excellent. The light yellow, straw-colored flesh, which is firm and easy of digestion, is of superior taste. The goramy has been praised for the excellence of its flesh and has always been held in high

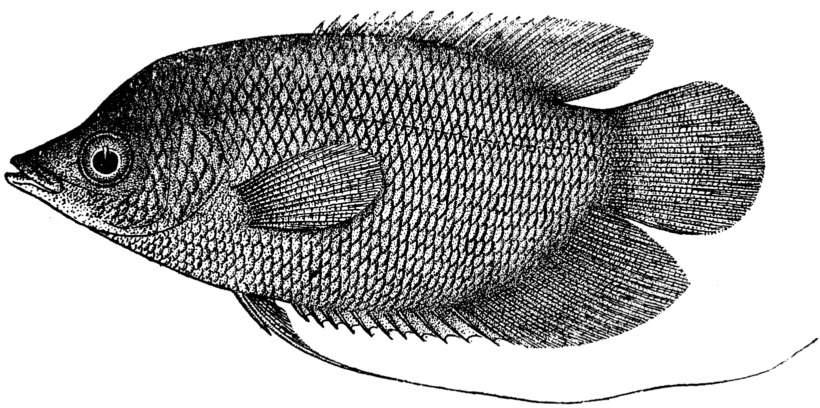

FIG. 3. An adult male goramy.

esteem by both Europeans and the natives of Java. In the Philippines all that have eaten it are unanimous in their praise and appreciation of its exquisite flavor, which compares favorably with that of the famed sea bass, *Lates calcarifer* (Bloch). The giant goramy is most adaptable to pond culture, because it is capable of attaining the gigantic size of 183 centimeters and a weight of 50 kilograms,[2] although the largest so far recorded in the artificial concrete ponds of the Bureau of Science is only 61 centimeters long, from the tip of the snout to the end of the tail. Moreover, it is essentially vegetarian, and therefore neither predacious nor cannibalistic; it is able to breed in

[2] Rept. U. S. Bureau of Fisheries. Report of the Commissioner for 1872 and 1873 pt. II, pp. 712.

artificial or regularly constructed fishponds; it can survive extreme pollution, and, last but not least, the flavor of its flesh makes it one of the best fresh-water species in cultivation.

LIFE HISTORY OF THE GIANT GORAMY

Breeding—Under normal conditions the giant goramy reaches sexual maturity and may be expected to breed after the fourth year. In some artificial ponds, where environmental conditions are not normal, this period is considerably longer. The goramy is over 30 centimeters long when it reaches breeding stage.

The female is generally with its belly enlarged or bulging because of the eggs, which number from about 500 to 1,000 in a moderate-sized individual. The male, as in the other members of the group, is usually distinguishable by its greater pugnacity, biting or fighting other males that interfere with its mating or pairing, especially during the breeding period. But more distinctive is the very pronounced hump on the nape of the male, being somewhat lower and less defined in the females.

In the Philippines, and under the conditions obtaining in the artificial concrete ponds of the Bureau of Science, where the bottom is muddy, the water stagnant, the temperature at the surface ranging from 27° C. to 32° C., and where there is no vegetation except patches of water hyacinths [*Eichornia crassipes* (Martius)], confined along the sides by means of a wire stretched taut, the giant goramy breeds the year round, although the peak of the breeding season occurs during the warm months, from March to May.

On spawning, the goramy pair off, and each pair selects a suitable place along the sides of the tank just beneath and along the edges of the patches of water plants. The vegetation preferred is an aquatic plant that grows on the surface of the water and whose floating roots, which rise and fall with the surface of the water, form natural galleries under which the fish can conceal themselves from public gaze and disturbance.

In the pond, among the water hyacinths and a little below the surface of the water (text fig. 4), the goramy attaches its nest. The nest is composed of plants, mud, and other available floating or submerged materials. Its shape varies from somewhat spherical to oval, and in form it resembles those of some birds. Table 4 summarizes the features of nests A, B, and C, all of which were actually recovered from goramy ponds in the Philippines. Nests A and B are shown in Plate 1, figs. 1 and 2.

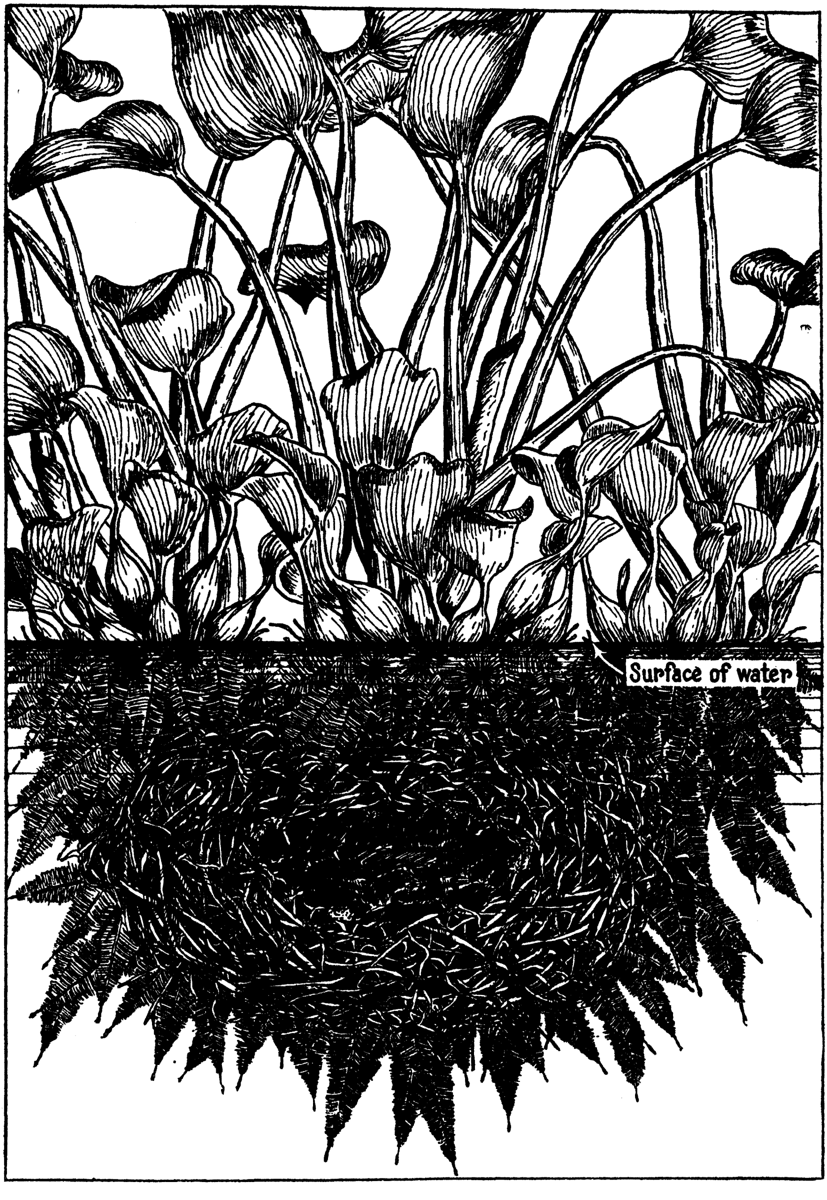

FIG. 4. The nest of goramy in situ.

The size of the nest varies with that of the fishes, while the materials of which it is built depend upon whatever is procurable in the feeding or spawning ponds. It takes about a week for the goramy to build its nest.

TABLE 4.—*Summarized features of goramy nests recovered from ponds in the Philippines.*

Nest.	Date recovered.	Locality.	Measurements. Length.	Width.	Depth.	Contents.	Composition.
			cm.	*cm.*	*cm.*		
A	Nov. 10, 1932	Manila Propagation Ponds.	30	18	9	Remnants of unfertilized eggs that have become decayed, soft, and mossy.	Roots, stalks, and leaves of water hyacinths; rattan; vines for tying kangkong, the feed of the fish; stalks of *Hydrilla verticillata*; mud.
B	Aug. 16, 1935	----do----	28	20	10	Newly hatched fry, with yolk sacs and some decayed unfertilized eggs.	Mostly roots, stalks, and leaves of water hyacinths, with scatterings of mud.
C	Oct. 19, 1935	Mexico, Pampanga.	28	26	10	Unrecorded-------	Grasses and twigs made compact and somewhat woven with roots of grasses and some wire, and pasted with mud.

When the nest is completed, the female deposits her eggs in the center of it. The eggs are round, shading from orange to yellow, and about 1 millimeter in diameter. After the eggs have been deposited and fertilized, the parents remain near, patiently aërating them by the constant fanning movements of the pectoral fins and zealously guarding them from predators and enemies.

The eggs hatch in about 10 days. Plate 2, figs. 1 to 4, shows various stages in the development and metamorphosis of the fry, from the time the individual is newly hatched until it reaches the age of 1 month and 12 days, when the appearance and shape of the adult become evident, and when the first ray of the ventral fin is distinctly beginning to prolong. The young find refuge in the nest during the first days of their life, under the protection of their parents; they do not soon disperse, but keep together in schools under the guidance of the parent fish.

Dr. A. W. Herre[3] describes the culture of the giant goramy in Java as follows:

[3] Asia 29 (1929) 210, 211, 213, 236, 238, 239.

In their fourth year a few large fish are placed in a breeding pond, in the ratio of two males to ten females. When their breeding time approaches, they make nests of the water plants growing in the pond. A close watch is kept, and, as soon as the eggs are laid and fertilized, they are transferred, nest and all, to large, wide-mouthed unglazed jars partly filled with water. These jars are left floating along the margins of the breeding-pond, either in some shady nook or else with a cover of palm-fronds. The eggs hatch in about 10 days, but the minute fry are left in the jars for a week longer. Eggs and fry are thus protected from all enemies and have a much better chance for life.

When the tiny fry are removed from the floating jars, they are first placed in small, shallow ponds, and for a number of weeks thereafter are fed upon a very strange diet. This is nothing less than the helpless, savory, soft-bodied young and workers of termites.

. . . At Garut the Javanese manage things quite differently from the Sundanese gurami-breeders in the lowlands. When the breeding fish are four years old, they are placed in comparatively large ponds about five feet deep. In due time they complete their nest and spawn. The eggs, however, are not transferred but are kept in the original pond, where they hatch in about ten days. The fry are given no special care but left solely to the protection of their parents. There is none of the forced feeding common in the ponds about Passar Minggu or Buitenzorg; the fry feed entirely upon the minute animal and vegetable life occurring naturally in the ponds. Consequently they grow more slowly, but they seem to be more vigorous.

The two methods were tried in the Manila Propagation Ponds, and it was found that the latter is the more desirable one, because the probability of pairing is increased when a greater number of individuals are mixed together in one pond. Due to the difficulty of distinguishing between the sexes, the segregation of the spawners, such that there will be a good ratio between males and females, is quite impossible and impractical.

TABLE 5.—*Goramy stock planted and offspring recovered in the Manila Propagation Ponds.*

Tank No.	Stock planted.			Offspring recovered.			
	Date.	No.	Length.	Date.	No.	Total.	Length.
			cm.				*cm.*
2	Aug. 8, 1930	10	36	Mar. 9, 1932	5	22	11
				July 16, 1932	17		10–20
4	Aug. 1, 1930	10	36	Aug. 27, 1931	------	85	(a)
				Dec. 23, 1931	2		10
				Mar. 17, 1932	12		11
				Apr. 9, 1932	4		11
				May 21, 1932	12		8–10
				June 15, 1932	55		10–23
5	Sept. 18, 1930	10	36	Dec. 23, 1931	32	123	8
				Apr. 9, 1932	3		11
				June 14, 1932	88		3–20

[a] Eggs.

Table 5 contains the data of the breeding recorded in the different nursery tanks of the Manila Propagation Ponds (text fig. 1), in which the segregation method was employed, although the young were left to the care of the parent fish. The breeding stock used was unassorted; that is, the proportion of the males to the females was undetermined, because of the difficulty encountered in ascertaining the sexes in this fish.

September, 1927, large tanks Nos. A and B in the Manila Propagation Ponds were planted with 343 and 91 young and adult goramy, respectively. The first spawns were observed in the summer of 1931. Table 6 shows the results of spawning in these two tanks.

TABLE 6.—*Goramy stock planted and offspring recovered in tanks A and B, Manila Propagation Ponds.*

Tank No.	Stock planted.				Offspring recovered.			
	Date.	No.	Length.	Total.	Date.	No.	Length.	Total.
			cm.				*cm.*	
A	Sept. 19, 1927	18	Adult	347	Dec. 23, 1931	5	8	1454
	do	101	Young		June 9, 1932	40	3–14	
	July 23, 1928	233	do		June 10, 1932	397	3–14	
					June 11, 1932	20	3–14	
					June 15, 1932	10	3–14	
					July 20, 1932	7	3–14	
					July 25, 1932	93	5–15	
					Aug. 2, 1932	19	5–10	
					Aug. 4, 1932	32	5–10	
					Aug. 9, 1932	15	15	
					Aug. 11, 1932	27	15	
					Aug. 20, 1932	9	15	
					Nov. 22, 1932	62	5–10	
					Nov. 25, 1932	24	5–15	
					Nov. 27, 1932	12	5–10	
					Dec. 1, 1932	33	3–14	
					Jan. 22, 1933	13	5–10	
					Mar. 1, 1933	4	5–10	
					Mar. 6, 1933	247	8–13	
					Apr. 12, 1933	6	8–13	
					Apr. 1933	10	5–8	
					Jan. 3, 1934	76	18–25	
					Nov. 4, 1934	126	13–20	
					Nov. 7, 1934	113	8–25	
					Dec. 20, 1934	50	8	
B	Sept. 1927	72	Adult	91	June 10, 1932	17	3–10	390
	Aug. 25, 1930	1	36		Aug. 15, 1932	68	5–10	
	June 7, 1932	10	36		Aug. 16, 1932	22	5–15	
	June 8, 1932	8	36		Aug. 20, 1932	6	5–10	
					Dec. 1, 1932	36	5–10	
					Aug. 12, 1933	101	8–13	
					Feb. 2, 1934	50	15	
					Feb. 13, 1934	60	10–20	
					Dec. 20, 1934	30	10	

From a total of 438 individuals allowed to spawn in large ponds, 334 of which were young when planted in 1927 and 1928, 1844 offspring were recovered. Even when the age of the stock in the second case is disregarded, the ratio of offspring recovered to the parent fish is 1: 3.5 by the segregation method and 1: 4.2 when the fishes were allowed to mix at random in large ponds.

Feeding.—The macerated vegetable matter of which the nest is partly composed forms the earliest and most suitable food of the young. When they disperse, it is advisable to segregate them from the parent fish in order that they may not have to compete with the adults for food.

The giant goramy are omnivorous, feeding on flesh, fish, frogs, insects, worms, and many kinds of vegetables; they are, however, essentially vegetarian, and are especially fond of the leaves of aquatic or semiaquatic plants. For the first two or three months of their existence the young may be fed twice or three times a week with young termites and with other insects. As they grow older, they will subsist upon the leaves of *Hydrilla, Naias, Potamogon, kangkong, gabi,* cabbage, radish, lettuce, and similar plants. They also take potatoes, corn, camote leaves, arrowroot, bread, and the like.

They are extremely voracious feeders, so much so that a supply of 40 kilograms of kangkong fed the 400 adults and about 2,000 young in the Manila Propagation Ponds does not last 15 minutes. Both the leaves and the hard stalks are eaten up. Given this vegetable feed in abundance, they grow much faster and reproduce in greater numbers.

Age, growth, and development.—The rate of growth of the goramy depends upon the peculiarity of the individual, the amount of food given, and the space and the depth of water inhabited by the fishes. The following are the results of observation on the early growth and development of the gray variety of goramy grown in an indoor aquarium with a capacity of about 1 cubic meter of water.

Newly hatched fry (Plate 2, fig. 1).—A newly hatched fry is about 9 millimeters long, the body being somewhat elongate. The head measures 5 times in the total length, while the eye is contained 3 times in the length of the head. The yolk sac is still present. Although somewhat short, the caudal fin is fully formed. Only the beginnings of the soft dorsal and anal fins are evident as fleshy projections, there being as yet no distinct ray formation. The pectoral and the ventral fins are entirely absent, although fleshy indications of the former are already visible. The pigmentations are still wanting except as scattered patches in some portions of the head and body.

Fry 15 days old (*Plate 2, fig. 2*).—The fry is now 10.8 millimeters long, with the body becoming deeper. The head is contained 4 times in the total length, while the eye is 2.5 in the head. The remnants of the yolk sac are hardly distinguishable. The caudal fin has become longer, while the dorsal and anal, which have also grown longer, have their rays fully discernible. The pectoral and ventral fins are still undeveloped. The pigmentation on the head and body are more visible, with the traces of the bands across the body somewhat outlined.

Fry 26 days old (*Plate 2, fig. 3*).—The fry is now 14.5 millimeters long, the body having become very much deeper. The head is 3 times in the total length, while the eye is contained 2.5 times in the head. The opercular flap is developing and traces of the yolk sac have completely disappeared. The caudal and the soft or rayed portion of both the dorsal and anal fins are fully formed, the spinous portion of the last two fins beginning to be evident. The pectoral and ventral fins are now developed, the latter showing indications of the prolongation of its first ray.

The color is now darker and more fully scattered throughout the head, body, and portions of the vertical fins. The bands across the body are fully formed, with indications of the circular spot at the caudal peduncle.

Fry 1 month and 12 days old (*Plate 2, fig. 4*).—The individual is now an advanced fry, having reached 17 millimeters in total length, with the appearance of a regularly developed goramy fry as regards its coloration and proportion of the body, head, eyes, and fins. The head is 2.2 times in the total length, while the eyes are 2.5 in the head. The opercular flap is now fully formed. Although still low, the spinous dorsal and anal fins are more fully differentiated. The pectoral and ventral fins are completely formed, with the elongation of the first ray of the latter somewhat longer. The bands have become more pronounced with the circular spot on the eighth band located just below the lateral line in full view.

From this stage the fish grow into fingerlings and yearlings, the most pronounced change being the projection of the snout, the formation of a somewhat whitish band across the nape, and the disappearance of the bands across the body and the spot on the caudal peduncle, the body finally turning grayish in color, and lastly, the pronounced elongation of the first ray of the ventral fin.

Table 7 shows the maximum sizes reached and the stage of development attained at different ages, as observed and measured from fishes grown in the rearing compartments of the Manila Propagation Ponds, with kangkong feed as the sole nourishment, the young feeding on the leaves while the adults feed on both the leaves and the stalks.

TABLE 7.—*Length and stage of development of goramy at different ages.*

Age.	Length.	Stage of development. [a]
	cm.	
4 months	10	Fingerling No. 3.
8 months	15	Fingerling No. 5.
1 year	23	Yearling.
2 years	31	Two-year-olds.
3 years	36	Three-year-olds.
4 years	43	Adults or spawners.

[a] California Fish and Game 14 No. 4 (1928) 308.

In Java, according to Doctor Herre, the goramy are usually harvested when they are 1 or 2 years old at most. Those that are fattened for the great hotels are kept for 4 or 5 years or even longer, when they are said to attain a weight of from 2.3 to 6.8 kilograms.

The comparative data on two adult goramy caught in the Manila Propagation Ponds shown in Table 8 give the size and weight of goramy grown in the Philippines.

TABLE 8.—*Measurements of two goramy caught in the Manila Propagation Ponds.*

Serial No.	Length.		Depth.	Thickness.	Weight.
	Overall.	Standard.			
	cm.	*cm.*	*cm.*	*cm.*	*g.*
1	43	33	18	5.5	1,360
2	39	31	15	5	1,127

Under normal environmental conditions the giant goramy breeds at four years of age in these artificial ponds.

Diseases and enemies.—Like other species of fish that are cultured in artificial ponds, the giant goramy are attacked by such enemies in fishponds as the fish-eating birds and several species of water snakes and lizards.

Being essentially vegetarian, they are more apt to be preyed upon by such carnivorous fresh-water species as the murrel (*dalag*), the fresh-water catfish (*hitô*), and the climbing perch (*puyô*), and for this reason the supply and drain gates must be properly screened in order to prevent the entrance of predatory fishes and their eggs. The pond itself must be free from the above-mentioned species before it is stocked with goramy. The top minnows, such as the mosquito fish and the mollies, are spawn eaters and therefore a menace to the dispersing fry.

Unlike other delicate fishes reared in confinement in artificially constructed fish farms, the goramy are more free from the attacks of various fish diseases. However, in cases of extreme pollution and heating of the water, they also succumb. Careless handling and overheating of the containers during catching for transportation and in transit have been detrimental to the stock of many amateur fishpond owners, giving rise to attacks of fungus; when these attacks become advanced and extensive they are impossible to remedy and cure.

Instructions on the transportation and introduction of fish for culture (*text fig. 5*).—The following instructions are recommended to beginners to avoid unnecessary losses in the transportation of live fishes and their introduction into propagation ponds.

1. In transit:
   a. The water should be removed partially or entirely from the container if it becomes fouled or smells badly, and replaced by fresh water of practically the same temperature.
   b. The water should be aërated from time to time by dipping it and pouring it from a height. Care should be taken in dipping so as not to injure the fishes.
   c. Heating by exposure to direct sunlight or in any other manner must be avoided.
   d. Dead fish must be removed immediately.
   e. Feeding the fishes should not be attempted.
2. Upon arrival and before planting:
   a. The approximate difference in temperature between the water in the container and that in the pond should be determined either by means of a thermometer or by merely feeling with the hand.
   b. The temperature of the water in the container should be tempered by gradually adding water from the pond.
   c. The can should be tilted into the pond and the fish liberated without handling.

In the successful transfer of live fish, three important factors must not be lost sight of: Cleanliness, temperature, and vigilance.

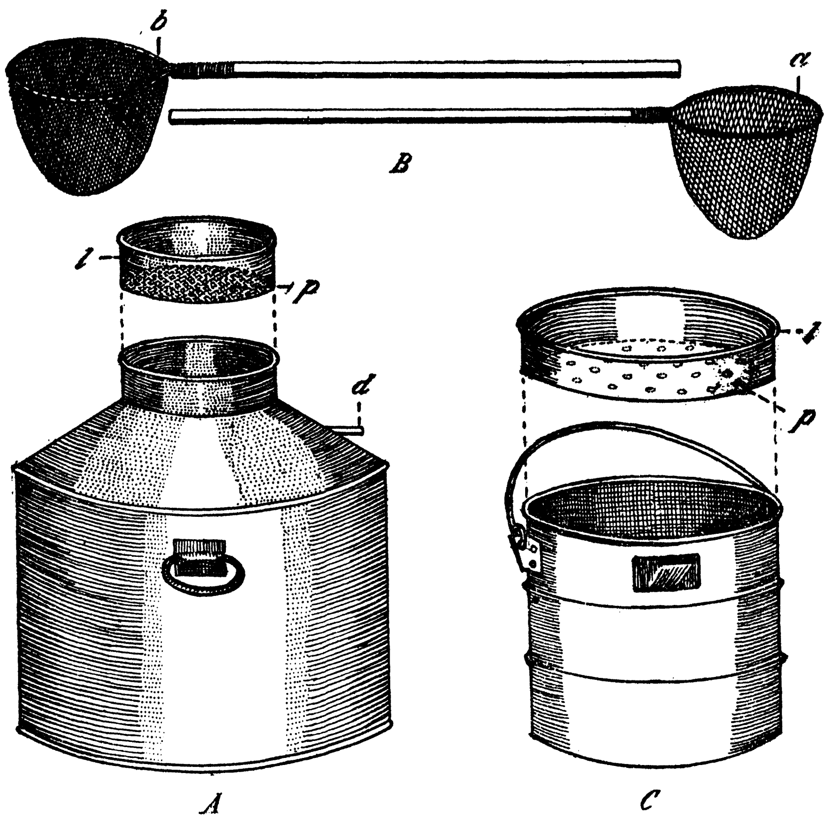

FIG. 5. Accessories in a fresh-water fish-culture establishment. *A*, Transportation can for adults: *d*, drain pipe of can; *l*, lid; *p*, perforated bottom of lid. *B*, Dip nets: *a*, coarse-meshed (for adults); *b*, fine-meshed (for young). *C*, Pail for young: *p*, perforated bottom of lid; *l*, lid of pail.

THE COMMERCIAL POSSIBILITIES OF THE GIANT GORAMY IN THE PHILIPPINES

As has been mentioned in the foregoing paragraphs, of the many native and foreign pond fishes the giant goramy is the only fresh-water species that has all the qualities and characteristics of a fish suitable, practical, and profitable for culture in fresh-water ponds.

Being a labyrinthine fish, like the murrel and the climbing perch, the giant goramy does not require a wide space for its cultivation. In Java, according to Doctor Herre, "some of them were mere isolated pools." They could even be cultured in backyards where a sufficient supply of water is available, and fed, like hogs, with kitchen off-fall, provided oil and lard are not introduced into the pond. Little care is needed, besides that of maintaining enough volume of water, feeding the fish, and excluding, checking, or driving away their enemies.

Because of its superior flavor, this fish should be in good demand, especially in the interior regions, and during the stormy season when the supply of marine species is very much diminished. On the market it would probably be preferred to the bony milkfish, for, besides being free from small troublesome bones, the goramy has the desirable flavor of first-class marine species. It should, therefore, be very much in demand with the big hotels and restaurants in Manila, a city with a fish-eating population.

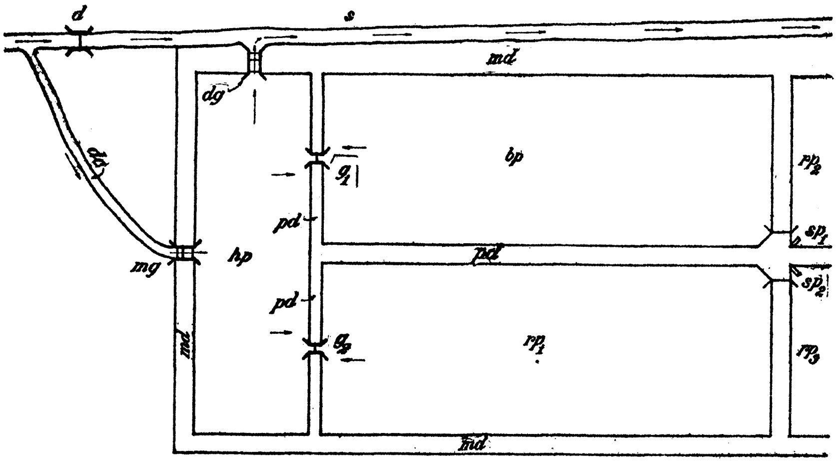

FIG. 6. A goramy pond system at Mabalacat, Pampanga. *S*, Stream; *hp*, head pond; *bp*, breeding pond; rp_1, rp_2, rp_3, rearing ponds; *d*, dam; *dc*, diversion canal, *md*, main dike; *pd*, partition dikes; *mg*, main gate; *dg*, drain gate; g_1, g_2, gates; sp_1, sp_2, supply pipes. The arrows point in the direction of the flow of water.

The ability of the goramy to breed in the ponds could furnish the basis for two industries, fry raising and the raising of the marketable size for the fresh-fish markets. A proprietor proficient in breeding and rearing the fry and selling them to large fishpond owners for transplantation into their larger ponds would surely net a good income, in much the same way as the Malabon fishpond owners engaged in the selling of bañgos fingerlings to fishpond owners of Bulacan and Pampanga (text fig. 6) earn a fair margin on their investment, in spite of the added expense incurred in the purchase of the tiny *kawag-kawag*, or bañgos fry.

The following is the approximate data on the commercial possibilities of a giant goramy venture. The maximum capitalization and the minimum income have been used in the computations. For convenience, the figures used are all in round numbers.

	Pesos.
I. Probable capitalization:	
A. 1 hectare of fishpond site	200
B. Development of site	1,500
C. Fluid capital	300
Total	2,000
II. Probable expenses (annual):	
A. Maintenance:	
1. Wages (1 laborer at 20 pesos per month)	240
2. Supplies	50
3. Repairs	60
B. Fixed charges:	
1. Interest on capital, 10 per cent	200
2. Land tax, .0087 per cent of assessed value (200 pesos)	2
C. Sales charges:	
1. Sales tax, 1.5 per cent of sales	23
2. Bad debts, 1.5 per cent of sales	23
3. Marketing, 8 per cent of selling price	120
Total	718
III. Probable gross income (annual):	
Sale of 5,000 marketable fish (1-year- to 2-year-olds) at 30 centavos each	1,500
IV. Operating expenses (Item II)	718
V. Probable net income:	
39.1 per cent of the total capitalization	782

FRESH-WATER POND CONSTRUCTION

Although goramy is a hardy fish and could be cultured in scattered and isolated small backyard ponds, as has been observed by Doctor Herre in Java, cultivation in regularly constructed farms, where the volume of water and the proportion of plant to fish life are all under complete control, will result in considerable improvement in goramy raising. While the isolated and the haphazardly constructed fishponds are sometimes satisfactory, they are subject to the danger of insufficient water supply during extreme droughts and of drainage of the excess water during floods. Enough precaution and care must be observed in the selection of a site for such a project, in much the same way as a merchant or any other businessman considers the various factors before he decides on the final location of his enterprise, in order to avoid discouragement and collapse of

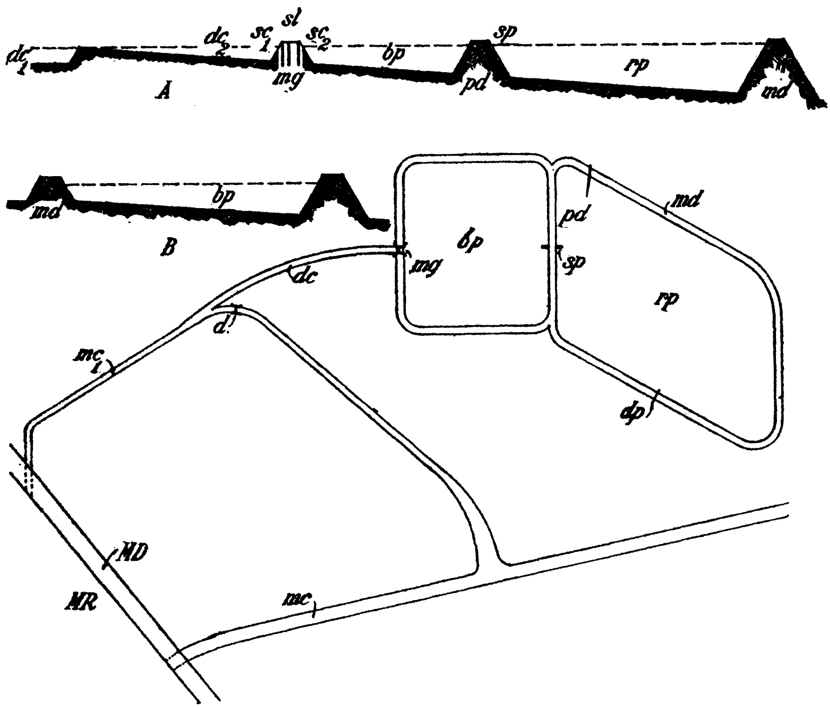

FIG. 7. Plan of the Molino Goramy pond. *A*, *B*, Sectional views; *MR*, Molino Reservoir; *MD*, Molino Dam; *mc*, main canal; mc_1, minor canal of *MR*; *d*, dam for pond; *dc*, diversion canal; *dp*, drain pipe (rubber siphon); *mg*, main gate; *md*, main dike; *sp*, supply pipe; sc_1, fine-meshed wire screen; sc_2, coarse-meshed wire screen; *sl*, wooden slabs; *bp*, breeding pond; *rp*, rearing pond; *pd*, partition dikes.

what might have been a very lucrative business. It is better that no such enterprise be undertaken as a passing fancy, for then it will result in unnecessary loss of money and energy. The fish-raising industry is one of the few undertakings that require patience, care, and perseverance, not only for a short period of time but for several years, in order to yield their best results, both in experience and technic, and in increased earnings for every peso of capital invested.

Three important factors must, therefore, be considered; the selection of the site for the pond, correct procedure, technic, and practice in construction, and the investment of enough energy and money so as not to sacrifice correct practice to stinginess. If all of these factors are strictly observed, barring unforeseen circumstances, there is no reason for such a venture proving a failure.

SELECTION AND LOCATION OF THE POND SITE

Area and topography.—For the profitable cultivation of goramy on a commercial basis, a site of not less than a hectare should be selected. A smaller site would be impractical to divide into the various compartments needed in the pond system, and would not allow space for the house, garden, and small farm of the caretaker. The farm should be dedicated to the raising of feed of the fishes. The site must be free from inundation and surface drainage, to avoid the flooding and washing out of the dikes and the resulting loss of fish and need for repairs. Many fish have been lost in floods by several goramy fishpond owners in Luzon because of faulty selection of the site, to the extent that even ordinary flood and surface waters are hard, if not impossible, to control.

Type of soil.—While any type of soil except sandy and rocky or other extremely porous soil will do for the construction of fresh-water fishponds, heavy clay, through which water cannot percolate, is the most desirable. A site in which the soil is of somewhat loose texture can be made water-tight by puddling it with clay. Sandy soil is impractical, for while the bottom may be puddled as above, the construction of earthen dikes that will remain intact and in form is a great problem, as the dikes are likely to collapse with very heavy rain. Moreover, it is difficult to haul such types of soil from the pond bottom to the site of the dike construction. An extremely rocky or gravelly soil is also impractical, as it gives rise to great expense in the excavation of the pond bottom, while the excavated materials will be useless in the construction of the dikes.

Water supply.—The availability of an adequate water supply is the most important factor to be considered before the construction of a pond is contemplated, for upon it depends the whole fate of the investment. The presence of water in a site is no guaranty that the pond will have sufficient water throughout the year. The volume of water needed is enough to fill the pond to sufficient depth to maintain the normal life of the goramy. That volume must be maintained through even the driest part of the year, so as to replace the amount that is lost in seepage and evaporation. In other words, the water supply must meet the exigencies of the most adverse conditions. Fish need to be in water all the time, or else they will perish. The source of the water must be properly investigated to determine whether the demands made upon it above the site will not endanger the enterprise during some time of the year—demands for irrigation, and similar purposes. The study of the behavior of the level in the source is essential for the construction of the dam and the diversion canal in such a manner as to maintain a flow, so that whenever necessary all the different compartments of the fishpond can be flooded. The level of the head needs, therefore, to be determined by a competent engineer during the two extremes of the year with regards to the possibility of maintaining the desired volume in the various ponds of the system.

Nearness to market.—Although nearness to market is not as important as the other three factors mentioned, it needs to be looked into in order to determine the financial success of the enterprise. The advantage of being near a good market is obvious. There the produce can be disposed of with the least delay and a minimum of expense. The pond does not need to be near the market when there are adequate transportation facilities at hand, although transportation involves an additional item of expense that must be recovered in the higher price that the commodity should command in isolated places where the supply of fish is very limited.

Procedure of construction.—It is unwise to construct a pond system right in the course of a stream or a river, where the water cannot be controlled during freshets and is likely to cause damage to the embankments and dams. Even if the dikes and dams do not give way during high water, there is the difficulty of screening the pond and preventing the escape of the fish. The pond itself will become shallow, due to the gradual accumulation of sediments carried by these intermittent floods. Should it be found cheaper, and otherwise good policy, to build in this manner, an artificial ditch should be built at one side the whole length of the pond, to carry off surplus water.

The pond system (text fig. 11) must be built at one side of the stream by digging the ground and building dikes or embankments, and the water let into the compartments by a system of canals, pipes, and sluices (concrete or wooden-screened gates), and damming the stream at a point above the site and diverting a portion of the flow through a narrow diversion canal. The source of the water then available from the dammed portion of the stream must be high enough to water all the parts of the pond by the force of gravity.

Main dikes (text fig. 8).—Once the site of the pond system is found from all angles to conform to the conditions necessary, the next step is to lay out the plan of the main dikes. Inasmuch as these structures may be considered the pillars of the fish-pond, they must be built as strong as possible in order to weather all climatic conditions prevailing in the locality.

The construction of the main embankments depends upon the topography of the land, the character of the soil, and the volume and pressure of the water to be confined. The place where the pressure of the water is greatest is the danger point in the pond system, requiring a safe dike 2 meters high, 6 meters thick at the base, and 1 meter thick at the top, the earth gradually sloping on the sides. This dike will be able to retain 1.5 meters depth of water. A safe proportion for such an embankment is a slope of 1.5 on the horizontal for 1 on the vertical towards the outside of the pond; while a grade of 1 to 1 must be maintained towards the inside. For the less-exposed portion of the pond, where the water pressure is correspondingly less, depend-

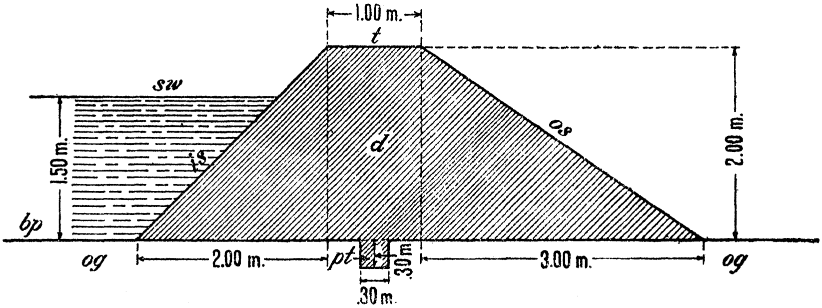

FIG. 8. Cross section of a portion of the main dike for the weak sections of the pond system, showing the slopes and the puddle trench. *sw*, Surface of water; *bp*, bottom of pond; *og*, original ground; *d*, dike; *is*, side of dike towards the inside; *t*, top of dike; *os*, side of dike towards the outside; *pt*, puddle trench.

ing upon the topography of the land, the main dikes may be built at varying strengths in the proportion set forth above.

Once the line for the construction is laid, the site should be cleared of all trees, including stumps, roots, underbrush, pieces of wood, and other organic matter that is likely to decay and possibly result in loss of water by seepage through these potential leaks in the construction.

Then a puddle trench should be dug, 30 centimeters wide, 30 centimeters deep, and extending the whole length of the main dikes into which the new earth will settle. This trench will form a break between the original ground and the construction, and increase the stability of the embankment. Without such a trench, the superficial junction between the damped earth and the surface ground is a natural weakness, giving rise to much seepage, especially in the case of elevated sites. The fillings should progress by layers over the full length and width of the levee as a continuous operation rather than by sections, for otherwise the completed work will develop checks by reason of variations in materials and difference in compactness. Rocks and grasses with entwining roots are of use as a protecting riprap on the slope after completion. It has been found that corners in the form of arcs are more desirable than those with an angle of 90 degrees, because the latter are more rapidly eroded by waves created by the movement of the surface water striking the side at a sharp angle. Text fig. 8 is a cross section of the main dike, showing the correct slope.

The diversion dam and canal.—In view of the fact that the pond system needs to be constructed on the side of the supply stream, the diversion of a portion of the latter's flow into the various compartments necessitates the building of a diversion

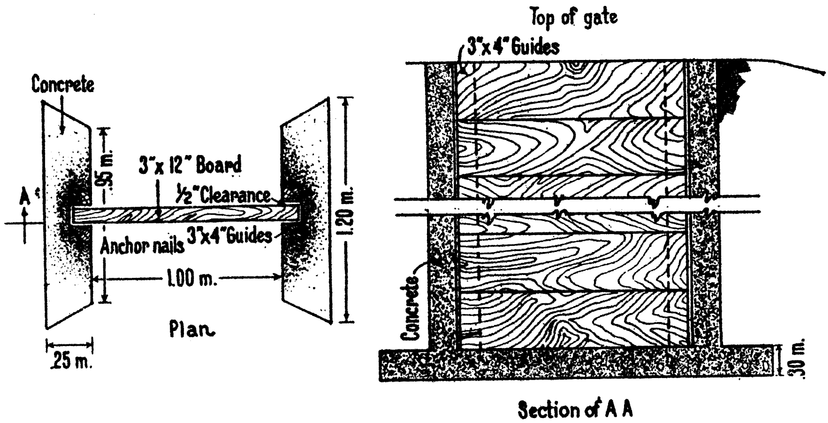

FIG. 9. Plan of the diversion dam of the Molino Goramy Pond, Bacoor, Cavite; diagrammatic.

dam and a diversion canal. A point where the stream or spring is narrowest and highest must be located above the pond, the former in order to reduce the cost of construction and the latter in order to flood any part of the system at least cost, through gravitation. This is accomplished by a system of removable flashboards, placed in the dam when water is desired and removed when water is not needed. Thus, while the pond can be flooded at will by diverting a portion of the flow of the streams, the danger of it being overflooded during freshets is obviated by simply removing the flashboards of the dam and allowing the stream water to flow through its natural course. Text fig. 9 is a plan of a diversion dam together with the details of its construction. Plate 7, figs. 1 and 2, shows the working of such a dam.

In the construction of the dam there must be built a sufficient thickness of concrete work along both sides of the bank, so that it will be able to resist the pressure of the water current when blocked. The flashboards must fit into wooden guide boards embedded into the concrete sides so as to avoid the breaking or chipping off of any portion of the concrete work. In order to maintain the volume of water in this dam when the ponds are to be flooded, the first flashboard must, likewise, fit into a wooden groove at the bed of the stream so as to form a water-tight inclosure. This device is especially useful during droughts, when the volume of flow in the supplying stream is very much diminished.

The diversion canal must not be dug as low as the bed of the stream; it must be constructed at least 30 centimeters higher in order to prevent the backing up of the flow once the dam is opened. From this point the canal must be dug in such a way that a gradual slope is maintained towards the pond system. The end towards the main gate of the pond must be about 30 centimeters higher than the bottom of the pond itself. A canal about ½ meter wide, with the depth varying with the topography of the site and in conformity with the conditions set forth above, is sufficient to supply the desired volume needed in the whole pond system. This canal should be screened at least at one, if not at both ends, by a screen purposely constructed at the end towards the stream and at the main gate towards the pond, to prevent the ascent of the cultivated species to the stream, and to keep undesirable fish and fish eggs and floating drift out of the pond system.

The gates.—With a view to safeguarding the pond from the entrance of enemies and to preventing the escape of the cultured fish, a well-built and properly screened main supply gate is essential. Text fig. 10 is the plan of a concrete main gate, together with the details of its construction.

Since the gate provides the main entrance of water from the outside, it needs to be located at the highest portion of the pond site that is adjacent to the diversion canal. From this point the general contour of the pond bottom must be gradually sloping down to the last compartment and to the deepest portion, where the main drain gate is to be built. The whole structure must be provided with three pairs of wooden guides, into the grooves of which will fit the fine-meshed wire screen, the wooden slabs, and the coarse-meshed wire screen, from outside to inside in the order enumerated. The fine-meshed screen is for

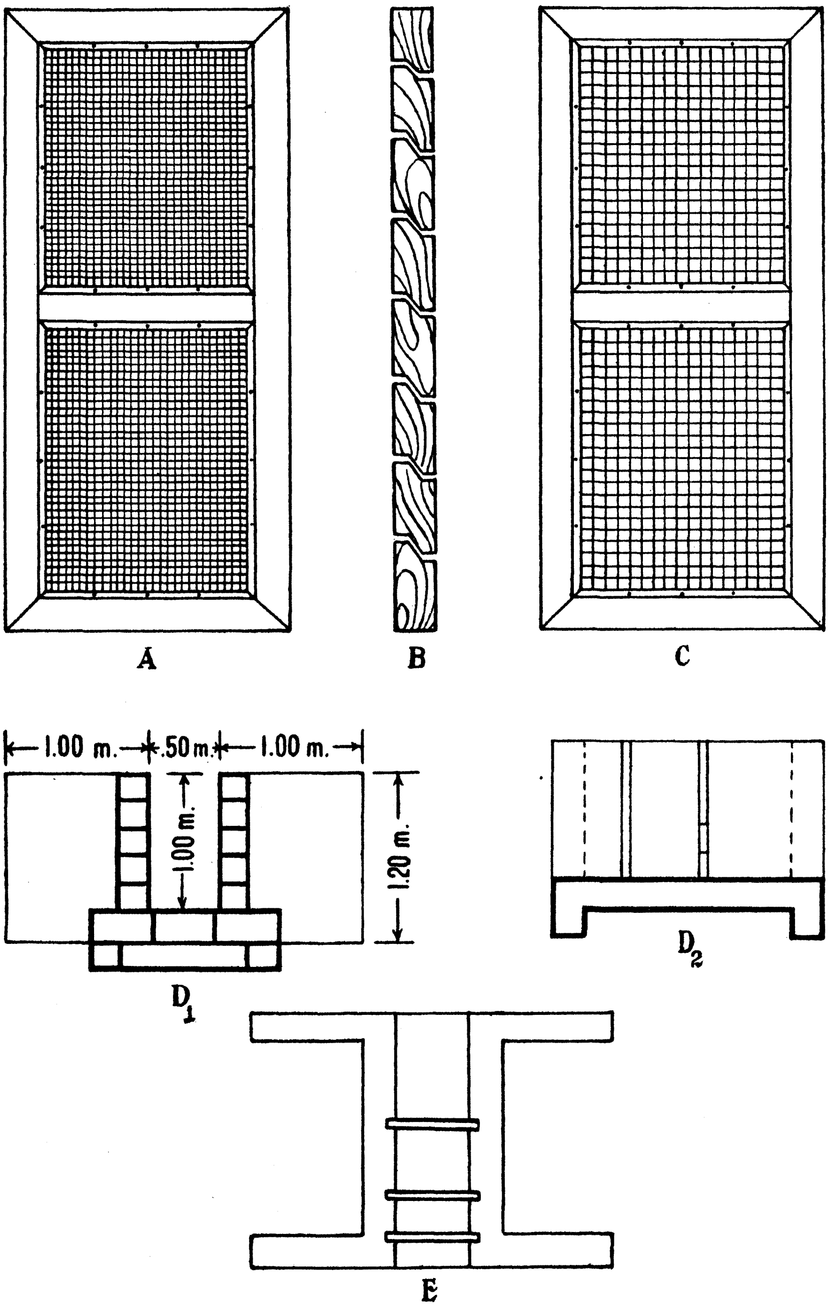

FIG. 10. A, Fine-meshed wire screen; B, groove arrangement of wooden slabs (cross section); C, coarse-meshed wire screen; D_1, D_2, sections of main gate; E, plan of main gate.

excluding all undesirable eggs and young of enemies; the wooden slabs are for retaining the water in the pond, especially in the head and in the supply and drain canal; the coarse-meshed screen is for preventing the cultured species from ascending the stream and crowding at the main supply gate, especially when water is let into the ponds.

Just as important as the main supply gate is the main drain gate, which, as stated above, must be situated at the lowest point of the pond system so as to effect complete drainage when desired. This device is also of use in lowering the level of the water in catching fish and in cleaning the compartments. The construction of such a gate is the same as in the main supply gate, except in the order in which the screens are placed; in this main drain gate the fine-meshed screen must be towards the inside of the pond, while the coarse-meshed screen is towards the outside. This reverse order is to check the escape of the eggs and young of the cultured species.

Besides the two main gates, partition gates need to be built for supplying water and at the same time for draining the different compartments as occasion demands. These do not need to be strong gates and may be built of wood only. Properly screened concrete, iron, or wooden pipes will also do for this purpose, but small wooden gates of similar design as the main gates are preferable.

Compartments.—To make the culture systematic, there arises the need of dividing the pond system into compartments by the construction of lower and narrower dikes, the partition dikes. As each compartment is to serve one definite purpose, if they are constructed independently of each other, trouble in one will not cause a disturbance in the other compartments, neither in supplying nor in draining off the water. This system is essential to avoid disturbance in the normal spawning in the breeding ponds and the bruises occurring in the undersized fishes that are mixed with the marketable groups in the rearing ponds. A farm outlay should consist of three units; namely, head ponds, breeding ponds, and rearing ponds.

Text fig. 11 is a ground plan of a model goramy farm, together with sections showing the contours of the pond bottom of the whole system.

The head pond.—This compartment must be adjacent to the main supply gate and, therefore, directly connected with the diversion canal. It must cover at least one per cent of the whole

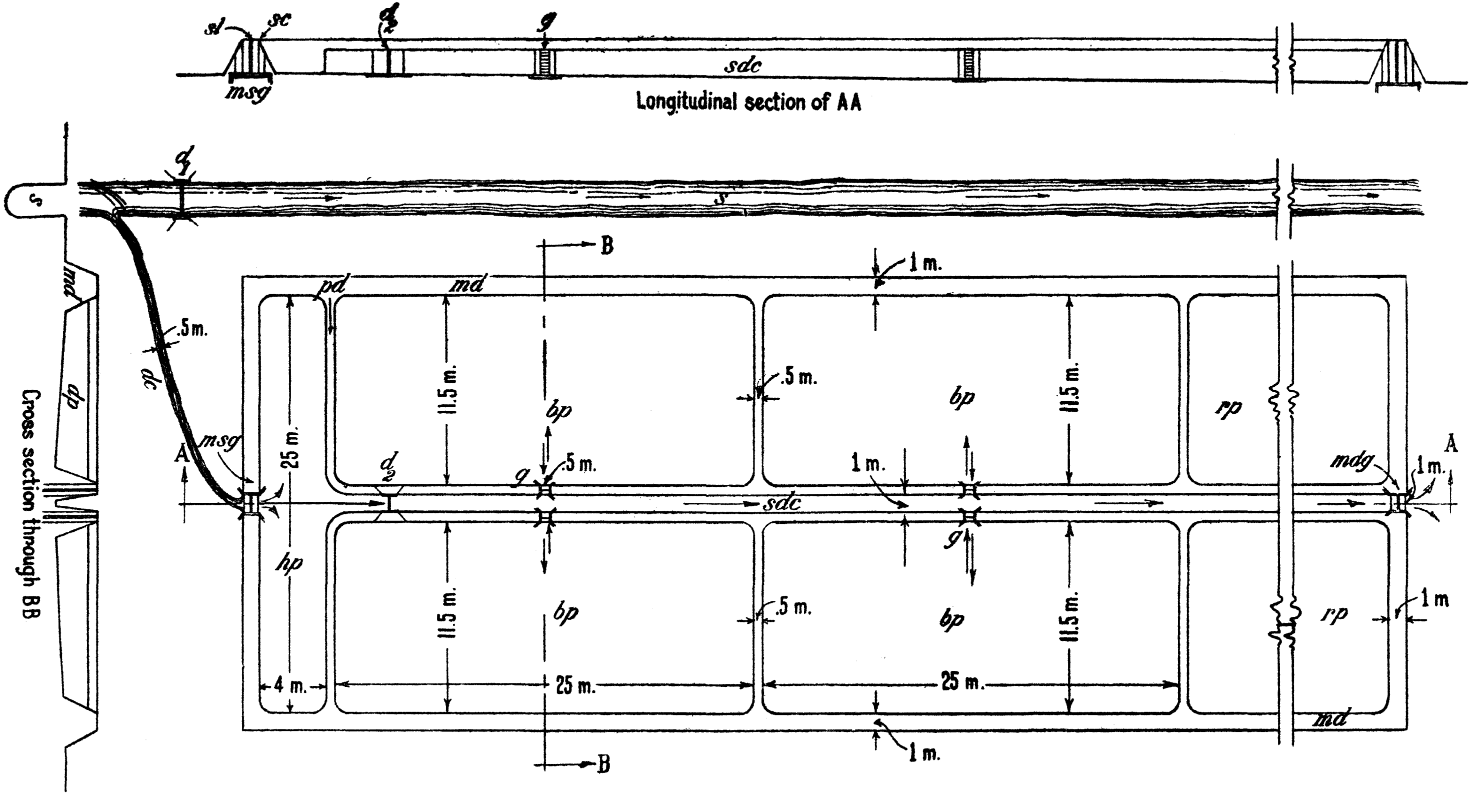

FIG. 11. Ground and sectional plans of a model goramy pond; diagrammatic. *s*, Stream; *hp*, head pond; *bp*, breeding pond; *rp*, rearing pond; d_1, diversion dam; d_2, dam of head pond; *dc*, diversion canal; *msg*, main supply gate; *md*, main dike; *pd*, partition dike; *sdc*, supply and drain canal; *g*, gate; *mdg*, main drain gate; *sc*, wire screens; *sl*, wooden slabs; arrow points in the direction of flow of water.

area of the pond site. This pond acts as a reservoir where the water can subside and breed plankton. The other divisions are constructed on both sides of a central canal, the supply and drain canal that leads from the head pond.

The breeding ponds.—The breeding ponds, otherwise known as the stock ponds, must cover an area of not less than 10 per cent of the entire site. At least two of such ponds must be built, so that when one is being cleared of the enemies of the species, the other can be used to accommodate the breeding stock.

In these ponds the spawners build their nests and breed. It must, therefore, be of sufficient depth (1.5 meters) so that the fishes can move about properly and enjoy a habitat approximating their natural state, conditions that are essential and conducive to proper spawning. Abundant growth of floating vegetation, the roots of which rise and fall with the level of the water, must be provided along the sides for the attachment of their nests and for supplying them with materials for nest building.

The rearing pond.—The remaining 89 per cent of the pond site may be converted partially or completely into rearing ponds, as the demand for quartering a greater number of offspring arises. These are compartments for the young once they are segregated from the parent fish, and serve also as nursery ponds, where the young can get the proper care until they reach a marketable size, when they are caught and marketed. The more rearing ponds there are in a pond system the better, for then the various sizes of young can be sorted and quartered separately. This provision will facilitate catching during marketing and cause the undersized to be spared from being unnecessarily bruised and injured. It will also afford the young the equal chances of feeding and growing that they would not have if young and old were mixed together in the same compartment.

As the breeding and rearing ponds are on both sides of the supply and drain canal, the bottom must slope down towards the latter so as to effect complete drainage when necessary.

After the whole pond site is completed and before it is filled with water, all roots, stumps, rocks, and everything that may prevent the free sweep of a net dragged along the bottom, must be removed.

As adjuncts to the pond system, a portion of the 89 per cent remaining may be set aside, after the head pond and the breeding ponds have been reserved, for the house of the caretaker and a small farm or garden where vegetables and other greens, especially aquatic and semiaquatic plants, may be raised for the feed of the fishes.

Summarizing, therefore, the following are the areas that must be allotted to the different compartments in a 1-hectare fishpond site:

Compartments.	Areas in sq m.	Per cent.
One head pond	100	1
Two or more breeding ponds	1000	10
Rearing ponds, house site, and farm	8900	89

APPROXIMATE COST OF CONSTRUCTING A 1-HECTARE GORAMY POND

The cost of construction depends upon several factors:

1. The topography of the land, whether level, sloping or undulating.

2. The type of soil, whether clay, mud, gravel, or rock.

3. The type of vegetation to be cleared, whether tall trees, shrubs, bushes, or grasses.

4. The cost of labor in the locality.

The following approximate cost is based on conditions obtaining in provinces near Manila, and in which the site is fairly clean and level:

Expenditures.	Pesos.
2 Diversion dams (concrete)	90
1 Main supply gate (concrete)	100
1 Main drain gate (concrete)	100
6 Partition gates (wooden)	60
Labor for the construction of main dikes Labor for the construction of partition dikes Labor for digging diversion canal	1000
1 House for caretaker	50
Tools, implements, and various accessories	100
Total	1500

DON'TS IN FRESH-WATER FISH FARMING

1. Do not begin a fresh-water fish farm without the necessary capital to complete the project.
2. Do not attempt to culture dalag, as it has been proven impractical and unprofitable to raise in captivity.
3. Do not mix noncarnivorous species with carnivorous ones in the same compartment.
4. Do not attempt to construct a pond where you are not certain of a reliable water supply the year round.
5. Do not locate your ponds in inundated sites or those where the soil is too sandy or rocky.

6. Do not dig your pond site deeper than necessary to maintain a sufficient depth of water after the dikes are completed; do not think that fishpond construction is all a question of digging.
7. Do not fill the finished or completed pond with water without clearing the bottom of obstructions so as to permit the free sweep of a net.
8. Do not undertake fishpond farming as a mere passing fancy.
9. Do not fail to replace your stock with new spawners after the old ones have reached "the point of diminishing returns" in the production of young.
10. Do not handle live fish with the dry bare hands; use a dip net or wet the hands before touching them.

ILLUSTRATIONS

PLATE 1

FIG. 1. Goramy nest recovered from the Manila Propagation Ponds, November 10, 1932.

2. Goramy nest recovered from a fishpond at Mexico, Pampanga, October 19, 1935.

PLATE 2

[The short (scale) line beside each figure represents 1 mm.]

FIG. 1. A newly hatched goramy fry.

2. A 15-day-old goramy fry.

3. A 26-day-old goramy fry.

4. Goramy fry 1 month and 12 days old.

PLATE 3

FIG. 1. Feeding goramy at the Manila Propagation Ponds. Note the fishes actually biting at the bundles of kangkong.

2. Bundles of kangkong scattered as feed in the goramy pond.

3. The bundles of kangkong in figure 2, 15 minutes after feeding.

PLATE 4

FIG. 1. Preparing the drag seine for catching goramy.

2. Dragging the seine in one of the concrete ponds.

PLATE 5

FIG. 1. Drag seine hauled in with adult and young goramy for transplantation.

2. Quarrying adobe rock at the bottom of the Molino Goramy Pond, Bacoor, Cavite.

PLATE 6

FIG. 1. Scraping soil from the bottom of the Molino Goramy Pond, Bacoor, Cavite.

2. Building the main dike of the Molino Goramy Pond, Bacoor, Cavite.

PLATE 7

FIG. 1. Closing the diversion dam to raise the level of the head water at the Molino Goramy Pond.

2. The diversion canal of the Molino Goramy Pond.

PLATE 8

FIG. 1. The main gate of the Molino Goramy Pond, showing the outer coarse-meshed and the inner fine-meshed wire screens.

2. The main gate of the Molino Goramy Pond, with the wire screens in place.

PLATE 9

FIG. 1. Letting water into the Molino Goramy Pond.
2. Close-up of a portion of the main dike of the Molino Goramy Pond.

PLATE 10

FIG. 1. A completed compartment of the Molino Goramy Pond.
2. The Molino Goramy Pond system.

TEXT FIGURES

[Drawings by A. Verzosa.]

FIG. 1. Ground plan of the Manila Propagation Ponds of the Bureau of Science.
2. An adult female goramy.
3. An adult male goramy.
4. The nest of the goramy in situ.
5. Accessories in a fresh-water fish-cultural establishment. *A*, Transportation can for adults: *d*, drain pipe of can; *l*, lid; *p*, perforated bottom of lid. *B*, Dip nets: *a*, coarse-meshed (for adults); *b*, fine-meshed (for young). *C*, Pail for young: *p*, perforated bottom of lid; *l*, lid of pail.
6. A goramy pond system at Mabalacat, Pampanga. *s*, Stream; *hp*, head pond; *bp*, breeding pond; rp_1, rp_2, rp_3, rearing ponds; *d*, dam; *dc*, diversion canal; *md*, main dike; *pd*, partition dikes; *mg*, main gate; *dg*, drain gate; g_1, g_2, gates; sp_1, sp_2, supply pipes. The arrows point in the direction of the flow of water.
7. Plan of the Molino Goramy Pond. A, B, Sectional views; *MR*, Molino Reservoir; *MD*, Molino Dam; *mc*, main canal; mc_1, minor canal of *MR; d*, dam for pond; *dc*, diversion canal; *dp*, drain pipe (rubber siphon); *mg*, main gate; *md*, main dike; *sp*, supply pipe; sc_1, fine-meshed wire screen; sc_2, coarse-meshed wire screen; *sl*, wooden slabs; *bp*, breeding pond; *rp*, rearing pond; *pd*, partition dikes.
8. Cross section of a portion of the main dike for the weak sections of the pond system, showing the slopes and the puddle trench. *sw*, Surface of water; *bp*, bottom of pond; *og*, original ground; *d*, dike; *is*, side of dike towards the inside; *t*, top of dike; *os*, side of dike towards the outside; *pt*, puddle trench.
9. Plan of the diversion dam of the Molino Goramy Pond, Bacoor, Cavite; diagrammatic.
10. Molino Goramy Pond. *A*, Fine-meshed wire screen; *B*, groove arrangement of wooden slabs (cross section); *C*, coarse-meshed wire screen; D_1, D_2, sections of main gate; *E*, plan of main gate.
11. Ground and sectional plans of a model goramy pond; diagrammatic. *s*, Stream; *hp*, head pond; *bp*, breeding pond; *rp*, rearing pond; d_1, diversion dam; d_2, dam of head pond; *dc*, diversion canal; *msg*, main supply gate; *md*, main dike; *pd*, partition dike; *sdc*, supply and drain canal; *g*, gate; *mdg*, main drain gate; *sc*, wire screens; *sl*, wooden slabs. The arrow points in the direction of the flow of water.

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PLATE 1.

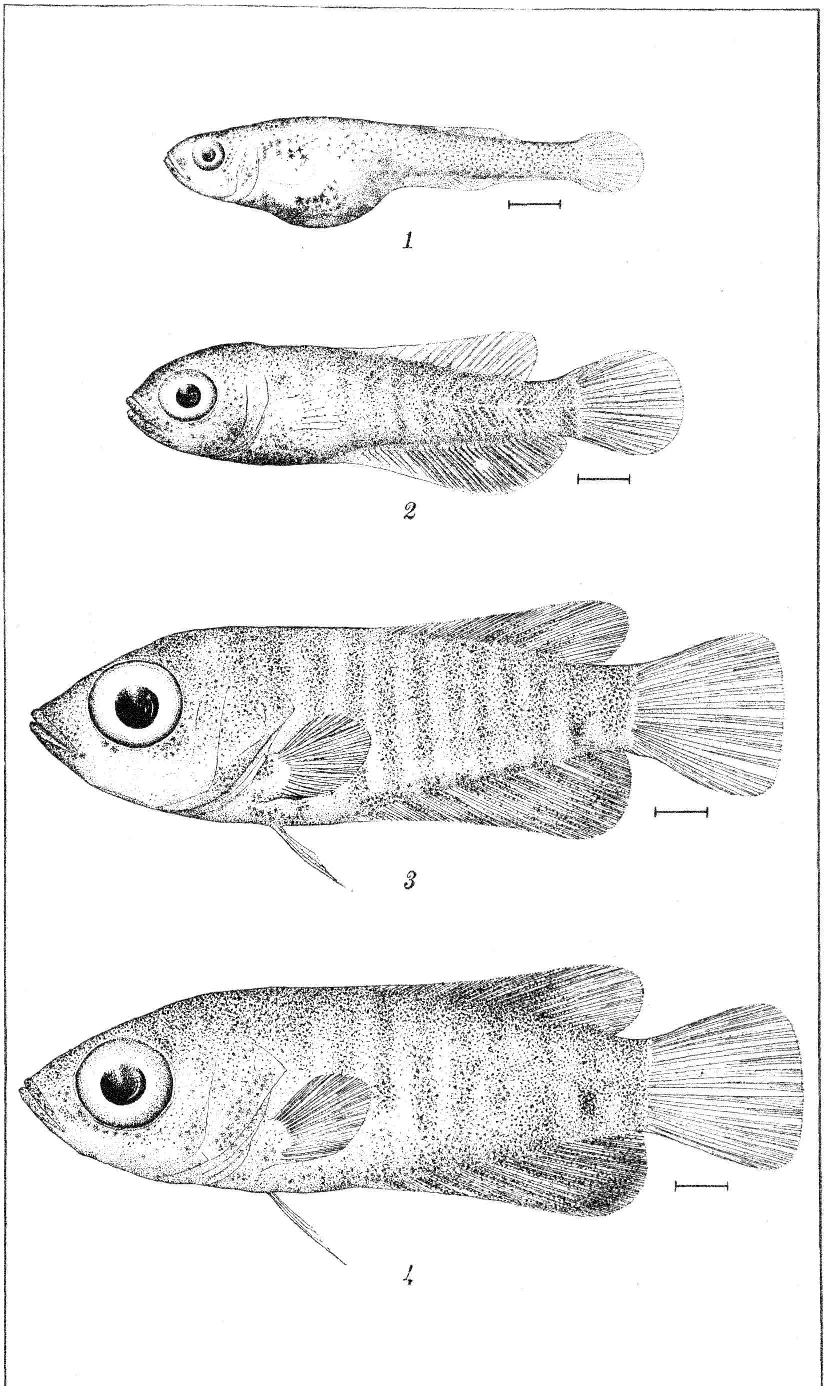
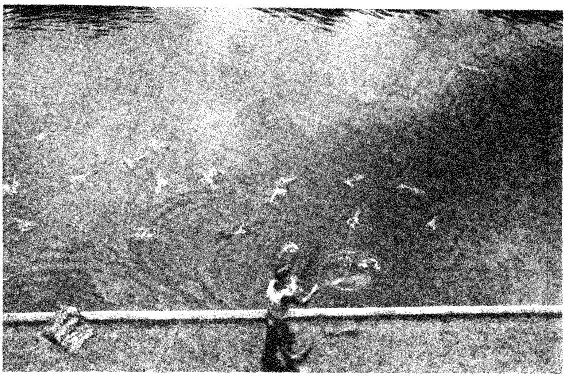


PLATE 2.



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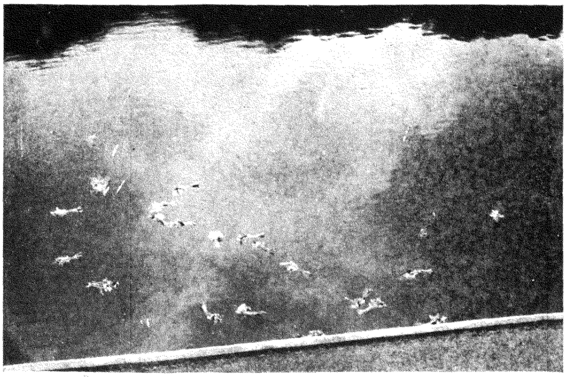

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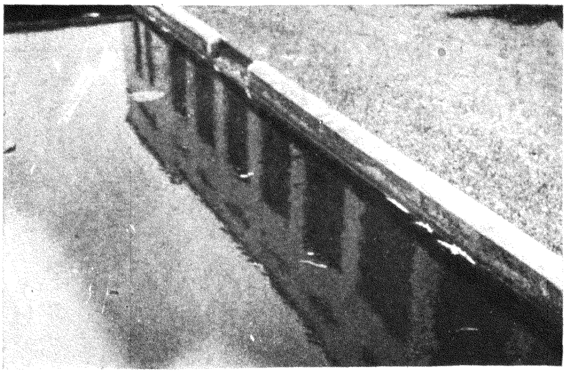

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PLATE 3.

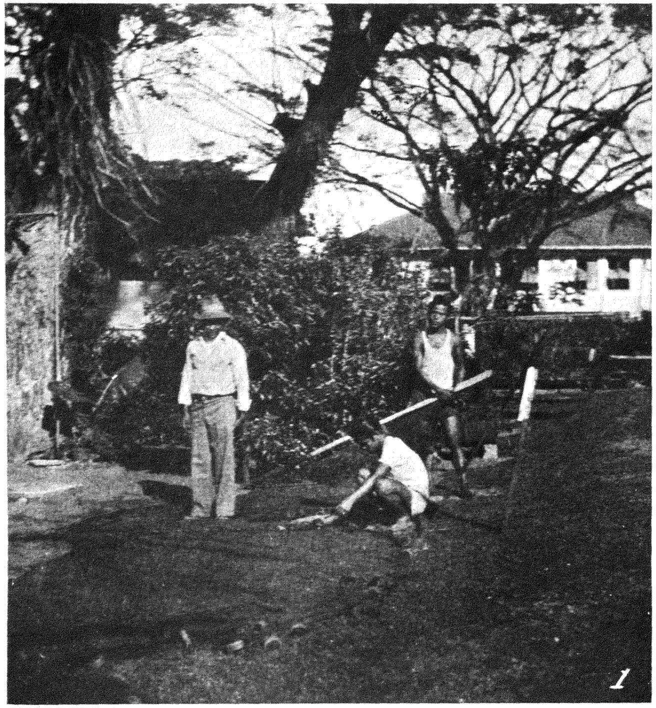


PLATE 4.

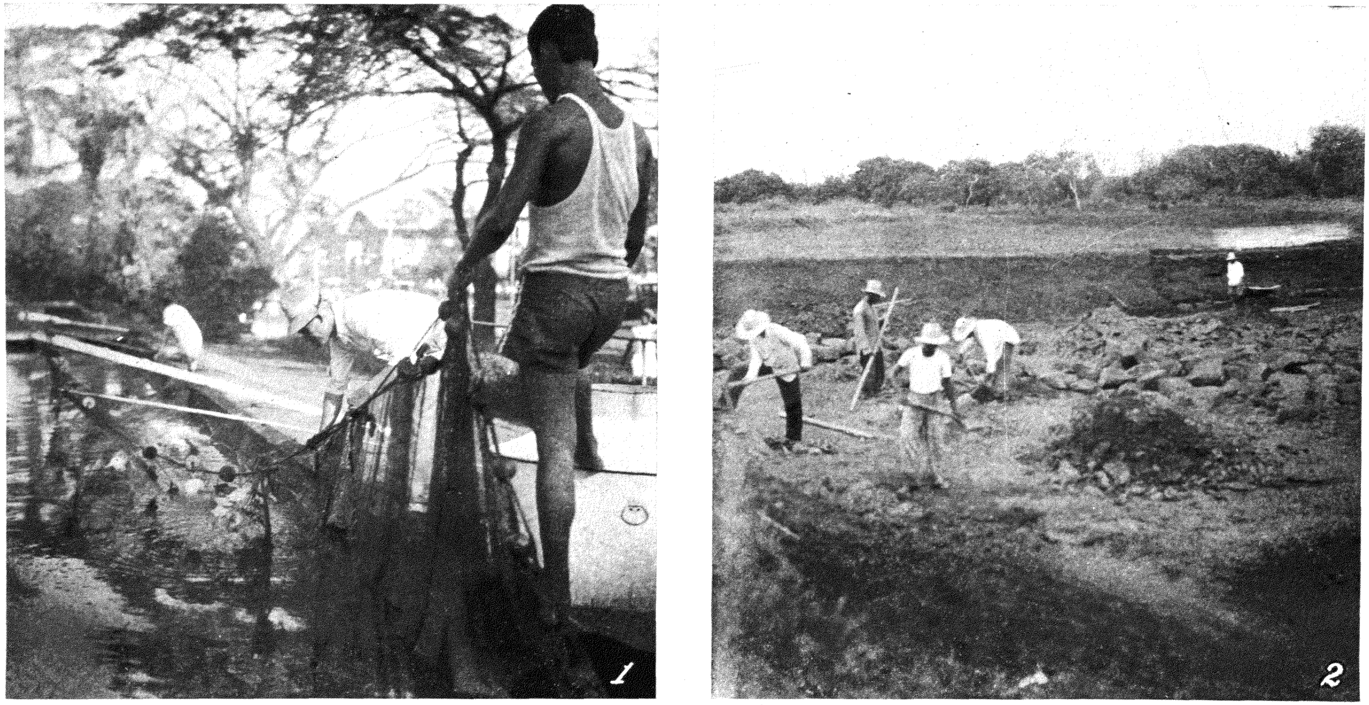


PLATE 5.

PLATE 6.

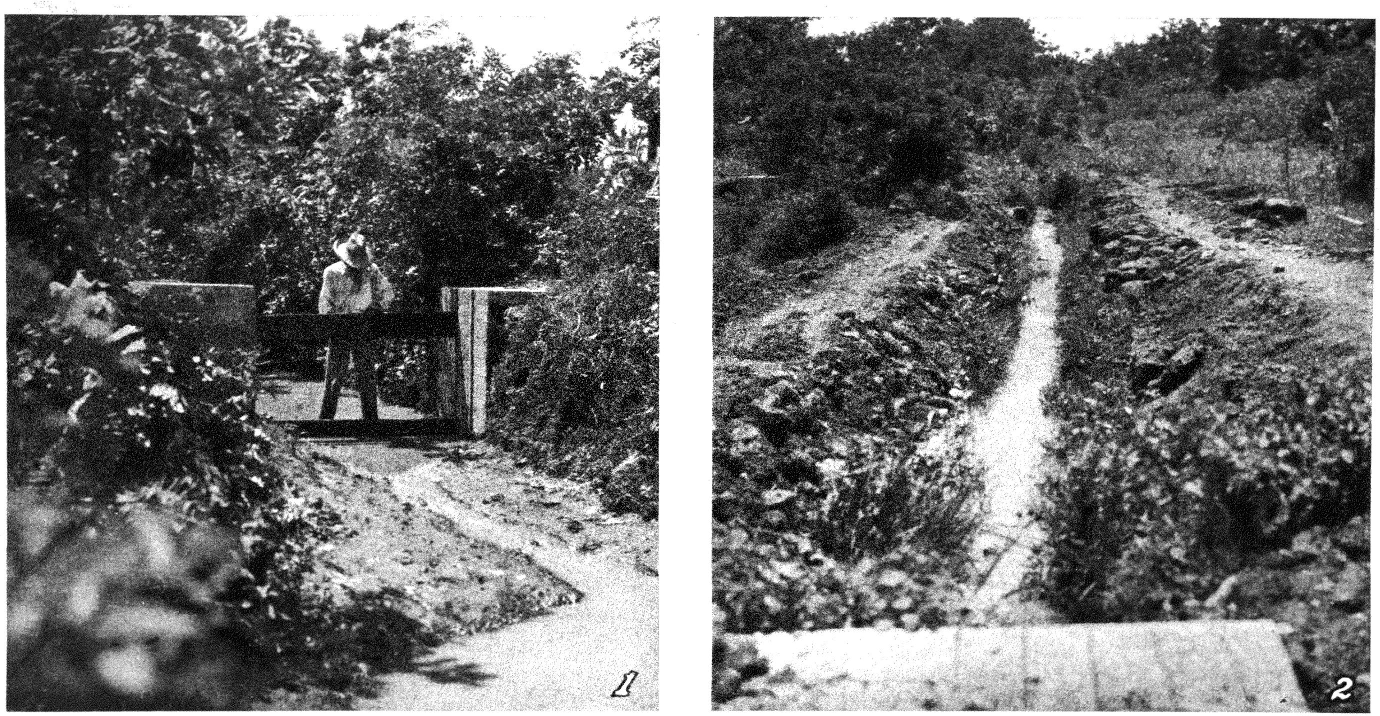
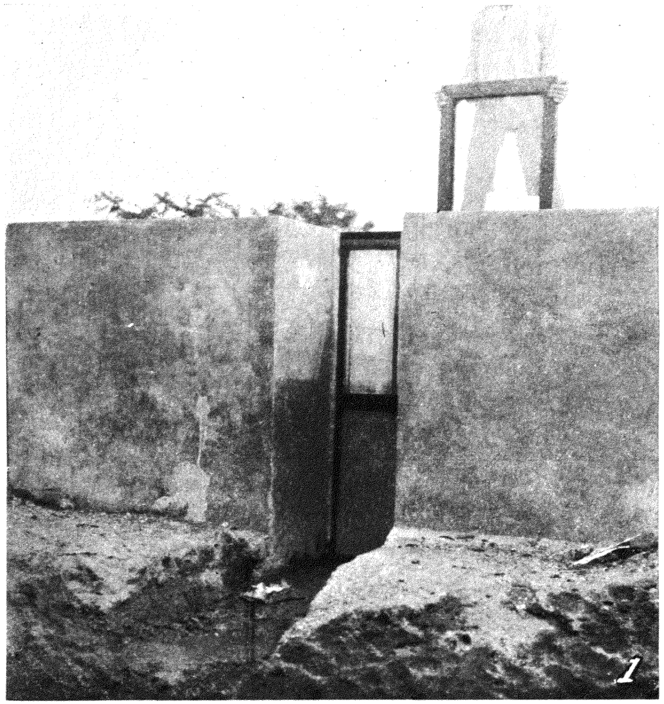


PLATE 7.



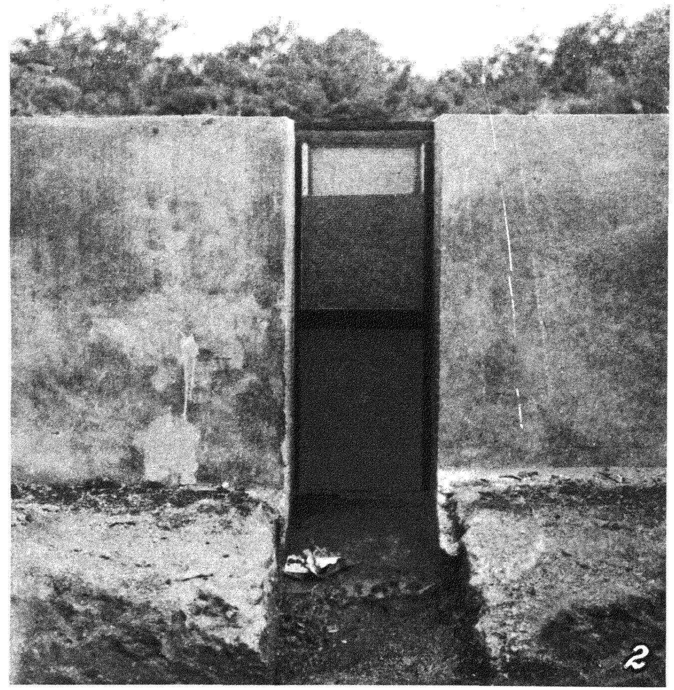


PLATE 8.

PLATE 9.

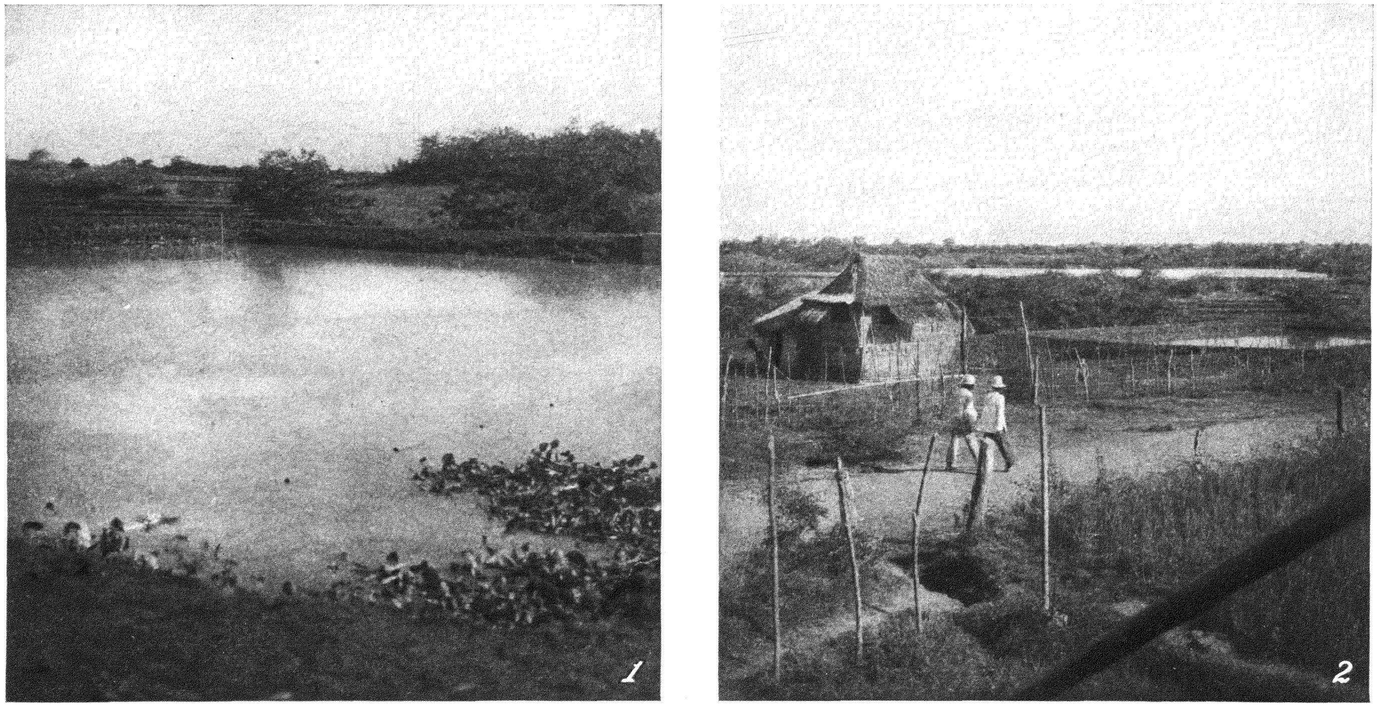


PLATE 10.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

Asia directory; a complete and up-to-date guide to the principal manufacturers, exporters, importers, merchants, shipping and insurance companies, banks, commercial and governmental organizations, etc. 1936–37 edition. Yokohoma, The Asia Directory Publishing Company. Price, Y16.96.

BARNARD, K. H. Amphipoda. (The John Murray Expedition, 1933–34, Scientific Reports, v. 4, no. 6, pp. 131–201.) London, The Trustees of the British Museum, 1937. Price, 5s.

The Economics of isolation. Pamphlet series No. 5, The American Academy of Political and Social Science, Phila., 1937. 54 pp. Price, paper, $0.50.

ELLIS, HAVELOCK. Psychology of sex; a manual for students. Emerson Books, inc., New York, 1937. 377 pp. Price, $3.

EVANS, W. H. Catalogue of the African Hesperiidae indicating the classification and nomenclature adopted in the British Museum. London, Printed by order of the Trustees of the British Museum, 1937. 212 pp., plates. Price, £1.

British Museum (Natural History). Diptera of Patagonia and South Chile. Part VII, Fascicle 3, Calliphoridae. Sarcophaginae by David Hall; Calliphorinae by John Smart. London, The Museum, 1937. pp. 347–384. Price, paper, 2s.

HICKSON, S. J. The Pennatulacea. (The John Murray Expedition, 1933–34, Scientific Reports, v. 4, no. 5.) London, Printed by order of the Trustees of the British Museum, 1937. pp. 109–130. Price, 2s.

LAUFER, STEPHEN. Yeast fermentation and pure culture systems, by Stephen Laufer and Robert Schwarz. New York, Schwarz laboratories, inc., 1936. 107 pp., illus. Price, $2.50.

New York State Traffic Commission. Creating safer communities. New York, The Commission, 1937. 48 pp.

RIKER, A. J., and R. S. RIKER. Introduction to research on plant diseases; a guide to the principles and practice for studying various plant-disease problems. St. Louis, J. S. Swift, 1936. 117 pp. Price, $2.50.

SHELDON, A. E. Land systems and land policies in Nebraska; a history of Nebraska land public domain and private property. (Nebraska state historical society. Publications, v. 22). The Society, Lincoln, 1936. 383 pp., illus., maps. Price, $3.50.

SHEPHARD, C. Y. The cacao industry of Trinidad. Series III and IV. Trinidad, Gov't print. off., 1937. 101 pp.

SMITH, A. R. H. A Carolina rice plantation of the fifties. 30 paintings in water-color, by Alice R. Juger Smith, narrative by Herbert Ravenel Sass, with chapters from the unpublished memoirs of D. E. Huger Smith. New York, William Morrow and Co., 1936. 97 pp., front., col. plates. Price, $10.

STAHL, AGUSTIN. Estudios sobre la flora de Puerto Rico. Con un prologo de Carlos E. Chardon. 2da. ed. tomo 1. San Juan, Puerto Rico, Publicaciones de la Federal Emergency Relief Administration, 1936. 343 pp.

STEVENS, BLAMEY. The identity theory. 2d ed., rev. and amplified. Manchester, Sherratt & Hughes, 1936. 143+xvi pp., tables, diagrs. Price, 7s. 6d.

STIASNY, G. Scyphomedusae. (The John Murray Expedition, 1933–34, Scientific Reports, v. 4, no. 7, pp. 203–242) London, The Trustees of the British Museum, 1937. Price, 5s.

VERE HODGE, E. H. Birch's management and medical treatment of children in India and the Tropics. 8th ed. Calcutta, Thacker, Spink & Co. (1933) ltd., 1936. 377 pp., illus. Price, Rs. 7–8.

WALKER, J. C. Diseases of vegetable crops. Ann Arbor, Michigan, Photolithoprint reproduction of author's manuscript by Edwards brothers, 1936. 65 pp. Price, $1.60.

WARREN, CARL. On your guard! the prevention and treatment of sex diseases. Foreword by Mr. J. Exner. New York, Emerson books, inc., 1937. 142 pp., front., illus., diagrs. Price, $1.

REVIEWS

The British Plastics Year Book 1937. The Handbook and Guide to the Plastics Industry. Plastics Press Ltd., London, 1937. 602 pp., illus. Price, 15s.

This standard book on plastics gives an account of the materials used in plastics, and the progress of this industry in Great Britain. Special chapters are devoted to methods of manufacturing cellulose plastics, methacrylate resins, synthetic resins from aniline condensation products, and similar topics. The book also gives the names and addresses of the firms interested in the plastic industry as well as the proprietary and general commercial names used. It has a section devoted to the numerous products made from plastics, and another section that contains useful data for manufacturers of these products.—A. P. W.

Diagnostic Criminology. By Lowel S. Selling. 1st ed. Edwards Brothers, Inc., Ann Arbor, Michigan, 1935. 175 pp. Price, $2.25.

This brief manual of scientific criminology may well serve as a practical guide to every scientific service in relation to criminal or juvenile court clinics. The variety and nature of the material treated in this book, together with the technical diagnostic procedures recommended, affords very useful information to all persons interested in the modern application of criminology to social needs. The goal in view is that physicians, lawyers, psychologists, and sociologists could derive practical means for adjusting themselves to the exacting demands of their official or social duties and services on matters pertaining to criminals and crimes.

The author has succeeded in gathering and summarizing, with special ability, the enormously extensive data concerning the social, legal, biological, and medical aspects of criminology, and in evaluating them carefully on the basis of their practical merit and application.

The book consists of only 175 lithoprinted pages, and its present edition is limited to 350 copies, for economic reasons and to have the opportunity to add gradually comments, criticisms, and suggestions for a later edition. Nevertheless, none of the essential information on modern criminology has been neglected, and the technique of examinations for diagnostic purposes and treatment have been described with remarkable completeness. Its contents include, aside from the definition and historical introduction of the subject, the examination of adult and juvenile offenders, the important syndromes common to the adult offenders and those particularly found in the juvenile offenders, and recommendations concerning treatment of different clinical cases. The appendix, containing some illustrative cases and the extensive carefully prepared bibliography arranged according to a classified division of the subject, are noteworthy.—S. A.

Doctor Colwell's Daily Log for Physicians; A Brief, Simple, Accurate Financial Record for the Physician's Desk. Champaign, Ill., Colwell Publishing Company, 1937. Price, $6.

This volume consists of blank forms. All financial data on each patient can be conveniently recorded in this excellent record system for medical practitioners. Forms are also provided for monthly and yearly summaries of income and disbursements. Special records are also provided for inoculations, narcotics dispensed, obstetrical cases, surgical operations, notifiable diseases, and deaths.—P. S. S.

Essentials of Cardiography. By H. B. Russell. J. and A. Churchill Ltd., London, 1936. 82 pp., illus. Price, 7s. 6d.

This little compendium of cardiography is a concise clear outline of what students should know about graphic examinations for the most common cardiac ailments.

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The facts are given in clear terms, and after reading the book one should get a good perspective of the whole subject that ought to create in an interested reader enough enthusiasm to spur him on to more intensive study.

The book is good not only for students but also for practitioners who may not have much time to devote to reading more extensive treatises on cardiography.—W. L.

Euthanasia and Other Aspects of Life and Death. By Harry Roberts. London, Constable and company, 1936. 278 pp. Price, 7s. 6d.

The book is made up of essays covering a wide range of subjects on euthanasia, on love and sex, on crime and punishment, on mind and reason, on education of the child, and on various sociological subjects, including sterilization of the ineffective. Most interesting of all is the discourse on euthanasia and the English Voluntary Euthanasia Legalization Bill. The bill seeks to legalize voluntary euthanasia under very limited and strict conditions so as to avoid abuse in its practice. The author should have specified whether the bill was enacted or not. The other subjects are of passing interest to a casual reader. Sociologists will probably find this book of some interest.—I. F.

Fleas as a Menace to Man and Domestic Animals: Their Life-History, Habits and Control. By James Waterston. 3d ed. rev. by P. A. Buxton. British Museum (Natural History) Economic Series III. Printed by order of the Trustees of the British Museum, London, 1936. 20 pp., illus. Price, 4d.

This pamphlet is a valuable contribution to the subject of fleas, which transmit the bacillus of bubonic plague. It points out that some fleas transmit certain types of endemic typhus, that a certain flea acts as the intermediate host of a tapeworm, in the adult state, in both dog and man, and other pertinent information.

The pamphlet is so well illustrated and simply written that the layman can understand it without difficulty. It sums up cur present-day knowledge of the life history, habits, and various ways of control of fleas.—G. C. B.

The Gold-Exchange Standard in the Philippines. By George F. Luthringer. (Princeton University Department of economics and social institutions. International finance section. Publications, v. 4) Princeton University Press, 1934. 291 pp. tables, charts. Price, $3.

This book describes the Philippine Gold Standard Act of 1903 which provided a mechanism for maintaining the parity of the silver peso with a theoretical gold peso containing 12.9 grains of gold 0.900 fine, a unit with a gold content precisely half that of the United States gold dollar. This was accomplished by establishing the Gold Standard Fund which consisted of silver coins held in the Treasury in Manila and dollar deposits in Banks in the United States.

Partly for the reason that in Oriental countries there is a tendency for the gold to disappear from circulation to be hoarded or converted into jewelry and partly for economic reasons, the purpose of the Philippine Gold Exchange Standard was to establish a form of gold standard that would function automatically without the necessity of circulating gold coin or maintaining a reserve of gold coin or bullion in the Islands.

The Gold Exchange Standard Act and the Silver Certificate Reserve Act were later superseded by the Currency Reserve Fund Act, creating the Silver Certificate Reserve which provided for the maintenance of the parity of the currency with gold through acting as a regulator fund which also served as redemption fund for treasury certificates, thus allowing the people to secure coins or notes as they desired.

The creation and operation of the Philippine National Bank is also described; in this description is reviewed the gradual dissipation of the currency reserve, through the inefficiency and ignorance of the basic principles of the currency system by the responsible officials of the bank and the Insular Treasury.

Such modifications as: (*a*) Disposition of part of the Gold Standard Fund in Philippine banks, and (*b*) The investment of part of the Gold Standard Fund in the Philippines, which were introduced after several years of operation of the Gold Exchange and the Silver Certificate Reserve, contravened with the basic principles of operation of a sound currency system. These modifications resulted in the dissipation of almost four-fifths of the dollar balance of the currency reserve, and would have resulted in a complete collapse of the Gold Exchange Standard mechanism if the Silver Certificate Reserve Act had not superseded the Gold Standard Fund as regulator of the fund of the currency system.

The book also describes the desperate attempt of the Insular Government to prevent financial chaos, which resulted in tampering with the currency reserve which would have resulted in the closing of the Philippine National Bank but for the adverse political financial effects such a step would have.

The book contains valuable footnotes, references, and statistics obtained from authentic official documents, besides a bibliography. To those who are interested in the study of the relationship of the Philippine peso to the United States dollar and to students of banking, finance, and currency measures, this book is an invaluable guide.—D. A.

Handbook for the Amateur Lapidary. By J. Harry Howard. Published by S. H. Howard, Greenville, S. C., 1935. 140 pp., illus. Price, paper, $2.

The Handbook for the Amateur Lapidary, although evidently intended for amateurs, is comprehensive enough to be useful also to the professional lapidary. It not only gives valuable information in the art of cutting and polishing gems and the equipment required, but is also good reading for a man who wishes to have a scientific knowledge of the physical properties of gems, their behavior to light, and the proper way of orienting and disposing them in order to enhance their optical properties. Useful information is also given about artificial coloring of certain gems. This book is also useful to mechanical engineers who design mechanical equipment for the lapidary and the mineralogist, as well as for gem collectors and carving and engraving men.—Q. A. A.

On the Incidence of Anaesthetic Complications and their Relation to Basal Narcosis. By C. J. M. Dawkins. Foreword by Joseph Blomfield. Published for the Middlesex Hospital Press by John Murray, London, 1936. 56 pp. Price, 3s. 6d.

This is a volume of practical experiences on the action of different anæsthetics, together with their complications and their relation to basal narcosis. It is a worthy and useful guide to be consulted when one is in doubt as to what anæsthetic should be administered.—C. D. F.

Our Enemy the Termite. By Thomas E. Snyder. Comstock Publishing Company, Inc., Ithaca, New York, 1936. 196 pp., plates, figs. Price, $3.

This book is based largely on experience gained by the author since 1909. It treats the termite from both the economic and the entomological point of view, for, as the author indicates, it is impossible to prescribe a method for control until the type of termite concerned and its life history are understood. The book discusses various species of termites, their distribution, their life history and cast system, their physiology and behavior, their food and enemies, and guests which sometimes dwell in termite colonies. It points out the damage done by termites to woodwork of buildings, to boats, poles, mine props, to stored materials, to living vegetation, to nursery stock, young plantation stock, and vineyards, to shrubs, flowers, and greenhouse stock, and to field crops and grazing land.

The author discusses two general methods of termite control; namely, biological and artificial. For the former, he enumerates various parasites, but points out that because of the life of termites in darkness, and because of their constant activity, termites are among the very few forms of insect life that do not harbor internal insect parasites; he also enumerates various predators, including man. For the latter the author emphasizes that termites may be permanently controlled by eliminating all wood from foundations, cellars, basements, and porches—these structures to consist of masonry or concrete, in the case of houses of masonry as well as those having a wood superstructure. Various remedial control measures are also suggested and described.

The appendix specifies the remedy of termite damage to various types of buildings and contains a form on which a building inspector can record the important facts concerning termite damage and for insuring protection against termites and decay.

Although the book is fully authoritative and highly scientific, it is so well illustrated and simply written that it can be easily understood by the intelligent layman.—G. C. B.

Textbook of Meat Inspection. By J. Drabble. Angus & Robertson Ltd., Sydney, Australia, 1936. 353 pp., illus. Price, 21s.

The book is well conceived and, due to the extensive experience of the author, well carried out. It is divided into two parts: The first part gives the fundamentals in anatomy and physiology, the knowledge of which is very necessary to technical men and laymen engaged in meat inspection work; the second part deals essentially with the basis of meat inspection.

In view of the importance in meat inspection of the knowledge of what constitutes food animals, a chapter on food animals and methods of slaughtering and dressing is included. Then come discussions of meat inspection, including the ancient and modern methods of meat inspection practiced in various progressive countries; preservation of meat, with emphasis on the different processes of preservation practiced in meat-producing countries; and veterinary pathology, bacteriology, and parasitology, discussed on levels within the province of meat inspection, including the judgment on each case involving a pathological condition.

The book is well written, in crisp and easy language. The discussions are brief but comprehensive. The summary and review questions at the end of each chapter will be of great aid to the reader.

With supplementary demonstrations of the lesions of animal diseases from preserved specimens, as the book is not so profusely illustrated, it would serve as a satisfactory textbook for students in meat inspection. The technical, experienced men, as well as the students and lay meat inspectors, will profit from this volume.

This book will deservedly find a place as a text or reference of great value in this field.—R. A.

Toxicology or the Effects of Poisons. By Frank P. Underhill. Thoroughly revised by Theodore Koppanyi. 3d ed. P. Blakiston's Son & Company, 1936. 325 pp. Price, $2.50.

This book is a convenient reference for busy medical practitioners. The chapter on the principles of toxicology is one of its strongest points. The other chapters are: Inorganic poisons—Corrosive Acids, Alkalies, Poisonous Gases, Metallic Poisons, Alkaloidal Poisons, Miscellaneous Organic Poisons. —D. P.

The Use of Vegetable Dyes for Beginners. By Violetta Thurstan. Rev. ed. Dryad Press, Leicester, London, 1936. 51 pp. Price, paper, $0.75.

This practical and comprehensive method of dying wool with vegetable dyes is useful for amateur dyers who are more interested in the production of brilliant and varied colors than in the fastness of the colors in the dyed fabric.—F. A.

Vitamin and mineral Therapy. By Casimir Funk. New York Vitamin corporation, 1936. 94 pp.

Volumes of information in a nutshell is the outstanding quality of this book. The work is by no means entirely original. It consists of a brief but comprehensive summary, rightly called a practical manual, of the work of leading authorities, such as Sherman, Rose, Cameron, Eddy, and others, incorporated with the author's own scientific investigations on nutrition. At the same time the authors introduced a new balanced vitamin requirement for different age groups in figures quite different from those introduced by the League of Nations in a conference at Geneva in 1936. There are 617 references and 318 authors and experimenters cited in the book, material that even the best read persons may find it difficult to finish reading during a lifetime.

While the book is full of practical and up-to-date information on vitamins, very little is said of minerals as one would expect from the title of the book. Moreover, the general make-up of the volume is not that of a book on therapy in which a reader expects more emphasis on the physiology, physical appearance, commercial preparations, indications and contraindications to administration, and dosage. Physiology and normal bodily requirements of vitamins are fairly well covered, however, despite the fact that there is still a wide range of conflict as to the vitamin requirements of normal individuals. At least the amount and mode of administration of various commercial vitamin and mineral preparations should have been included if the authors wished to justify the title they selected for the book.

During perusal of the book and after computations numerical errors were noted in Table III, page 23.—I. F.

The Wine Book of South Africa; The Western Province of the Cape and its Wine Industry. "Wine and Spirit," Stellenbosch, South Africa, 1936. 224 pp. Price, ₱3.

This books deals mostly with the history of wine making and its industrial development in the southern part of Africa, especially in the Cape of Good Hope, where the growth of the finest wine grapes is favored by the best climatic condition.—F. A.

INDEX

[New names and new combinations are printed in **boldface.**]

N

O

Q

R

S

T

U

V

W

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