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PHILIPPINE MUSHROOMS

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SEVENTY-NINE PLATES AND FIVE TEXT FIGURES

INTRODUCTION

The mushroom from time immemorial has been considered one of the delicacies of the table. According to classic literature, Roman aristocrats prepared their own mushroom dishes, and in eating them used only amber knives and silver service. The following epigram shows the esteem in which the mushroom was held among the Romans as food: "Gold and silver and dresses may be trusted to a messenger but not boleti." History tells us that a fungus called "Caesar's mushroom" (*Amanita cæsaria*), said to be one of the most delicious, was seasoned by his wife, Agripina, herself, for the last meal of the Roman Emperor Claudius. The Chinese have long been known to be very fond of the mushroom. It is present in practically all their dishes. Mushroom culture among the Chinese has been known for centuries, and dried mushrooms have been brought from China to the Philippines in large quantities.

In the Philippines mushrooms are becoming popular as an article of diet. Interest in mushrooms as food is shown by the number of people who collect them wild for the table, and by the increasing number of inquiries received at the Bureau of Science. Unfortunately lack of familiarity with the different types of mushrooms has given rise to cases of mushroom poisoning in Manila and in the provinces. This work has, therefore, been prepared in response to inquiries received by the author, and as a guide in distinguishing edible from poisonous mushrooms.

To enhance the practical value of this work, the author has taken pains to keep it within the understanding of the layman. Technical terms are used only whenever their replacement by popular expressions would jeopardize scientific accuracy. Moreover, considerable help can be obtained from the glossary.

The descriptions, together with the corresponding photographs and drawings here presented, should enable anyone to identify the different kinds of mushrooms commonly found; and it is hoped that this work will prove useful to those more seriously interested in the study of mushrooms.

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GLOSSARY

ABERRANT. Differing from the customary structure of related groups.

ACRID. Biting to the taste.

ACUMINATE. Tapering to a point.

ADHERENT. Grown to or sticking to.

ADNATE. Attached squarely to the stem.

ADNEXED. Attached to the stem only at the upper corner.

ADPRESSED. In close contact, but not joined.

ANALOGY. Resemblance in certain respects only, not in the plan of structure.

ANASTOMOSING. Running together irregularly.
ANNULUS. Ring formed on the stem by the inner veil.
APEX. Opposite to the point of attachment (the top).
APICULATE. Ending in a little point.
APPENDICULATE. Hanging in small fragments.
APPROXIMATE. Gills approaching to, but not actually touching the stem.
ASCUS, pl. ASCI. The spore-bearing structure in Ascomycetes.
BASIDIUM, pl. BASIDIA. The spore-bearing structure in Basidiomycetes.
BI-, BIS-. In combined words, meaning 'twice.'
BIENNIAL. Growing one year, flowering or fruiting the succeeding year; of two years' duration.
BIFID. Divided halfway into two.
CÆSPITOSE. Growing in tufts like grass.
CAMPANULATE. Bell-shaped.
CANALICULATE. With a longitudinal channel or groove.
CAPILLARY. Threadlike.
CAPITATE. Having a head.
CARTILAGINOUS. Tough-brittle. Breaking with a snap like a piece of cartilage.
CILIATE. Fringed with hairs.
CLAVATE. Club-shaped.
CONFLUENT. Meeting or coming together.
CONIDIUM, pl. CONIDIA. An asexual spore.
CONNIVENT. Coming into contact or convergent.
CORACEOUS. Leathery.
CORTEX. The outer skin.
CORTINA. A veil of spiderweblike structure.
CRUSTACEOUS. Of brittle texture.
CUTICLE. The outer skin.
CYATHIFORM. Cup-shaped.
CYSTIDIUM, pl. CYSTIDIA. A sterile cell, often inflated, projecting beyond the basidia and paraphyses in the hymenium of Basidiomycetes.
DECIDUOUS. Falling or subject to fall, in season.
DECURRENT. Gills running down the stem.
DELIQUESCENT. Becoming fluid when mature.
DENTATE. Toothed.
DEPRESSED. Sunken.
DICHOTOMOUS. Forking in pairs.
DISCOLORED. Of a different color.
DISTANT. Separated by wide spaces.
ECCENTRIC. One-sided.
ECHINULATE. With short bristles.
EFFUSED. Expanded.
EMARGINATE. With a sudden curve as if scooped out.
ENDOGENOUS. Produced inside another body.
ENDOPERIDIUM. The inner layer of the peridium.
EPIPHYTE. A plant which grows upon other plants but not parasitically.
ERUMPENT. Bursting through the surface of the substratum.
EVANESCENT. Lasting only a short time.
EXOGENOUS. Produced on the outside of another body.
EXOPERIDIUM. The outer layer of the peridium in the Gasteromycetes.
FACULTATIVE. Occasional, incidental, as opposed to obligate.
FARINOSE. Covered with a white mealy powder.
FASCICULATE. Growing in bundles.
FERRUGINOUS. Of the color of iron rust.
FIBRILLOSE. Clothed with small fibers.
FILIFORM. Threadlike.
FIMBRIATE. Fringed.
FISTULOSE. Hollow, like a pipe.
FREE. Reaching the stem but not attached to it.
FURCATE. Forked.
FUSIFORM. Spindle-shaped.
GILLS. The lamellæ or plates which bear the hymenium in Agaricaceæ.
GLABROUS. Smooth, not hairy.
GLEBA. The internal tissue in Gasteromycetes and Tuberaceæ.

GREGARIOUS. Growing in company.

GROOVE. A furrow, channel.

HABIT. The general appearance.

HABITAT. The place of growth.

HETEROGENEOUS. Not uniform in structure.

HOMOGENEOUS. Uniform in structure.

HOST. Plant or animal on or in which a parasitic fungus exists.

HYALINE. Colorless, translucent.

HYMENIUM. The layer composed of the spore-bearing organs.

HYPHA, pl. HYPHÆ. The threadlike element of which fungi are composed.

IMMARGINATE. Without a distinct border.

INDEHISCENT. Not splitting when ripe; not opening in a definite manner.

INFERIOR. Low down on the stem.

INFUNDIBULIFORM. Funnel-shaped.

INNATE. Adhering by growing into.

INVOLUTE. Rolled inward.

LAMELLA, pl. LAMELLÆ. The gill or plate which in Agaricaceæ bears the hymenium.

LATEX. The fluid or "milk" present in the cells of certain fungi.

LURID or LIVID. Discolored.

MARGINATE. Having a distinct border.

MATRIX. The substance upon which a fungus grows.

MEMBRANOUS, MEMBRANACEOUS. Thin and semitransparent.

MULTI. Many.

MYCELIUM. Spawn; vegetable hyphæ.

MYCOLOGY. The study of fungi.

NODULOSE. Having nodules, or small knobs or knots.

OB-, prefix. Inversely or oppositely.

OBCONIC. Inversely conical.

OBLONG. Considerably longer than broad, and with nearly parallel sides.

OBOVATE. Inversely ovate.

OBSOLETE. Wanting or rudimentary.

OBTUSE. Blunt or round at the end.

OCHREOUS. Like yellow, not red, ochre.

OPAQUE. Mostly used in the sense of dull, not shining.

OPERCULUM. A cover.

ORBICULAR. Circular; flat, with a circular outline.

OSTIOLE. The aperture through which the spores escape in certain genera.

OVATE, OVOID. Egg-shaped.

PALMATE. Lobed in a fingerlike manner.

PAPILLA. A nipplelike elevation.

PARAPHYSIS, pl. PARAPHYSES. Sterile filaments in a hymenium.

PARTIAL. Extending from the margin of the cap to the stem.

PEDICEL. A small stalk.

PERIDIOLUM. The rounded bodies in Nidulariaceæ (Bird's nest).

PERENNIAL. A plant that continues to live from year to year.

PERIDIUM. The outer cover investing the gleba in Gasteromycetes, as in puffballs.

PERITHECIUM, pl. PERITHECIA. The flask-shaped structure which in Ascomycetes contains the asci.

PILEATE. Having a cap or pileus.

PILIUS. The cap structure bearing the hymenium in Agaricaceæ.

PLANE. Even, flat.

PLICATE. Folded into plaits.

PLUR-, PLURI-. Used as a prefix for 'many,' or 'several.'

POLY-. Many.

PORES. Openings or orifices for the escape of the spores.

POROUS. Equipped with pores.

RADIATE. Spreading from a center.

RECEPTACLE. An axis bearing one or more organs, as the stem in the phalloids; also used for any hymenium-bearing structure.

REMOTE. The position of the gills when they do not reach the stalk but leave a free space around it.

RHIZOMORPH. A rootlike strand of compacted mycelium.
RUDIMENT. The earliest condition of an organ.
SCLEROTIUM. A compact mass of hyphæ in a dormant state.
SCURF. Thin dry scales or scabs.
SEPTATE. Having divisions or partitions.
SERRATE. Notched or toothed on the edge.
SIMPLE. Unbroken; unbranched; undivided.
SINUATE. Gills that are notched near the stem.
SPORES. The analogues of seeds in flowering plants.
SPOROPHORE. The fruit body.
SQUAMOSE. Scaly.
STELLATE. Star-shaped.
STERIGMA, pl. STERIGMATA. The portion of the basidium-bearing spores.
STIPE. A stalk.
STIPITATE. Having a stalk or stem.
STRIATE. Marked with fine lines, grooves, or ridges.
STROMA. A cushionlike body in which the perithecia are immersed in many Ascomycetes.
STUFFED. The condition of the stem in which the interior is filled with a substance of a texture different from that of the walls.
SUB-, prefix. 'Under,' 'below,' or 'partly.'
SULCATE. Marked with grooves.
SUPERIOR. Annulus or ring that is near the apex of the stem.
SYNONYM. A superseded or unused name.
TAWNY. Of a dull yellowish-brown color.
TRAMA. The tissue between the hymenium in gills.
TRUNCATE. Ending abruptly as though cut off at the end.
TUBERCLE. A small wartlike protuberance.
TURBINATE. Top-shaped.
UMBLICATE. With a small central depression.
UMBO. A central elevation of the pileus.
UMBONATE. Having an umbo.
UNIVERSAL. A term applied to the volva or veil which completely envelopes some fungi when young.
VEIL. The outer envelope in the Agaricaceæ within which development takes places.
VENOSE. Having veins.
VERRUCOSE. Warty.
VESICULOSE. As if composed of bladders.
VISCID. Clammy; sticky.
VOLVA. The tissue enveloping the young sporophore usually ruptured at the apex, leaving a cup-shaped structure at the base of the stem.
ZONE. A girdle.

MUSHROOMS AND TOADSTOOLS

The question is often asked: "How can the mushroom be distinguished from the toadstool?" The answer is simple enough: There is no difference between these two groups of fungi. A fungus with a fleshy, tough, or jellylike fruit body that can be studied with the naked eye is called mushroom. A stool-shaped mushroom is called a toadstool. By inference the word toadstool has come to mean a poisonous fungus, and the word mushroom, an ordinary field agaric. Such a definition leaves out varieties that are neither toadstools nor mushrooms. To avoid confusion, a better usage is suggested, in which "toadstool" and "mushroom" are synonymous.

The Philippine Islands are extremely rich in fungi, especially the mushroom group. The question of vital importance now is not how to distinguish the mushroom from the toadstool or vice versa, but how to distinguish between mushrooms that are poisonous and those that are edible, in order to avoid eating the poisonous kinds.

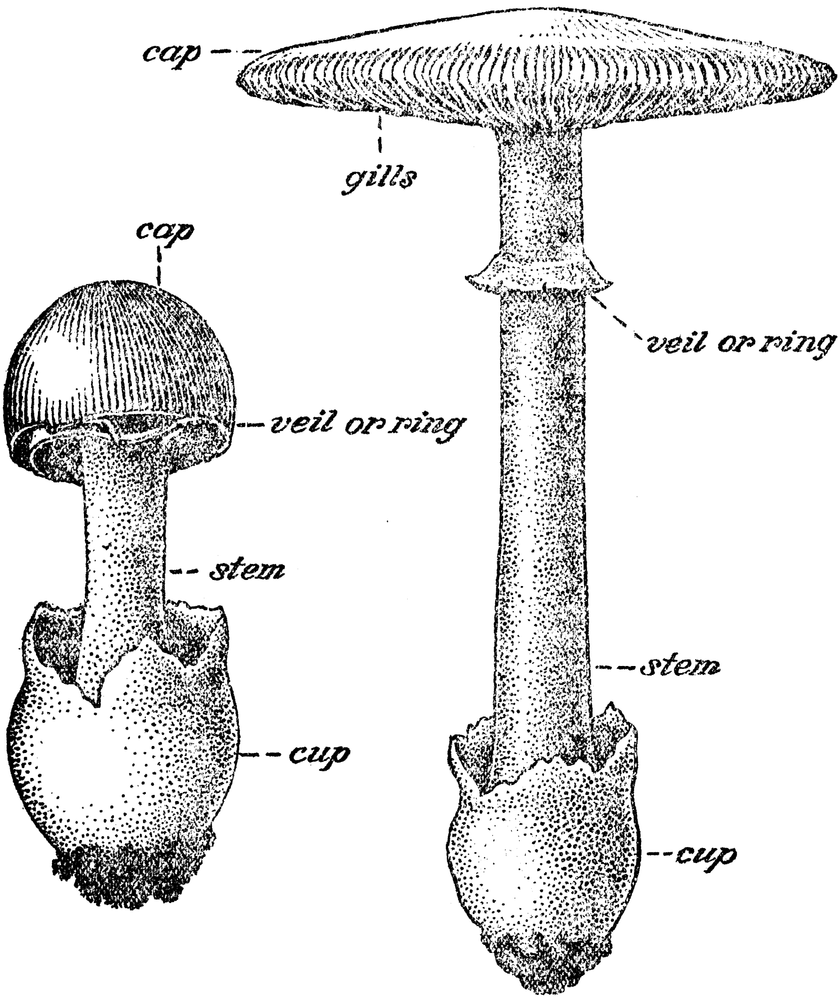

FIG. 1. Structure of a gill mushroom.

Gill mushrooms.—The structure of a gill mushroom (text fig. 1) consists of the stem, or *stipe;* the cap, technically called *pileus,* which is the expanded portion at the top; the gills, or *lamellæ;* a cuplike structure at the base of the stem, called *volva;* the veil covering the gills; and a ring, or *annulus,* just on top or at the center of the stem. In some mushrooms the ring or the cup, or both, are present. In the genus *Amanita* (Plate 12) the cup and the ring are present. In *Lepiota* (Plates 14 and 17) and *Psalliota* (Plates 47 to 50) the ring is present,

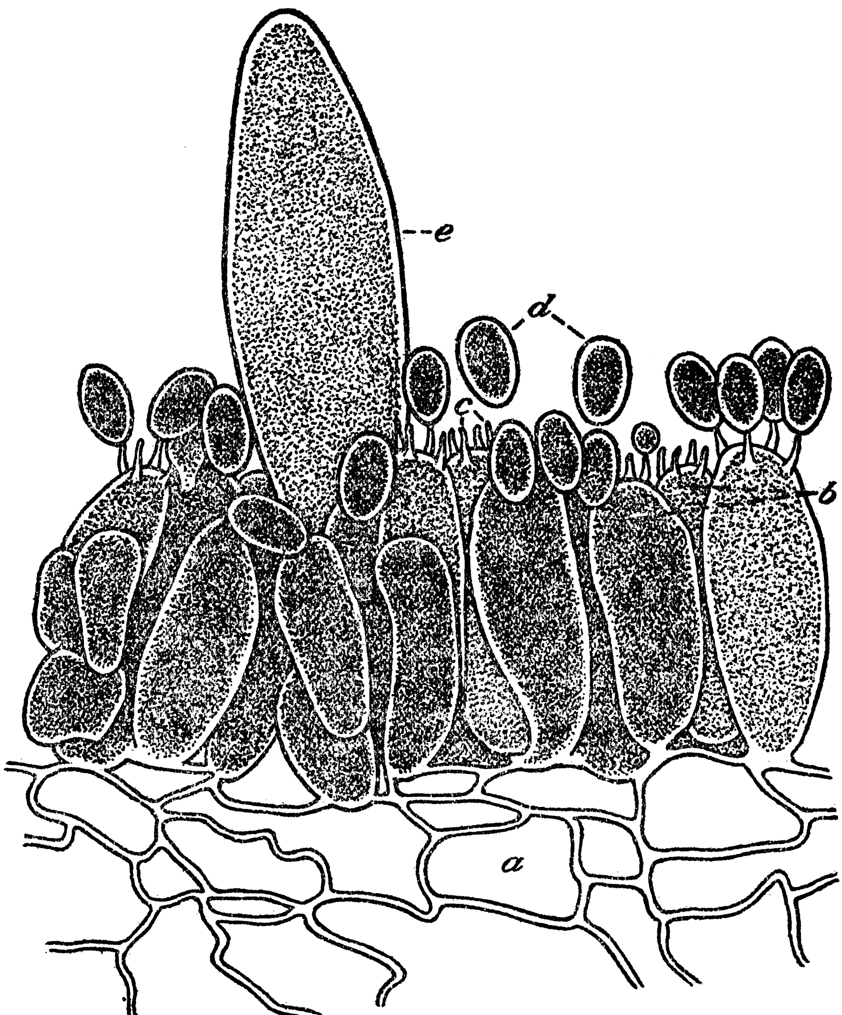

FIG. 2. Cross section of a very small portion of a gill, showing *a*, hyphæ; *b*, basidia; *c*, sterigmata; *d*, spores; *e*, cystidium; highly magnified.

while in *Volvaria* (Plate 42) the ring is absent but the volva is present. In the case of *Collybia* (Plate 23) the ring and the volva are absent. On the underside of the cap are found the gills, or lamellæ. They appear as thin bladelike structures, extending from the stem to the margin of the cap in some mushrooms, while in others they extend further out off the margin. In some species the long gills alternate with the short ones. The cap is covered on the underside with a delicate membrane, called the veil. The veil is prominently seen in the early stages, but soon breaks off. When a sliced thin portion (text fig. 2) of the gill is examined under the microscope, it is found to be composed of a large number of threadlike hyphæ similar to those that compose the mycelium, except that hyphæ composing the gills are close together so as to form a compact body. The spores are produced on the sides of the gills. Certain hyphæ of the gills are modified into club-shaped structures, called *basidia* (sing. *basidium*), each club having four tiny projections technically known as *sterigmata* (sing. *sterigma*) at the end. For this reason these mushrooms are called Basidiomycetes. Some of the basidia become larger at the end and extend further to form *cystidia* (sing. *cystidium*). These serve to stretch the gills and thus tend to liberate the spores much more readily.

The basidia are very minute, and a small space can accommodate a large quantity of them. The gills of a mushroom accommodate numerous basidia. Each of the sterigmata in a basidium bears a spore. The spores vary in shape from round to oval, and from smooth to spiny. Professor Buller, of the University of Manitoba, found that a single individual of *Psalliota campestris* produces about 1,800,000 spores. Others, like the simple puffball, produce as many as 7,000,000,000 spores. But not all spores germinate, otherwise the whole earth would be covered with mushrooms. It is estimated that not more than one in 20,000 spores succeeds in developing. As the spores mature, they are discharged from the basidia, being projected outward at right angles to the surface of the gill.

In certain kinds of mushrooms, such as many of the species of *Coprinus* (Plate 52), and in others belonging to the same group, the gills are very close together, but at maturity they dissolve into an inky fluid. This process is in no sense comparable to the dissolution of chemical substances, but is a process of autodigestion. The spores on these gills mature in a definite order. Those that are at the lower end of the gills mature first, followed by others in succession upward. As the cap begins to open in bell-shaped form, the lower ends of the gills are slightly separated from each other. There the spores mature and fall. At once autodigestion sets in and removes the now useless parts of the gills, thus leaving a clear path for the fall of the spores from higher up. This continues until all the spores have fallen and the gills have entirely dissolved.

There are two stages; namely, the vegetative or the growing stage of the mushroom, and the fruiting stage. The former, which is the *mycelial* stage, is equivalent to the common term *spawn* in the mushroom, while the fruiting stage is the mushroom stage. Mushroom spawn, therefore, takes the form of strands of mycelium (Plate 1, fig. 3), which are usually interlaced into definite threads, each thread growing by increasing in length at the end. The thread grows independently and even branches out. The strands of mycelium which constitute the spawn grow rapidly under favorable conditions, but if they are retarded, it takes weeks, months, and even years for them to mature and to produce mushrooms. In countries like the United States and some parts of Europe, where mushrooms are grown artificially, commercial spawn is used. It is sold in bottle- and brick-shaped forms (Plate 1, figs. 1 and 2).

Other types of mushrooms.—So far we have been dealing only with the gill type of mushrooms. There are, however, a number of types of fungi that are just as truly mushrooms, among which are a large number of shelflike mushrooms that do not have gills at all, but, instead, on the under side of the shelf a large number of little pores or tubes (Plate 55). The spores are produced on the inner surface of these tubes. They are produced on the basidia, just as in the gill fungi, so that the inner surface of the tubes, sufficiently magnified, looks very much like the surface of the gill. Many of these pore fungi are woody or leathery and tough, and therefore not good to eat; but a few of them are fleshy and tender and very palatable. There are also a large number of umbrella-shaped fungi which have pores instead of gills. These are mostly fleshy and tender. Some of them are edible, while others are poisonous.

A number of other mushrooms produce their spores on the basidia. Among them are the hedgehog fungi (Plate 59) and the club fungi (Plate 60). The hedgehog fungi are so called because they bear many spinelike branches on the surface of which the spores are produced. These species always hang downward, no matter in what position the fungus is growing; this fact serves to distinguish them from the club fungi, since in the latter the branches always project upward.

Another important group of mushrooms is the puffball group (Plate 70). The spores of a puffball are produced on the basidia which are scattered through the greater part of the interior of the mushroom, and when they are mature they can easily be puffed out by pressing on the sides of the puffball.

All mushrooms so far mentioned produce their spores on the basidia and are, therefore, Basidiomycetes. There is another very large group of fungi, which includes a few mushrooms and produces its spores in a very different way. These are the sac fungi, or Ascomycetes, so called because their spores are produced within little saclike structures. Most of the sac fungi have small fruit bodies, and grow as parasites on other plants. They are very important as causes of plant diseases; they are not mushrooms, except a few that are large enough to be studied without the aid of a microscope. Familiar examples of mushrooms belonging to this group are: *Morchella esculenta* (Plate 74, fig. 1), *Peziza sulcipes* (Plate 75, fig. 1), and *Xylaria dealbata* (Plate 77, fig. 2). These sac mushrooms discharge the spores forcibly, the eight spores in a sac being hurled in a cluster. Usually a considerable number of sacs discharge their spores at the same time, and then it is several minutes before others are discharged, so that at periodic intervals a cloud of spores may be seen issuing from the fruit body.

Another very interesting group of mushrooms are the stinkhorns (Plates 64 to 69). The spores of these fungi are sticky and are deposited in a mass on an exposed portion of the body. From this mass of spores emanates a fœtid odor that attracts insects, especially flies. The spores attach to the feet of the insects and are carried away in this manner.

Development of mushrooms from the button stage.—Since the spawn is the vegetative, or the growing stage of the mushroom, it developes through the substratum or host on which the strands grow. When the mushroom or fruiting stage begins, small knots, or buttons, appear on these strands. This stage is known as the button stage (Plate 2). At first these knots appear as tiny dots, developing from the size of a pinhead to that of a pea, or even larger; later they elongate, while the end becomes larger. At this period the main parts of the mushroom—the stem and the cap—begin to be more distinct.

The substratum.—The substratum here is the material on which a fungus grows, whether it be soil, bark, wood, dead leaves, a living tree, or some other material. Every mushroom lives on some kind of substratum. Many of them, however, are limited to certain definite kinds. Some species, for instance, grow only on dung, or on soil that is rich in humus; others, like to grow on dead wood; while still others thrive on meadows and lawns.

Light requirement of mushrooms.—Most fungi grow better in the dark than in the light; others grow only in the shade; while still others grow only in the open sunny places. Obviously, then, some mushrooms require only a certain amount of light. Some are able to live very well in the dark, but fail to produce fruiting bodies. In caves, and in abandoned mines, or tunnels, where there is no light, *Psalliota campestris* is grown commercially.

Water requirement of mushrooms.—The notion, based on superficial observation, that mushrooms require a great deal of water, holds true for many fungi, but not for all. The shelving fungi (Plate 57), for example, require very little water. Most mushrooms require an abundance of water for the development of their fruiting bodies, but they do not flourish in places that are continuously saturated with water. Most mushrooms develop fruiting bodies only during the wet season. A single downpour of rain during the dry season does not bring a good crop of mushrooms; a shower must be followed within one or two days by another shower for the fruiting bodies to develop.

Animals in relation to mushrooms.—There are a number of ways in which animals affect the life of mushrooms. Chief among these is the destruction of the fruiting bodies. Many animals feed upon mushrooms. Carabaos, cattle, sheep, and goats are very fond of certain kinds, especially the large puffballs. Rats are very fond of mushrooms when they are still in the button stage. In mushroom culture these rodents are often the cause of failure. Slugs and crickets habitually feed upon various kinds of mushrooms. In mushroom beds the most destructive animals are the maggots, the young of small flies or gnats. They bore into the mushroom and riddle it in a short time. Mushroom mites are sometimes troublesome; these multiply very rapidly.

A very interesting mushroom is *Collybia albuminosa,* which has the habit of growing on or near ant hills. There is a certain substance excreted by ants that stimulates the appearance of this mushroom. Because of its habit to grow from termite nests, this mushroom is sometimes called termite fungus. In certain tropical countries, not excluding the Philippine Islands, a very interesting interrelation of mushrooms and animals is presented by the leaf-cutting ants. These carry pieces of leaves from some trees on their back to a suitable place. The pieces of leaves are chewed to a pulp and spread out. On this, they plant the mycelium of a mushroom, and in a few days under favorable conditions mushrooms grow. These ants take good care of their gardens, weeding out undesirable fungi and in return obtaining an abundant supply of food. The mushroom they cultivate is *Rozites gemylophora*, one of the umbrella types of gill fungi.

Parasitic and saprophytic mushrooms.—A great number of mushrooms are destructive parasites. In many trees heart rot is caused by the growth of the penetrating mycelium of some fungi. *Armillaria mellea* (Plate 22, fig. 1) which is one of the worst parasites, even attacks living trees, ultimately causing death. Many of the bracket types (Plate 57) and the oyster mushrooms, like *Pleurotus* (Plate 3), attack roots and trunks of trees. Some mushrooms live as parasites on other mushrooms. A great many of the wood-destroying fungi are parasitic for a part of their lives, and become saprophytic later. Once they have gained entrance into a tree through a wound, they begin to develop, and when the tree is killed, they continue to live on it. Others exist as saprophytes, living entirely on dead wood (Plate 4). Many of the *Lentinus* belong to this type of mushrooms.

The fairy rings.—Fairy rings are more or less circular forms of mushrooms or toadstools (Plate 5). They are easily recognized in fields, lawns, or grassy places. All over the world, including the Philippines, fairy rings are connected with superstitious beliefs that vary in different countries. In the Philippines it is a common belief that fairy rings mark the path of dancing fairies and that they bring good luck to the people that live near them. In France, however, the peasants are afraid to enter these rings because they believe that huge toads that are apt to injure men are to be found there. In Germany, country folks believe that the center of the ring marks the place where an enormous dragon has rested the previous night. Even in scientific circles it was formerly believed that thunder, lightning, whirlwinds, ants, or animal urine cause the formation of fairy rings, until 1796, when Withering discovered that *Marasmius oreades* is responsible for the fairy-ring formation. Later many scientists followed up this problem and ultimately came to the same conclusion; namely, that fairy rings are caused by the growth and habit of certain mushrooms, and have no connection whatsoever with any supernatural influences.

Fairy rings are formed by the mycelium that starts from a single spore. This mycelial growth extends in all directions, forming a circular periphery at which mushrooms spring up. Outward from the center the mycelium dies off, after using up the organic matter in the soil, while at the periphery it grows luxuriantly, because the soil there is still rich with food materials. Every year, as fresh organic matter becomes available, the mycelium continues its outward growth, retaining its circular margin, so that another crop of mushrooms springs from the periphery as before, leaving behind the dead mycelium as previously. In this way the ring increases in diameter year after year. The decayed mycelial materials are naturally rich in organic matter, and it is said that fairy rings could continue growing for many years, even for centuries.

In countries outside the Philippines about 100 species of mushrooms are reported to form fairy rings. A few are *Lepiota chlorospora, Marasmius oreades,* and *Psalliota silvicola.* Copeland reported in 1905 that *Psalliota perfuscus* forms a ring in the Philippines. Two mushrooms, *Lepiota cepaestipes* and *Calvatia lilacina,* were also observed to form fairy rings in this country.

Common belief about mushrooms in relation to thunder.—It is a common belief in the Philippines that thunder and lightning have something to do with the spontaneous appearance of mushrooms. When thunder begins to rumble, especially during May or early June, at the start of the rainy season, young and old in rural communities rush out to the open fields and meadows in search for mushrooms. A heavy rain occurring at night and accompanied by loud thunder is said to be a sure sign that mushrooms will appear the next morning. Of course, moisture is essential to the development of mushrooms. Before or during the early part of the rainy season the days are warm, and naturally during downpours the atmosphere is full of electrical charges, causing thunder and lightning. This phenomenon gives rise to the belief that thunder and lightning are responsible for the spontaneous appearance of mushrooms in the fields and meadows.

Luminosity in mushrooms.—Luminosity in some mushrooms has long been known by men. Past writings have stated that people gathered certain luminous mushrooms and put them in appropriate places to guide their ways at night in the forest. In places where there is danger from fire, or where grain, corn, and the like are stored, luminous mushrooms were used as illumination. Even the mycelium of such mushrooms is luminous, and the wood that is attacked by this kind of fungi also emanates light. In the Philippines people are familiar with the luminosity of some fungi. Most common among these are the species of *Pleurotus* (Plates 29 to 31). They are called *anandap* in Ilocano and *alitaptap*[1] in Tagalog. The luminosity of some of these mushrooms would also help to distinguish one species from another. Among the mushrooms besides the many species of *Pleurotus* reported to emanate light are: *Armillaria mellea*, some species of *Xylaria*, and several of *Fomes*.

Native names of Philippine mushrooms.—In the Tagalog provinces the general name for edible mushrooms is *kabute*, derived from the Tagalog word *kabutihan*.[2] Common names are applied to particular forms, often according to the place in which they are produced, and sometimes according to the outstanding characters of the mushrooms themselves. *Kabuteng punso*[3] is the name given to *Collybia albuminosa*, because of the habit of this mushroom to grow on or near ant hills. *Volvaria esculenta* is given the name *kabuteng ginikan*, because of its habit of growing on rotten palay straw. The fanlike mushrooms of the genus *Pleurotus* are called *anandap* in Ilocano and *alitaptap* in Tagalog, because of the phosphorescence given off by them at night. The puffballs are called *parapara*[4] in Ilocano, because of their likeness to the embryo of the coconut. *Bakui*, *kulat*, or *kuat* are terms applied to rather leathery fungi in Tagalog. The word for mushroom in Negros Occidental and Panay is *ohong;* in Leyte, *ulaping;* in Pangasinan and Ilocano Provinces, *oong;* in Bicolano, *tobó* or *tigbos;* in Cagayan and Isabela, *karulu;*[5] and in Zambal, *dakaakan*. In Pampanga the ordinary umbrellalike mushroom is called *payungpayuñgan*. *Balugbug daguis*[6] is the name given to *Auricularia* in Pampanga; *taiñgangdaga* in Tagalog, *taliñga ti otot* in Kalinga, and in Negros Occidental and Panay the members of this genus are called *dolongan sang kahoy*.[7]

[1] Firefly.
[2] Goodness.
[3] Mushroom on the ant hill.
[4] Embryo of the coconut.
[5] Umbrellalike.
[6] Rat's ear.
[7] Ear on the wood.

THE MUSHROOM AND ITS RELATION TO MAN

Poisonous mushrooms.—Poisonous mushrooms were known even before the Christian era. The Romans associated poisonous serpents and fungi in their minds. Pliny writes:

> Noxious kinds must be entirely condemned; for if there be near them a hobnail or a bit of rusty iron or a piece of cotton cloth, forwith the plant, as it grows, elaborates the foreign juice and flavors into poison; and country folk and those who gather them are alone able to discern the different kinds. Moreover they imbibe other noxious qualities besides; if, for instance the hole of a venomous serpent be near and the serpent breathe upon them as they open from their natural affinity with poisonous substances, they are readily disposed to imbibe such poison. Therefore we must notice the time before the serpents have retired into their holes.

An epigram attributed to Martial on the death of Macrinus, says: "You were wont to deny, Macrinus, that men could be killed by fungi; yet Boleti were the cause of your death."

In the Philippines the people in rural communities believe that mushrooms growing on animal dung and those that have white rings are poisonous or at least not edible. They are very cautious in collecting mushrooms in the woods for the table, especially those that are slightly colored. It is also a common belief that when a piece of garlic dipped in a cooked mushroom turns black, the mushroom is poisonous. To indicate the characters of the poisonous or nonedible mushrooms, descriptive names are given to them. For example, the Ilocanos call *Lepiota chlorospora,* a poisonous species, *oong ti takki nuañg;* [8] in Tagalog it is called *payong ahas.*[9]

Fortunately there have not been many cases of fatal poisoning in the Philippines from mushrooms. In fact the deadly poisonous species are rarely found in the lowlands. The deadly kinds, such as the species of *Amanita* that thrive in cold countries, are not met with, except in cool places in high mountains like Baguio, Mountain Province, and its vicinity.

Mushroom poisoning.—The question of toxicology of the higher fungi is of theoretical and practical importance. Unfortunately not much investigation has been accomplished so far, especially in the Philippines. A few toxic compounds, chiefly alkaloids, have been isolated from mushrooms, especially from *Amanita muscaria, A. phalloides, A. pantherina,* and other species of *Amanita.*

[8] Mushroom on carabao dung. [9] Snake mushroom.

Choline.—Choline is an alkaloid of wide occurrence in the animal and vegetable kingdoms. It has been isolated from *Amanita muscaria, A. pantherina,* and several other higher fungi. It is said not to be very toxic, but combined with oxygen it passes over into *muscarine.* According to Kobert the remains of choline on the decay of the mushroom containing it is not muscarine but a very closely related alkaloid, *neurin.* Thus a comparatively harmless alkaloid is transformed into an extremely deadly one, simply by the partial decay of the plant in which the former is usually found. Neurin in its physiological effects is practically identical with muscarine, which is described below.

Muscarine.—Muscarine is the most dangerous alkaloid found in mushrooms. It is most abundant in *Amanita muscaria,* other species of *Amanita,* and some members of *Boletus* and *Russula.* It is probably identical with *bulbosine,* which was isolated from *Amanita phalloides* by Boudier. Muscarine is an extremely violent poison, 0.003 to 0.005 of a gram (0.06 grain) being highly toxic to man. Like other constituents of mushrooms, the amount of muscarine present varies very greatly with the varying conditions of soil and climate. According to Kobert, *Amanita muscaria* contains besides choline and muscarine, a third alkaloid, which he calls "pilz-atropin." This alkaloid, like ordinary atropine, neutralizes to a greater or lesser extent the muscarine. Fortunately muscarine has a very unpleasant taste. *Amanita muscaria* is said to be used by the inhabitants of northern Russia as a means of inducing intoxication. To overcome the extremely unpleasant taste of the plant they swallow pieces of the dried cap without chewing them, or boil them in water and drink the decoction with other substances which disguise the taste.

The symptoms of poisoning with muscarine through eating *Amanita muscaria* are not at once evident. They usually manifest themselves in from one-half to two hours. Vomiting and diarrhœa almost always occur, with a pronounced flow of saliva, suppression of urine, and various cerebral phenomena, such as giddiness, loss of confidence in one's ability to make ordinary movements, and derangement of vision. This condition is succeeded by stupor, cold sweat, and a very marked weakening of the heart's action. In cases of rapid recovery the stupor is of short duration and usually marked with mild delirium. In fatal cases it continues from one to two or three days, and death at last occurs from the gradual weakening and final stoppage of the heart action.

Amanita muscaria must be definitely established as the cause of poisoning before the prognosis can be determined and proper treatment given. The treatment for poisoning by muscarine consists primarily in removing the unabsorbed portions of the mushroom from the alimentary canal and in counteracting the effect of muscarine on the heart. The action of this organ should be fortified at once by the subcutaneous injection, by a physician, of atropine in doses of from one one-hundredth to one-fiftieth of a grain. The strongest emetics, such as sulfate of zinc or amorphine, should be used, though in case of profound stupor even these may not produce the desired effect. Freshly ignited charcoal or two grains of a 1 per cent alkaline solution of permanganate of potash may then be administered, in order, in the case of the former substance, to absorb the poison, or, in the case of the latter, to decompose it. This treatment should be followed by oils or oleaginous purgatives, and the intestine should be cleaned and washed out with an enema of warm water and turpentine. The use of atropine to stimulate the heart that has already ceased to beat is indeed the means of saving numerous lives. Its use, therefore, should be pushed forward. *Phallin* may be present in *Amanita muscaria.* Symptoms of this poison should be looked for in the color of the blood serum discharged from the intestines.

Phallin.—Chemically this toxic substance is generally considered to be of an albuminous nature. It is so deadly that 0.0015 grain per 2 pounds live weight is a fatal dose for cats and dogs. It is the active principle of the most deadly of all mushrooms, *Amanita phalloides,* or death-cup fungus. (There are indications of the presence of this plant in Baguio, Mountain Province, and its vicinity.) Its effect is not, as in the case of muscarine, paralysis of the nerves controlling the action of the heart, but a rapid dissolution of the blood corpuscles, the blood serum escaping from the blood vessels into the alimentary canal, and the whole system being rapidly drained of its vitality. No bad taste warns the victim, nor do the preliminary symptoms begin until nine to fourteen hours after the poisonous mushrooms have been eaten. There is considerable abnormal pain, and there may be cramps in the legs and other nervous phenomena, such as convulsions, and even lockjaw or other kinds of tetanic symptoms. The pulse is weak, the abnormal pain is rapidly followed by nausea, vomiting, and extreme diarrhœa, the intestinal discharges assuming the "rice-wash" condition characteristic of cholera. The latter symptoms are persistently maintained, generally without loss of consciousness, until death comes, in from two to four days.

There is no known antidote against phallin. Competent medical advice should be obtained as soon as possible. Active emetics, such as ipecac, mustard, apomorphine, assisted by the stomach tube, purgative (castor oil being preferable to the salines), should be administered at once, and every effort made to reduce further absorption of the poison to a minimum. High enemata to empty the lower vowel must be used early. Later normal saline solution may be given in the forms of enemata or even intravenously to supply the body's need for fluid and to ease the torturing thirst. Narcotics and anodynes in large doses are necessary to relieve the intense pain and to quiet convulsive movements. Nitroglycerine and strychnine given frequently and up to the limit of tolerance are of great value. Cyanosis calls for oxygen inhalation. Atropine may be used as a stimulant and a corrective with morphine, but it has no antidotal value here. Milk, raw or boiled, may be regarded as a mild natural antidote. Alcohol should probably not be given in any form. Strong coffee is indicated, as are hot dry applications to the body. Digitalis may be used, but shows no effects until six to ten hours later. Camphor in sterile oil given subcutaneously every hour is very helpful. Large draughts of hot water, flaxseed tea, or starch water, may be used, as well as tannigen, bismuth subcarbonate, and opium, to quiet the excessive diarrhœa and vomiting. Supportive measures and good nursing are of the greatest importance.

A number of minor poisonous species of mushrooms, like *Lepiota chlorospora, L. cepaestipes,* some *Panæolus,* and others, produce symptoms that resemble the action of muscarine. These species have not been given the importance and attention which they deserve. Fortunately they usually have an emetic action which prevents fatal consequences. Some of them are violent gastro-intestinal irritants and may thus add gravity to the illness. Death from them is almost unknown in healthy adults.

General rules to prevent mushroom poisoning.—There are no set rules for telling whether mushrooms are edible or poisonous. The only safe procedure is to know a mushroom before eating it. Such tests as "peels," or "blackens a silver coin when cooked," are of no value. Some of these tests happen to apply also to edible mushrooms. The following rules may help to avoid mushroom poisoning:

1. Avoid fungi in the button or unexpanded stage, also those in which the flesh has begun to decay.

2. Avoid all fungi that have death cups, stalks with a smaller base surrounded by a saclike or scabby envelope, especially if the gills are white.

3. Avoid fungi having a milky juice, unless the milk is reddish.

4. Avoid all tube-bearing fungi in which the flesh changes color when cut or broken, where the mouths of the tubes are reddish; in the case of other tube-bearing fungi proceed with caution.

5. Fungi that have a sort of spider web or cottony ring around the upper part of the stalk should in general be avoided.

6. Mushrooms with white gills and a ring on the stem, especially when the gills become greenish at maturity, should generally be avoided.

7. Mushrooms that have brown to black gills which grow on animal dung should generally be avoided.

8. Unless you are very familiar with the edible species you are collecting, never gather mushrooms in or near wood areas except for study.

9. Do not eat any mushroom on the word of the self-styled expert, unless you are personally familiar with the species in question.

10. Boiling does not suffice to rid a deadly variety of mushroom from poison.

11. Upon arrival from a collecting trip, examine again all mushrooms in the collection basket and discard any poisonous or undesirable ones.

12. Mushrooms should always be eaten soon after gathering (though many species may be dried for future use). As in the case of all organic substances, changes brought about by bacteria and molds soon set in. A fungus in which the gills or pores are altered by parasitic attack should never be gathered for the kitchen. No one would think of eating meat that was not fresh, unless frozen, or fish or fruit from a damaged tin. Old mushrooms and those burrowed by larvæ should be rejected.

13. As in the case of some other foods, many people are unable to eat mushrooms of any description without discomfort.

14. Mushrooms that are perfectly fresh and wholesome may prove indigestible even to those whose digestive powers are in no wise defective. Faulty cooking or overindulgence in eating are frequent causes. A heavy meal of mushrooms on returning from a long walk, tired and hungry, is harmful; in no case should fungi be eaten unaccompanied by other foods, such as rice, bread, or meat.

MUSHROOMS IMPORTED INTO THE PHILIPPINES

Mushrooms imported from foreign countries constitute the only regular mushroom supply for the restaurants and homes in the Philippines. The native mushrooms are available only during the mushroom season, yet a small quantity of these reach the market. The growing popularity of Chinese dishes in chop-suey houses, and the introduction of the popular Japanese "sukiyake" in Japanese restaurants demand an increasing supply of mushrooms. The most popular imported mushrooms are *Pleurotus ostreatus* (Plate 6, fig. 1) and *Auricularia* spp. (Plate 6, fig. 2) from China, the "shiitake" (Plate 6, fig. 3) from Japan, the champignon from France, or mushrooms from the United States. The last two mentioned are *Psalliota campestris*.

The species of *Auricularia* are imported in dried form. Foochow, China, is the center of trade. These species are somewhat leathery. Before cooking, they should be soaked in water to restore their original form. They become tender and melow. The species of *Auricularia* are the most popular of the mushrooms in the Philippines. They are almost always combined with Chinese dishes, especially those that are stewed, like chop suey, "pinsi," and others. There are several species of *Auricularia* sold in the market, chief among which are *A. auricula-judæ* (Plate 62) and *A. polytricha* (Plate 63, fig. 2). All these species are also found in the Philippines. Unfortunately few people know them. These mushrooms are found abundantly on rotten trunks and branches of trees, especially in the forest. The native species of *Auricularia* are clean; besides, they can be collected in the fresh condition. The sources of imported auricularias and the methods used in their preparation for market are unknown to us.[10] Imported auricularias are found in Ma-

[10] On the Chinese method of mushroom culture, JULIAN ARNAUD, Mushroom as an article of commerce, Daily Consular Trade Reports, Washington, D. C., No. 299 (1918) 1117–1118, may be consulted.

nila markets, particularly in Chinese "tiendas," where they are sold at 4 pesos [11] per kilo for the first grade, and at 2 pesos per kilo for the second grade.

The shiitake mushroom, scientifically known as *Cortinellus Shiitake,* is now becoming very popular in Japanese restaurants, as well as in Chinese chop-suey houses. It can be purchased both in the large Chinese "tiendas" and in Japanese groceries. It is imported in dried form and sold according to grade, depending on the size. The first grade is sold at 4 pesos per kilo, and the second at 3 pesos per kilo.

Like other dried mushrooms, *Cortinellus Shiitake* should be soaked in water before cooking, and later rinsed well so as to remove all dirt adhering to the crevices and surfaces of the plant. After soaking, it regains its original shape and softness. This is the most delicious species among the dried mushrooms. *Pleurotus ostreatus* is imported from China in dried form and found in Chinese chop-suey houses, although it is much less used than the auricularias, for it is used in highly prized dishes. This mushroom can be purchased in Chinese "tiendas" for 4 pesos per kilo. *Pleurotus ostreatus* is also found in the Philippines, although in more limited numbers. It grows on rotten, fallen trunks of trees in humid forests. There is no doubt that, once the artificial method of growing it has been studied, this mushroom can also be grown commercially in the Philippines. *Pleurotus ostreatus* should also be soaked in water and washed well before cooking in order to restore its freshness and its normal form and size, and at the same time to remove the dirt from the gills and other parts of the plant. When it is cooked, it is as good as any other good mushroom, like *Collybia* sp. and *Volvaria esculenta.* The stem is somewhat tough, but the cap and gills are soft. Mixed in chop suey or some other stewed dish, it is delicious.

Shiitake mushrooms in Japan are fast becoming an important forest by-product. Interesting information on the food value of this mushroom and on the methods of culture by the Japanese are given by Shozaburo Minura, in Notes on "Shiitake" (*Cortinellus Shiitake*) culture. Extracts may also be referred to in the Bulletin of the Forest Experiment Station.[12]

[11] One peso equals 50 cents United States currency.

[12] Meguro, Tokyo, Bureau of Forestry, Department of Agriculture and Commerce, Tokyo (1915) 109–114.

"Champignon" is the French name for mushroom. *Psalliota campestris* is the mushroom imported from France and the United States. It is sold canned in the market. Hotels, restaurants, and homes use a good deal of this mushroom. It is very delicious and used in many European dishes, especially French.

Lately, the importation of canned mushrooms from the United States has increased materially along with the progress in the development of the mushroom industry in that country. The artificial growing of *Psalliota campestris* has increased rapidly in recent years. Many of the states are now engaged in highly specialized methods of culture. They use mushroom houses which are artificially heated during winter and cooled during summer. In the United States mushrooms are now produced all the year round and can be purchased at nominal prices.

METHODS OF MUSHROOM CULTURE IN THE PHILIPPINES

There are no well-developed methods of growing mushrooms in the Philippines. Those that are practiced, although alike in principle, vary in different localities according to the cultural materials most abundantly available. They are simple affairs, evidently the product of experience based on the observation of the growth of mushrooms in their natural habitats.

In the Ilocos provinces, and in Pangasinan, a rectangular plot is laid out (Plate 7, fig. 1), a low bamboo fence is built to hold the fillings inside, and to keep away animals. A pit about a foot deep is dug in the ground inside the fence. It is said that the deeper the pit, the better will be the result. The pit is filled up to the surface of the ground with chopped banana trunks. Chopped banana materials rot fast, and a good crop may be obtained early. As the material is being dumped into the pit, it is trampled down in order to make the bed as compact as possible. Sometimes rice straw is piled up to about a foot high on top of the banana filling and trampled down also. On top again of the rice straw or on the banana filling, empty mongo pods are piled up as thickly as possible. In some Ilocano districts rice husks are spread out to a good thickness on top of the banana trunks, rice straw or mongo shells or both being omitted. Closely woven bamboo strips are placed over the beds, and on top of the fence in order to keep animals away, especially chickens. These mushroom beds are made about the middle of March or at the beginning of April, long before the rainy season begins, in order to allow ample time for the materials to rot. As the rainy days start, and the beds begin to be continuously soaked in water, they soon rot, so that about the middle of May or early in June mushrooms begin to grow. There is no limit for the growing of mushrooms in the beds, as the length of the season depends mainly on how long the rains last. When the rainy season is long, the production of mushrooms in these beds is extended to as late as October or November. When the rainy season is short, mushroom production lasts only to about the end of September.

In the Tagalog provinces, like Bulacan, Nueva Ecija, and Rizal, farmers pile their rice straw into big stacks (Plate 8) for animal feed. Because of continuous rains, the surface of these stacks of rice straw is soaked with water and soon rots. At first the stacks become ashy brown on the surface, then cottony white. This is the spawn. This stage is followed by the button stage of the mushroom itself. Mushrooms grow almost everywhere on the surface of the stack, but more readily at the crevices at the base. Unfortunately the production of mushrooms on these stacks does not last long, for the animals are continuously being fed on the rice straw until it is all consumed. On the scattered animal feed and manure mushrooms grow continuously throughout the season (Plate 9).

In regions where there is a much longer period of precipitation, as in the Bicol provinces, the mushroom season is more extended. Besides the favorable climate for mushroom growing in these places, the abaca plant, which is an excellent substratum for its culture, is found in abundance. Mushrooms still in the button stage are gathered every morning in baskets. They are of very good flavor and constitute a good and sure supply of viand in every home of the plantation.

The manner in which mushroom beds are prepared depends mainly on the materials available in a given locality. For example, in regions where sugar cane is the main crop, bagasse is most suitable. In places, where abacá is available, as in the Bicol regions, the trunks, stumps, and leaves of this fiber plant are used instead of banana. In cities like Manila, Cebu, and Davao, where banana and abacá waste is abundant, these materials can be satisfactorily used. Banana sheaths are used for wrapping large bales of tobacco leaves. These bales are commonly called "fardos." When the tobacco leaves are used in making cigars or cigarettes the banana sheaths are thrown away. The abacá fiber waste could be obtained from the many cordage companies in the large cities. Even old rice sacks could be made into a mushroom bed (Plate 7, fig. 2).

In Vivencio's work on mushroom culture [13] four methods based on those used in Pampanga Province are described: The rice-wash method, the common-salt method, the bagasse method, and the banana method.

The rice-wash method and the common-salt method call for piling chopped rice straw in a shady cool place, usually under bamboo trees, the bed of rice straw being about 25 cm thick above the surface of the ground after being trampled down. The rice-wash method and the common-salt method are identical, except that the liquids used for keeping the beds moist are different; in the rice-wash method, the liquid used is rice wash. This liquid is milky in appearance. For the common-salt method, the liquid used is a weak brine, a solution containing one spoonful of salt for every liter of water. In all cases the mushroom bed should be rectangular in form so that it can be easily worked.

The bagasse method consists in piling together fine pieces of sugar-cane bagasse. This bed should be watered with much sugar-cane juice, at least seven times daily for one month, and afterwards kept moist.

In the banana method, chopped banana trunks, stumps, and leaves are piled to a thickness of about 30 centimeters or more. As in other cases, it should be watered.

The use of spawn to inoculate the beds is not necessary, for the common edible mushroom, *Volvaria esculenta,* grows spontaneously.

POSSIBILITIES OF GROWING MUSHROOMS COMMERCIALLY IN THE PHILIPPINES

Volvaria esculenta has great commercial possibilities in the Philippines, if mushroom culture is carried on properly. The good qualities of this mushroom and the presence of abundant materials for its culture are favorable for the development of the mushroom industry in the Philippines. In fact this mushroom is grown in many provinces in Luzon, although on a limited scale and for a brief period of the year. *Volvaria esculenta* is one of the most popular mushrooms in the market, and is sold at a high price.

[13] Philippine Agriculturist and Forester 5 (1916) 119–128.

Another mushroom that has great commercial possibilities in the Philippines is the ordinary *Psalliota campestris*. This species is grown in the United States and in some countries of Europe. For its culture an appropriate mushroom house should be constructed, like those used in the United States. In this mushroom house the temperature should be kept at from 50° to 60°F. For this purpose a refrigerator is necessary. Another encouragement for this mushroom is the use of rice straw. It has been proven that *Psalliota campestris* can be grown artificially in the Philippines under controlled temperature, and on rotten rice straw instead of on horse manure. The problem is to secure a suitable temperature and at the same time to reduce expenses so as to make mushroom growing a profitable industry in the Philippines.

EDIBLE WILD MUSHROOMS

The first and most important thing to be remembered by the collector of wild mushrooms for the table is that he must gather only such species as he is perfectly familiar with. Any one who will accept a mushroom merely because the gills are pink or because the skin of the cap will peel off, or merely because it is growing along with a well-known species or in a place where a well-known species has previously been collected, should be discouraged from collecting mushrooms for the table, for he is certain, sooner or later, to get some poisonous specimens mixed in with the good ones. It is best to reject all specimens of doubtful edibility.

The best time to collect mushrooms is early in the morning, for at that time all those which have opened during the night are fresh and free from insect infestation. The only thing needed for collecting is a basket to carry the specimens in. It is well, however, to take along a garden trowel and a sharp knife or small "bolo," and to get into the habit of digging up the mushrooms instead of picking them, because there are some species which even the expert cannot recognize unless he has the whole of the stem. If the mushroom is picked or broken off above ground, one of the most evident marks for identification, the volva, may be left behind in the soil.

All mushrooms that are not perfectly fresh should be rejected. Many cases of so-called mild mushroom poisoning have been caused by the careless eating of specimens infested by larvæ of insects. Tainted mushrooms are as unwholesome as tainted meat. Although many of them will keep well for a considerable time when the weather is cool, in warm weather they very soon become unfit for food.

Side by side with the known edible species, many beautiful and interesting fungi are found, which are not discussed in this publication. If one becomes interested in knowing what they are, he must obtain one or more of the larger publications or books listed on pages 116 and 117. For those that cannot be identified with the help of these publications or books, specimens may be sent to the mycologist of the Bureau of Science, Manila, for identification. These specimens should always be accompanied by a letter giving full information as to the appearance of the fresh specimens, their place and manner of growth, and other pertinent data. The specimens should be wrapped in oiled paper or grocer's butter paper, placed in a box, and mailed at once. In hot weather specimens that are apt to decay quickly should be first wrapped in a cloth that has been moistened with 6 per cent formalin, and then in butter paper. Another way, which in some cases will serve even better, is to photograph the fresh specimen, dry it, and send both the dried specimen and a copy of the photograph with the letter.

The following mushrooms are suggested for collection by a beginner. Puffballs (Plate 70), are said to be all edible, white, tender, and homogeneous inside. Puffballs grow on the ground. Oyster mushrooms, such as the *Pleurotus* species (Plates 29 to 31) and their nearest relatives, are recommended; they are large, having white gills and a short stem. The stem is generally eccentric. *Collybia* (Plate 23) and *Lentinus* species (Plates 37 and 40) are all edible, and although *Lentinus* species are a little tough, they make delicious soup. The ordinary field mushrooms, *Psalliota* species (Plates 47 to 50) are highly recommended. They can easily be detected because of their brown gills and their shaggy ring, the remnant of the veil. All species of *Auricularia* (Plate 61, figs. 2 and 3; Plate 62), taiñgang-daga in Tagalog, the smooth and the hairy species, are edible. Cooked, they are deliciously mellow, especially if stewed in chop suey. The *cudet* (Ilk.), *Schizophyllum commune* (Plate 33, fig. 2), is not to be scorned. Dried taiñgang-daga and the cudet should be well soaked in water before cooking in order to restore their normal form and softness.

THE PREPARATION OF MUSHROOMS FOR THE TABLE

All mushrooms should be thoroughly washed, but they should be washed quickly and in cold water only, since warm water or prolonged soaking in water injures the flavor of many species. Some species are improved by soaking for some time in salt water. All specimens that are not perfectly fresh or that are in the least infested with insects should be discarded. A few kinds should be peeled, but as a rule peeling removes some of the best-flavored parts. The stem of most species should be removed, although if the stems are very tender there is no reason why they should not be used. Mushrooms should not be kept long in a fresh condition. If they cannot be used at once, they should be perfectly cooked and placed in the ice box until needed.

As a rule mushrooms may be cooked along with meat and poultry, or used as flavoring for soups and sauces, or for stuffing peppers or tomatoes. The better-flavored species should be cooked simply and seasoned lightly, while those of poorer quality may be improved by more elaborate cooking and thorough seasoning. A few species that are slightly bitter in the raw state should be boiled more. The majority of mushrooms, perhaps, are best simply broiled or stewed with vegetables, meats, or shrimps as ordinary "gulay." In "gulay" prepared with mushrooms, ginger is almost indispensable as an ingredient.

The Filipino recipes given below were collected from several housewives in different parts of the Philippines. Some of these recipes were tried in the laboratory and found to be very successful.

MUSHROOMS WITH AMPALAYA

One part ampalaya	Fried fish (bañgos or dalag)
One part mushroom	Bagoong[14] to taste

Cut the ampalaya into pieces 6 to 7 cm by about 4 cm. Place in a container with sufficient water to cover and add the bagoong. Bring to a boil, add the ampalaya, and cook for three minutes. Then add the mushrooms, and lastly the fried fish. (Left-over fried fish may be used.) Continue boiling until done. Do not stir the mixture.

FRIED MUSHROOMS

Beat the yolk of an egg with a tablespoonful of water, and season with pepper and salt. Dip each cap into this mixture, and then into fine

[14] Salted, fermented anchovies.

cracker crumbs or corn meal. Have butter or shortening very hot in the frying pan. Fry slowly on each side five minutes. A sauce can be made by thickening the butter or shortening with flour.

MUSHROOMS WITH CHICKEN

1 Small chicken	2 Segments garlic
24 Mushrooms	2 Tomatoes
1 Onion, sliced	Salt to taste

Dress the chicken, cut into pieces suitable for serving, wash, and boil with enough water until almost done. Fry the garlic, the onions, tomatoes, and the chicken meat with all bones removed, and lastly the mushrooms. Add the chicken broth to the mixture and continue boiling until done. Season with salt and pepper. Serve hot.

MUSHROOMS WITH YOUNG CORN

24 Large mushrooms	½ Lb pork, sliced fine
1 Cup young corn scraped from the cob	3 Chopped tomatoes
	Tender leaves of sili
1 Onion, sliced	Salt to taste

Fry the onions, the pork, the tomatoes, the corn, and the mushrooms. Add two cups of meat stock and boil slowly until cooked. Season with salt, and lastly add the sili leaves.

MUSHROOMS WITH SHRIMPS

24 Large mushrooms, more if they are small	3 Medium-sized guavas, sliced
	2 Big tomatoes
1 Cup sliced shrimps with skins removed	1 Onion, sliced
	2 Segments garlic, minced
1 Cup chopped pork	Salt to taste

Fry the garlic, the onion, the shrimps, the pork, the tomatoes, the sliced guavas, and lastly the mushrooms. Add about 1 cup of shrimp broth and allow to boil. Season with salt and pepper. Serve hot.

MUSHROOM TAMALE

Add enough salt to the mushrooms that have been previously sorted, cut into pieces of desired size, and washed, and wrap in banana leaves. Cook over live coals and when done on one side, cook the other side. Serve with calamansi juice.

MUSHROOM OMELET

6 Large mushrooms	1 Onion, sliced
2 Eggs	Salt to taste
1 Tomato	

Wash the mushrooms, cut into small pieces, and squeeze them to remove as much as possible of their water content. Fry the onion, the tomato, and the mushrooms. Season with salt. Beat the eggs and pour over the mushroom mixture, stirring with the fork until thoroughly mixed. Fry both sides on a well-greased pan. Serve hot.

STEWED KABUTENG PUNSO (*Collybia albuminosa*)

12 Large mushrooms	2 Tablespoonfuls of calamansi juice
A small piece of ginger	Salt to taste

Remove the cuticle from caps of mushrooms and cut caps into pieces of desired size. Cut the stem to a length of about one inch. Cover with about one-half cup of water and allow the mixture to boil. Add the ginger and season with salt. When tender, add the calamansi juice to remove the slimy characteristics of this mushroom. Serve hot.

Other mushrooms may be used instead of *Collybia albuminosa*. The cuticle may or may not be removed, according to the species of mushroom used.

MUSHROOM SOUP

12 Mushrooms, cut into small pieces	½ Cup sliced apulid
½ Cup boiled and flaked crabs	1 Onion, sliced fine
½ Cup shrimps, sliced	Young leaves of onions, cut into small pieces
1 Cup cabbage, previously blanched and cut into small pieces	Patis enough to taste
1 Cup sliced patola	2 Segments garlic
¼ Cup sliced chinese ham	Salt to taste
	Vet-Sin

Fry the garlic, the onions, the apulid, the cabbage, the mushrooms, the ham, the shrimps, and the crabs. Add enough ham stock, and allow to boil. Then add the patola, the sliced onions, the onion leaves, and Vet-Sin and patis. Serve with toyo and calamansi juice.

MUSHROOM DINENDENG (Ilocano)

10 Mushrooms (*Colybia albuminosa* or *Volvaria esculenta*)	2 Tomatoes
2 Ampalaya	3 Small pieces of fried or roasted fish
6 Eggplants	A small piece of ginger
	Bagoong to taste

Cut the mushrooms into long, thin pieces; cut the ampalaya and the eggplants into pieces 6 to 8 cm by 1 cm. Cut the tomatoes into halves and the ginger into thin slices. Place the ampalaya, the eggplants, and the ginger in a native cooking pot with enough water to cover. When it boils, add the mushrooms and the tomatoes, later the bagoong and the fried or roasted fish. Before the bagoong is added, it should be strained.

MUSHROOMS WITH COCONUT MILK

½ Cup shrimps, peeled	1 Onion, sliced
½ Cup pork, cut into pieces	2 Lbs lard
2 Cups mushrooms, cut into pieces	Salt to taste

Heat the frying pan and put in the lard; when the lard is hot, put in the onion, the pork, the shrimps, and the mushrooms in the order given. When half cooked, add enough coconut milk to cover. Stir while adding the coconut milk. When cooked, spread powdered black pepper on the surface. Serve hot.

CHOP SUEY

- 1½ Caps mushrooms, or taiñgang-daga or both (soak taiñgang-daga in water until it looks as if it were fresh)
- 1 Cup boiled sliced shrimps
- ½ Cup flaked boiled chicken
- 4 Tablespoons sliced Chinese ham
- 3 Chinese sausages
- 1 Cup boiled and sliced pork liver or chicken livers and gizzards
- ½ Cup sliced pork
- 2 Cups sliced patola
- 4 Cups cabbage, cut into pieces 1 inch long and ½ inch wide
- 5 Tablespoons toyo
- 1 Tablespoon flour
- 4 Sliced onions
- 3 Tablespoons chopped garlic
- 2 Cups chicken broth
- ⅛ Teaspoon pepper
- Salt to taste

Fry onions, garlic, shrimps, pork, ham, sausages, chicken, livers, gizzards, and mushrooms together. Add the toyo, pepper, and a small amount of chicken broth. Continue boiling for a while; then add the cabbage, later the patola, and lastly the rest of the chicken broth mixed with flour. Add enough salt to taste. Continue boiling until the vegetables are tender. Put in a big bowl and serve hot.

MUSHROOMS WITH TINAPA [15]

- 24 Large mushrooms
- 6 Tinapa
- 1 Small onion, sliced
- A small piece of ginger, sliced
- 2 Segments garlic
- Juice of 3 medium-sized calamansi
- Salt to taste

Sort and wash the caps and stems and cut into pieces of desired size. Drain well. Remove the head, the scales, and the spines of the tinapa. Fry the garlic, the onion, the ginger, the tinapa, and the mushrooms. Add a little water if necessary. If the mushrooms are rather watery there will be enough broth without the addition of water. Season with salt and pepper and lastly add the calamansi juice immediately before removing from the fire. Serve hot.

MUSHROOMS WITH STRING BEANS (PA-AYAP)

- 12 Mushrooms
- 1 Cup pork, cut into small pieces
- ½ Cup shrimps, sliced, with skins removed
- 1 Onion
- 1 Bundle string beans [16]
- A small piece of ginger
- 2 Segments garlic
- 2 Large tomatoes
- Salt to taste

[15] Smoked fish.

[16] A bundle is about 10 cm in diameter.

Clean and cut the mushrooms into pieces of desired size. Cut the tender string beans to lengths of about 1 inch. In the case of the mature ones, use only the seeds and discard the pods. Boil the string beans in 2 cups of rice water until tender. Fry the garlic, the onion, the ginger, the pork, the shrimps, the tomatoes, and the mushrooms, and add the string beans. Add to the mixture 1 cup of shrimp broth and the rice water in which the string beans have been boiled. Season with salt and pepper to taste.

PEPPERS STUFFED WITH MUSHROOMS

6 Large, partly ripe, peppers	1 Onion, chopped fine
12 Mushrooms	1 Large tomato
1 Cup chopped pork	Salt to taste

Cut the stem end of the peppers and carefully remove all seeds. If the peppers are quite brittle and likely to break easily, blanch them before removing the seeds, chop fine the previously sorted and washed mushrooms. Fry the onions, the pork, the tomatoes, and the chopped mushrooms. Season with salt and pepper. Fill the peppers with the mixture and lay them on a baking pan. Bake until done.

MUSHROOMS BAKED WITH TOMATOES

In a baking dish, arrange small round slices of buttered toast; upon each piece place a rather thin slice of peeled tomato, salted and peppered; upon each slice of tomato place a fine, thick mushroom, gill side up; in the center of each mushroom put plenty of butter, season with salt and pepper. Cover the dish and bake in a hot oven ten minutes; then uncover and bake for an additional five or ten minutes, as the mushrooms seem to require.

TOMATOES STUFFED WITH MUSHROOMS

Wash smooth, solid tomatoes (preferably an American variety); cut a slice from the stem end and remove carefully the seeds and core. To each tomato allow three large mushrooms; wash the mushrooms, dry, chop fine, and stuff into the tomatoes; put a half saltspoon of salt on the top of each and a dusting of pepper. Into a bowl put one cup of soft bread crumbs, season them with a half teaspoonful of salt and a dash of pepper, pour over them a tablespoonful of melted butter, and heap them on top of the tomato, forming a sort of pyramid, packing in the mushrooms; set the tomatoes in a baking pan and bake in a moderate oven 1 hour. Serve at once, lifting them carefully to prevent breaking.

OYSTERS AND MUSHROOMS

Wash ½ pound of fresh mushrooms and remove the stems; chop them fine; put them into a saucepan with a tablespoon butter, a half teaspoon salt, and a dash of pepper; cover closely, and cook over a slow fire for ten minutes. Have ready, washed, and drained, twenty-five large fat oysters; throw them perfectly dry into this mushroom mixture. Put the saucepan over a bright fire; boil, stirring carefully, for about five minutes. Serve on squares of carefully toasted bread.

METHODS OF PRESERVING MUSHROOMS

During the mushroom season there is always an abundance of mushrooms, and often a considerable surplus is left unused. In order to utilize this surplus, people should know some methods of preserving mushrooms. One method is drying and using them in the whole or powdered. Many of our mushrooms can be dried. The other method is either bottling or canning. Mushrooms can also be made into catsup.

After the mushrooms are gathered, they should be sorted at once, and those that are more or less torn separated from those that are still intact; those that are in the button stage should be set apart. The buttons of various sizes may be canned. At this stage they are firm and retain their color after heating. Old mushrooms that are canned lose very much in bulk, become mushy, and often turn black. The old ones and those which have broken caps and detached stems should be made into catsup. Those with fully opened and still firm caps may be dried or made into powder. Mushroom powder keeps very well and is one of the most delicious flavoring condiments of the kitchen.

In drying, the mushrooms should be first thoroughly cleaned in water to remove all dirt adhering between the gills or in the pores and on the surface. They should be placed singly on boards or racks and dried in the sun or air. They should be turned over every day, and not be left out during the night as they absorb moisture very rapidly. They may also be dried on wooden trays in a warm room, during the days when there are no rains. In making powder, those that are already dried and brittle can be powdered in a small mortar with a pestle. The powder should at once be placed in well-stoppered dry bottles or fruit jars, sealed, and kept in a cool, dry place. A very excellent method to make the dried mushrooms more delicious and to improve their keeping quality is the "toyo" method. It consists of soaking the mushroom in "toyo" for about one minute, after washing them thoroughly. Then they are dried as described above. In the Philippines "toyo" can be purchased in any "tienda" at very small cost.

Mushrooms may be canned as easily as fruit and much more readily than some vegetables. Those that are still closed are cleaned by peeling or by wiping with a cloth, removing dry dirt or earth which may have adhered to them. The stems are cut off, allowing a length of ½ to 1 inch to remain attached to the cap. Then they are placed in an iron kettle and heated without water until shrinking ceases, after which they are placed in cans that have previously been cleaned and scalded, and enough of the liquor poured over them to fill the can completely.

Fruit jars or mason jars may be used. After filling, they are placed in any kind of cooking vessel provided with a cover and containing a small amount of hot water. A sheet of asbestos, or a thin layer of excelsior is placed in the boiler to prevent the glass from coming in contact with the bottom. The caps are placed loosely on cans, and with steamer cover in place the water is allowed to simmer for half an hour. Upon removing the cover from the steamer the jar covers are immediately screwed down, in order to show leaks. If all are perfectly sealed, they are allowed to stand for 24 hours, when they are again heated in the same manner, except that the time of steaming must be prolonged to one hour, because the contents of the cans are cold. A repetition of this operation on the third day will complete the sterilization, and on opening the cans the mushrooms will be found to be as nearly like the fresh article as it is possible to have them. They keep well and do not deteriorate in consistency nor flavor. The cans must be kept sealed throughout the operation.

If desired, the mushrooms may be stewed in milk, or prepared in any manner for the table and then canned in the manner described. When the can or jar is opened, they require heating only before serving. When cans are used they are handled in the same manner as the glass jars, with the exception of soldering the lid as soon as the can is filled, leaving the vent open until after heating the first time, when it is immediately closed with a drop of solder while the can is hot, to form a partial vacuum that takes up the expansion caused by subsequent heating.

This method of sterilizing kills the vegetable germ cell at the first heating, and the intervals between heatings induce the spores to germinate into cells, so that a much lower temperature is needed than would be required to kill the spores.

If it is desirable to sterilize the mushrooms at one operation, the cans should be filled as already described, and after sealing, heated to a temperature of 240° F. for 30 minutes. This process, however, requires a steam chest capable of withstanding a pressure of over fifteen pounds to the square inch, which is not commonly found in the home; besides, the flavor and the texture of the article canned are materially impaired by this high temperature, and glass jars cannot be used.

FOOD VALUE OF MUSHROOMS

The food value of mushrooms lies chiefly in their flavor. Measured by the amount of energy that can be obtained from them, they do not rank very high. On that basis the ordinary mushrooms are found to have a food value about the same as that of cabbage, less than one-half that of potatoes, or about one-twentieth that of wheat flour; but nevertheless people enjoy them because of their flavor, and most of us can enjoy mushrooms as soon as we learn a few species so that we can eat them without fear of poisoning. The market price of mushrooms is beyond the reach of the common people, but there are tons of excellent wild species that are allowed to decay in the woods and fields every year. These will furnish variety and flavor to the diet of thousands of families, at the cost only of the time to collect them, as soon as people have learned to distinguish them from one another.

BENEFITS DERIVED FROM MUSHROOMS OTHER THAN FOOD VALUE

Mushrooms are of value not only as an article of food, but also as a source of various profitable enjoyments. The pleasure of the search, the thrill of the discovery, and the opportunity they afford for healthful outdoor recreation are no less important. Of course, these benefits cannot be obtained by the purchase of any amount of mushrooms from the market. Mushroom collecting is as exciting as game hunting. Moreover, mushroom hunting cultivates the power of observation toward nature, and provides a good chance for a man to forget his worries in life, to better and brighten his outlook, and last but not least, it provides a good means for prolonging dear life itself.

There is now a live interest in mushroom growing the world over. In many communities in the United States, clubs of mushroom growers have been formed and are very active. In some public schools of the Philippines, for example in Bataan Province, mushroom culture is included as a project in the school curriculum, together with poultry raising, hog raising, gardening, and others.

Another indication of the importance of mushroom growing is the increasing interest of people in them as objects for nature study. Their habit of growing in the ground, in the woods, and in living trees for weeks, months, years, and even centuries;

their development from an ordinary buttonlike structure to a large round shape, a hog's head or the umbrella-shaped, certainly offer a field for nature observation. Mushrooms help man in many ways; they cause dead vegetable matter to decay and thus fertilize the soil. Even the deadly poisonous *Amanita muscaria* (Plate 12) has some use. The extract of this mushroom is used to poison flies in some countries. Some of the hard fungi, like *Polyporus squamosus* and *P. betulinus,* were at one time used in the manufacture of razor strops. The fiber parts of several of the hard fungi were used as tinder. In powder form they were used as snuff. In some countries interesting objects, like bedroom slippers and smoking caps, were made from the pliant sheets of some of the hard fungi. Others, because of their shape, are used as flower pots. People are very fond of etching figures on some of the hard species that are easy to work on. When they are perfectly dry, they may be used for fuel.

A number of the fungi were formerly employed in medicine for various purposes. Some of them are still being used in some countries. Some of them were used as a purgative, as in the case of certain species of *Polyporus.* In England the species of *Auricularia* were formerly used as a remedy for dropsy and for sore throat. Other species of *Polyporus* are employed in Burma as a medicine to expel worms from the bodies of animals. Puffballs, when mature, are in great demand in rural districts in the Philippines for stopping bleeding.

COLLECTION AND PRESERVATION OF MUSHROOMS FOR STUDY

In the collection of mushrooms for study, it is essential that all parts be kept intact. A single character missing may make it impossible to place the specimen in the right genus, not to mention the difficulty of identifying it as to species. Notes on the important evanescent characters should be taken while the specimen is still in the fresh condition. Then the specimen may be dried or preserved for future study.

The following list of apparatus is recommended:

1. A rectangular hand basket with a capacity of 10 to 14 quarts.
2. A good quantity of soft newspaper.
3. A good, sharp knife, a small-sized "bolo," memorandum pad, and pencil.

During the rainy season mushrooms are found in great abundance in woods, thickets, open fields, and especially in forests. They are not so numerous during the dry season, although even then many can be collected in the damp forests, especially at high altitudes. In collecting specimens, care should be taken that the roots be not destroyed or left in the soil. Hence, in collecting specimens growing on the ground, like *Collybia, Lepiota,* and many others that are deeply rooted, a sharp, small-sized "bolo" is very handy. There are also many that grow on rotten wood, and in ordinary picking the roots and a portion of the stem may remain in the wood. A sharp knife or a small-sized "bolo" should be used to chop off the part of the wood where the substratum is rooted. The specimens should be wrapped in soft newspaper at once, as many of these fungi are characteristically covered with fine powder which will stick to the fingers unless precautions are taken against its rubbing off.

Only notes on the habitat and the environment, which are very important, should be taken down at once in the spot where a specimen is collected. These details may cover the place of collection—groves, woods, open fields, grounds, sticks, stumps, trunks, living trees, or rotting wood, and the kind and character of the soil. Other notes necessary to make the study complete should be made at once upon arrival in the laboratory, as mushrooms are perishable and many of the important characters quickly disappear.

Upon arrival from the field, the specimens should be sorted at once in order to avoid confusion later on. The species belonging to the genus *Coprinus* (Plate 52) deliquesce very fast, and *Galera* (Plate 44, fig. 2) and *Psathyrella* (Plate 53, fig. 3) collapse very rapidly.

The color of the spores cannot be well determined, even when they are examined under the microscope, unless a sufficient amount is collected on a piece of paper. This mass of spores is called 'spore print' (Plate 10). The spore print may be prepared by placing the cap on a piece of paper, removing the stem from the cap (the gills facing downward), and covering it with an inverted bell jar or tumbler. The spores fall on the paper in large quantities within an hour or so. To bring out the color of the spores, the color of the paper should be in contrast with it. For example, if the spores are white the paper should be black; or, if the spores are black, the paper should be white.

When the necessary notes have been taken, the mushrooms are ready to be preserved, in either liquid or dried form. While the weather is fair, specimens can be put into the sunshine to dry. During the rainy season they better be left in the room with the windows wide open, as it is dangerous to bring them out where they may get soaked in the rain and rot. A method to dry the specimens inside is by means of artificial heat from the stove. A crate of about a meter square is hung over the stove on the four corners. The distance between the crate and the stove depends upon the amount of heat given out by the stove. The opened packets containing the specimens are placed on the crate. Later the dried specimens are dipped for about 5 minutes into a poison solution which is prepared according to the following formula: 1 liter of denatured alcohol, 40 grams of mercuric chloride, 10 cc of phenol. The specimens are dried in the air, then packeted and kept for future study. It is necessary to poison the specimens so that insects cannot destroy them.

For preservation of fresh specimens in liquid, three solutions were found successful. These are: the sulphurous acid preservative, ordinary 75 per cent denatured alcohol, and formalin-water-alcohol. In the first method, the specimen is put in a 20 per cent solution of blue stone (copper sulphate) for 24 hours or less, depending on the texture of the specimen. If the specimen is soft, it should be put in less than 24 hours. Even if it is hard, it should not remain in the solution longer than 24 hours. After the specimen has been removed from the solution, the precipitated copper is carefully washed off, and the specimen transferred into a permanent bottle or container with clear or distilled water. Sulphur dioxide gas is then evolved from a small tank into the water that contains the specimen up to the point of saturation. The resulting solution is sulphurous acid. The preserving solution, 75 per cent denatured alcohol, is handy and cheap. The formalin-alcohol-water preservative is prepared in the following proportions: 1 liter of water, 226 cc of formalin, 140 cc of denatured alcohol. The solution is filtered through cotton.

The choice of the preserving solution depends upon the nature of the specimens; if the specimen is hard and the color disappears easily the use of the sulphurous acid preservative is satisfactory. If the specimen is soft and small, 75 per cent denatured alcohol would do very well. Formalin-alcohol-water was found satisfactory in all cases. The objection to the formalin-alcohol-water is that formalin is not very comfortable to handle as it peels the skin off.

Whenever possible, specimens should be preserved in liquid. This method has the advantage over the drying method, as it preserves the shape and often the natural color of the specimen.

LIST OF AUTHORS

The binomial botanical name of each plant is followed by the name, either abbreviated or in full, of the person or persons who named the species. The following is a list of authors of the species described in this paper, arranged by countries:

AUSTRIA.
- Bresadola, Abbe J.

CANADA.
- Bolton, James.

ENGLAND.
- Berkeley, Rev. J. M.
- Hill, John.
- Massee, George.
- Petch, T.
- Relhan, R.

FINLAND.
- Karsten, R. A.

FRANCE.
- Boudier, E.
- Bulliard, P.
- Durian, M. C. de.
- Desvaux, A. M.
- Gillet, C. C.
- Hariot, P.
- Léveille, J. H.
- Montague, Camille.
- Patouillard, N.
- Quelet, L.
- Roze, E.

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- Hedwig, Johann.
- Hoffmann, G.
- Klotzsch, J. F.
- Lasch, W. G.
- Wulfen, F. von.
- Schaeffer, J. C. von.
- Schroeter, Julius von.

HOLLAND.
- Junghuhn, F. M.

HUNGARY.
- Kalchbrenner, K.

ITALY.
- Cestadi, V. de
- Dillenius, J. J.
- Micheli, P. J.
- Notaris, C. de
- Saccardo, P. A.
- Villadini, Carlo.

PHILIPPINES.
- Mendoza, J. M.
- Palo, Simeona L.

SOUTH AFRICA.
- Persoon, C. H.

SWEDEN.
- Fries, E. M.
- Linné, Carl, or Linnæus, Carolus.

SWITZERLAND.
- Haller, A von.
- Zollinger, H.

UNITED STATES.
- Bosc, Louis.
- Copeland, E. B.
- Curtis, M. A.
- Graff, P. W.
- Lloyd, C. G.
- Peck, C. H.

CLASSIFICATION OF MUSHROOMS

The true fungi are usually divided into three classes; namely, the Phycomycetes, which include the common molds, the Ascomycetes or sac fungi, and the Basidiomycetes. With the first group we are not concerned, since its members are not large enough to be considered mushrooms or toadstools. In the Ascomycetes are included many fungi of high economic importance, causing many plant diseases. These also are too small to be called mushrooms, except a few, the most important of which are the morrel (Plate 74, fig. 1), the cup fungus (Plate 75), and *Xylaria* (Plate 77). The third group are the Basidiomycetes to which the majority of the mushrooms and toadstools belong. With this group we are primarily concerned. Its members are called Basidiomycetes because they have the club-shaped fruiting bodies called "basidia" (sing. "basidium," meaning a little pedestal).

The scientific name of a mushroom consists of two words. The first is the generic name or group name, the second is the specific or individual name. These names are usually of Latin or Greek origin, and when they are derived from other languages they are used with Latin inflection. For example, in *Coprinus comatus*, the scientific name of a mushroom, the generic name *Coprinus* is derived from the Greek *kopros*, meaning dung, and the specific name *comatus* is a Latin word for "hairy." Al mushrooms of a given kind belong to one species. All species that seem closely related are grouped together in one genus.

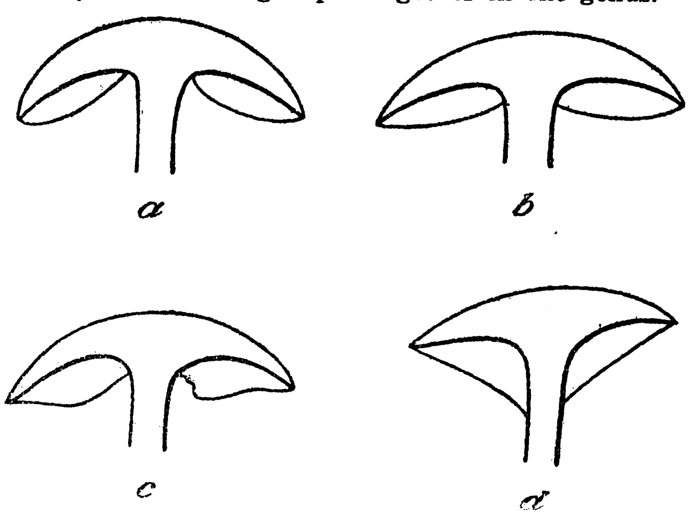

FIG. 8. Portion of the structure of agarics, showing the arrangement of gills. *a*, Gills free; *b*, gills adnate; *c*, gills sinuate; *d*, gills decurrent.

The color of spores plays an important part in distinguishing the various genera and species of mushrooms. The spores are classified according to color, such as white, pink, yellow, purple-brown, or black. In addition to the color of the spores it is necessary to determine the presence or absence of the volva or the ring, or both. It is also essential to note where the gills are attached. This may be determined clearly by making a longitudinal cross section through the middle of the cap and stem. The gills are free (text fig. 3*a*) when they do not touch the stem; adnate (text fig. 3*b*) when they are slightly attached; sinuate (text fig. 3*c*) when they show a slight curve or sinuation near the stem, and decurrent (text fig. 3*d*) when they run or descend down the stem.

In order to show the exact tint of the spores produced by a certain species, the print of the spores in mass should be secured. The method used is fully described on page 36.

The shape of the cap is also essential in the identification of mushrooms. The *pileus* or cap is either convex (text fig. 4*a*), campanulate or bell-shaped (text fig. 4*b*), or conical (text fig. 4*c*).

For the generic determination it is essential to know whether the consistency of the fungus is leathery or fleshy. In the determination of species it is important to go to the specific description and to become familiar with every detail.

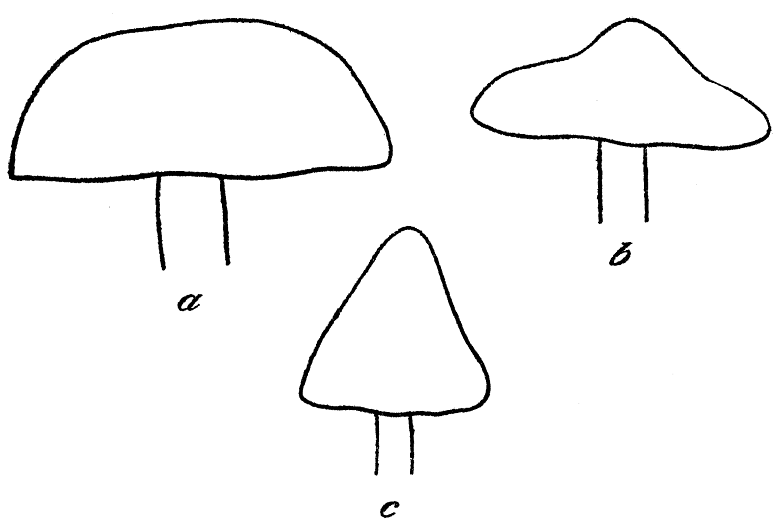

FIG. 4. Portion of the structure of agarics, showing the different formations of the caps. *a*, Convex; *v*, campanulate, or bell-shaped; *c*, conical.

Class BASIDIOMYCETES

The great majority of the fleshy fungi belong to the class Basidiomycetes. These are characterized by the development of the sporophore, or fruit body, called "mushroom," "toadstool," "punk," and other names. They are frequently large and different in form, size, and color. In certain areas the fruit body is differentiated into a spore-bearing surface. Sectioned and examined under a microscope, this fruiting surface (text fig. 2) is found to consist of a close layer from which the basidia arise, ordinarily in a palisade. Each basidium produces as a rule four spores. Every one of the spores is borne on a sterigma.

Order HYMENOMYCETES

The layer composing the spore-bearing organs is naked. The basidia and spores are exposed in mature plants.

AGARICACEÆ

The members of the family Agaricaceæ are characterized by their gills, usually bladelike structures on the under side of the cap. The surface layer of these gills constitutes the spore-bearing surface, called the "hymenium." The gills radiate from a stem, which usually is central, but sometimes eccentric or lateral. The umbrella-shaped kind is the most important and most common in this family. The Agaricaceæ constitute the majority of the conspicuous fleshy fungi. The spores of the family Agaricaceæ may be black, purple-brown, yellow, pink, or white.

The key to the genera of the family Agaricaceæ is divided into five columns based on the color of the spores; namely, white, yellow, pink, purple-brown, and black. In order to determine the genus to which a specimen belongs, we must be certain that the mushroom in question belongs to the family Agaricaceæ. This is determined by the presence of gills.

Upon collecting the spores of a mushroom on a piece of paper, we see that the spore print is white. The plant is fleshy and more or less firm, and when laid aside for a while it rots easily. The stem is central and the substance of the stem is distinct from the cap. Upon further examination we find that the stem has a ring, and a cup at the base. These findings lead us to the conclusion that the mushroom in question belongs to the genus *Amanita.*

The same key may be used to identify a brilliant red mushroom. Upon collecting the spores on a piece of black paper, we find the print white. The tissue is fleshy, more or less firm, and rots easily at maturity. The stem is at the center of the cap, the substance combining with and similar to that of the cap. The ring is absent and the gills are rigid and brittle. The volva is

Key to the genera of Agaricaceæ.

	Spore prints.				
	White.	Pink.	Yellow.	Purple-brown.	Black.
I. FLESHY, NOT LEATHERY NOR WOODY.					
A. Ring, volva, or both, present:					
1. Ring and volva present	*Amanita*				
2. Only volva present	*Amanitopsis*	*Volvaria*			
3. Only ring present, 4.					
4. Gills free	*Lepiota*			*Psalliota*	
Gills adnate or slightly prolonged down the stem	*Armillaria*		*Pholiota*	*Stropharia*	
B. Ring and volva absent:					
5. Gills exuding a milky juice when broken	*Lactarius*				
6. Stem eccentric or absent	*Pleurotus*				
7. Stem cartilaginous, 8.					
8. Gills adnate or free	*Collybia*		*Naucoria*		*Panaeolus* or *Copelandia*.
Gills decurrent	*Omphalia*				
Gills sinuate			*Galera*		*Psathyrella*.
9. Stem fleshy, 10.					
10. Gills free		*Pluteus*	*Pluteulus*		
Gills sinuate	*Tricholoma*				
Gills anastomosing	*Cantharellus*				
Gills decurrent, thin	*Clitocybe*				
Gills adnate, plant rigid, brittle, and usually brightly colored.	*Russula*				

C. With threadlike or spiderweblike veil:					
11. Veil forming a spiderweblike disappearing ring on the stem.			*Cortinarius*		
II. MEMBRANACEOUS, OR FLESHY MEMBRANACEOUS, FRAGILE, RAPIDLY DISSOLVING OR SHRIVELLING UP.					
12. Gills easily dissolve from below upward					*Coprinus.*
III. TOUGH, LEATHERY, OR WOODY.					
13. Stem central, 14.					
14. Gills simple; dried plant reviving when moistened	*Marasmius*				
15. Stem lateral or absent, 16.					
16. Gills simple, edge toothed	*Lentinus*				
Gills simple, entire	*Panus*				
Gills simple, edge split	*Schizophyllum*				

absent. The characteristics of specimen as mentioned above lead us to recognize the genus *Russula.*

THE WHITE-SPORED AGARICS

A good many of our well-flavored mushrooms are white-spored. *Collybia,* such as *Collybia albuminosa* Petch, called *kabuteng punso* in Tagalog (Plate 23); *Collybia* sp., commonly called *mamarang* by the Tagalogs and *mannagado* by the Ilocanos (Plate 24); the *Pleurotus* species, *anandap* (Ilocano) or *alitaptap* (Tag.), like *Pleurotus ostreatus* (Plate 30, fig. 3); many of *Lentinus,* the *kulatkulat* (Plates 38 to 40), are only a few examples of the many species of well-flavored white-spored mushrooms. We cannot deny, however, the fact that within the same group are also found deadly poisonous mushrooms, many of which are species of *Amanita* (Plates 11 and 12; Plate 13, fig. 1).

Genus AMANITA Fries

Amanos, a Greek word, is the name of a mountain in Asia Minor where edible mushrooms are said to abound. *Amanita,* the name given by Gallen, a Roman physician, to the common edible mushroom, *Agaricus campestris,* is derived from this word.

The genus is characterized by the usual warted cap and white gills which are free or are just touching the stem. The spores are white. The stem is swollen at the base and provided with a ring at the center and a volva at the base. The members of this genus are soft, fleshy, terrestrial. Most of the species are poisonous. They are usually of rather large size and grow in noncoherent groups.

The pileus or cap is soft, and in the early stage is enveloped together with the stem by a veil. In the process of development the stem is separated from the cap or pileus, leaving the veil behind attached on the cap. This veil breaks off into many fine particles resembling warts. In its youth the species vary widely in shape, built usually spherical or egg-shaped, and sometimes bell-shaped or conical. Usually the scales are covered by a powdery colored cuticle which easily sticks to the fingers when it is touched. The species have various colors, from pure white to pale brown, yellow-orange, or bright red.

The gills are white or nearly so. In some of the species the gills are stained yellow. They are free from the stem, leaving a ringlike space around. In some cases the gills are very close to the stem. They are swollen in the middle, often broader toward the edge, sometimes uniform in width, except near the stem, ending almost abruptly toward the edge. The short gills alternate with the long ones.

The stem is generally soft, hollow and pithy. The texture of the stem is not identical with that of the cap, and is separated easily from the latter at the apex. It is cylindrical or tapering upward, generally enlarging at the base into a bulb, and seldom cylindrical throughout. The manner in which the volva attaches itself on the base varies with the species. The first group includes species having the volva resulting from the remains of the universal veil. This remnant of the veil is the true cup or sheath at the base. In the second group are the species having the volva formed only by the lower half of the universal veil and adhering closely around the bulb, or sometimes forming only circular rolls or scaly ring on the lower part of the stem. The third group includes those that have a very fragmentary cup, more or less cottony in appearance, easily crumbled, or warty. This volva is formed by the loose and frail texture of the universal veil. While the stem is pulled from the soil during the process of growth, the remnants of this universal veil disappear easily from the stem. Because the volva does not show itself as a very distinct permanent character among this group of *Amanita,* it is advisable to rely on characters other than the death cup in order to insure the right identification. The annulus is more or less permanent on the stem, sometimes located on the lower portion, as an inferior annulus, or on the upper part, as a superior annulus.

Amanita is often called the poisonous genus, since many of the species are known to be deadly poisonous. It is true that many poisonous species occur in many other genera, yet their poison is not as deadly as that of the species of *Amanita.* No doubt, there are some edible species of *Amanita* in the Philippines, but because many of them are dangerous, it is better to let them alone, except for scientific study.

The writer on his many collecting trips on mushrooms has not noted any *Amanita,* except in December, 1933, when a species of this genus was collected on Mount Maquiling near the School of Forestry, Los Baños. However, an unreported species was found in Manila on a cool rainy day in January. Dr. W. H. Brown, who made many collections of mushrooms in the region around Baguio, Mountain Province, has brought down, during May and June, a considerable quantity of fresh mushroom specimens. From these collections, two deadly species, *Amanita mus-*

caria and *A. pantherina,* were identified. We see, therefore, that *Amanita* grows in the Philippines, and that it grows at high altitudes where the climate is cool and other conditions are favorable for growth.

AMANITA MANILENSIS Mendoza and Leus-Palo. Poisonous. Plate 11.

The cup is about 3.5 centimeters broad, covered with sharp pointed warts which are denser and larger at the center, becoming sparse and finer outwards, oblong, convex when young, becoming broadly convex when expanded, gray at the center, becoming paler towards the margin, fleshy, thicker at the center. The margin at first is entire, later cracking with age. The gills are free, white, moderately numerous, broad near the margin, gradually narrowing toward the stem, long gills intermixed with short ones. The stem is stout, white, stuffed, well formed, tapering gradually toward the pileus from a round, somewhat bulbous base, about 5 millimeters in diameter on the upper end and about 9 millimeters at the base, 3.9 centimeters long. The ring is very prominent, persistent, white, located midway on the stem, showing the remainder of a veil. The volva is thin, pale brown, adnate, irregular at the margin, covering entirely the base of the stem.

Mostly deadly poisonous mushrooms, such as *A. phalloides, A. muscaria,* and many other species, belong to the genus *Amanita*.

AMANITA MUSCARIA Persoon. Deadly poisonous. Plate 12.

The cap varies in color from bright yellow to orange or orange-red; it is 10 to 18 centimeters in diameter, covered with colored powdery scales that are easily washed off; at first it is nearly half-round and later flat. When young and moist, it is quite sticky. The gills are white and free from the stem. The stem is 10 to 19 centimeters long, white, or tinged with yellow, often scaly, enlarged at the lower end into a ball. The ring is white and prominent, but soon tears off. The volva is usually much torn and surrounds the swollen end of the stem in the form of scales or rings.

This species is one of the most deadly of the genus *Amanita.* The suffering of the victim is sometimes very intense. As the poison is already assimilated in the blood by the time it is felt, it has, in some cases, been difficult to save the life of the victim.

This mushroom grows on the ground in woods at very high altitudes, like Baguio, Mountain Province.

AMANITA PHALLOIDES Fries. Deadly poisonous. Plate 13, fig. 1.

This species and its various forms are the most dangerous of all poisonous mushrooms. It is often called "deadly amanita" or "deadly agaric."

The cap is fleshy, thick, viscid, slimy when wet, sometimes smooth, orbicular to bell-shaped, convex when finally expanded, yellow, white, or greenish to nearly olive. Sometimes there is only a tinge of yellow at the center of the white cap. In some cases a large part of the cap may be yellow with a deeper shade at the center. It is 5 to 11 centimeters broad. The gills are white, free, sometimes joined by only a narrow white ring to the stem. The stem is very often scaly, thick, cylindrical, varying from stout to slender, stuffed by fibrils, then hollow, white, or tinged by the color of the cap, often much lighter in color, 5 to 15 centimeters long, 6 to 10 millimeters in diameter. The ring is superior, membranous, white, evanescent. The cup is white, often olive to greenish, sometimes yellowish outside, thick, membranous, usually more or less buried in the ground. The flesh is white, olive to greenish under the cuticle. It has an unpleasant odor when young, which becomes very strong and fœtid with age.

This mushroom is quite common in and around Baguio, Mountain Province. It can be found from late May to September.

Genus AMANITOPSIS Roze

This genus resembles *Amanita* in all characters, except in the absence of the ring on the stem. For instance, the movable ring (often only fragmentary) of some species of the genus *Amanita* resembles that of *Amanitopsis.* So far none of the species have been reported poisonous. Like *Amanita,* they are found in cool, damp, places in the mountains. The members of this genus are soft, white-spored, fleshy, long or slender-stemmed, growing on the ground singly or in small groups. The partial veil and annulus are absent. The stem at the base is inserted into a cuplike structure as in *Amanita.*

AMANITOPSIS FULVA (Schaeffer) Roze. Suspicious. Plate 13, fig. 2.

The cap is light brown; the disc is deeper-colored, bell-shaped, then flattened, with a small round elevation on top called "umbo," covered slightly with a few remains of the volva 3 to 8 centimeters in diameter, lined on the margin. The stem is much paler brown than the cap, beset with small scales and surrounded at the base by a free, yellowish membranous volva, 7 to 19 centimeters long, 0.8 to 1 centimeter in diameter. The gills are free, white, tinged with yellow. The flesh is white, yellow under the epidermis.

This mushroom is not found in the lowlands. It is quite common however, on high mountains, growing under trees.

In Europe and America this mushroom is considered edible. Its edibility in this country has never been determined. As many of its characters resemble those of the genus *Amanita*, it is but prudent to let it alone, except for purposes of study.

AMANITOPSIS VAGINATA Fries. Kabuteng daga (Tag.). Suspicious. Plate 15, fig. 1.

This rare mushroom grows mostly in very rich soil composed of well-decayed organic matter. It is always found in humid places in thick forests. It grows solitary or in groups of very few. It can be found from late August to the latter part of December or early January, when the weather is cool and moist. The edibility of this mushroom in the Philippines has not yet been tested. Its close resemblance to the species of *Amanita* should make one careful, however, in using it for food. At best, for the present, it should be collected only for purposes of study.

This mushroom is soft and fleshy. The cap is humid or wet, striated on the thin margin and rather smooth on top, at first olive-brown, egg-shaped, then convex to plane, and gray to grayish brown. The stem is slender, white, hollow, cartilaginous, 16 to 35 centimeters long, and 6 to 10 millimeters in diameter. The gills are white, sharp, free, easily separated from the stem. The ring is absent. The volva is white, persistent, cup-shaped, with more or less irregular margin.

The color and shape of this mushroom when still undeveloped resemble the rat, whence it gets its tagalog name, *kabuteng daga.*

Genus LEPIOTA Fries

The generic name *Lepiota* is derived from the Greek word *lepis* meaning "scale," due to the numerous scales that are borne on the cap of many species.

The members of this genus are all white-spored, except *L. chlorospora* Copel., which has greenish spores. The cap is scaly from the breaking off of the cuticle, seldom smooth, often white, but also yellow, brown, or reddish brown. The stem is fleshy, generally hollow, easily separated from the cap, and provided with a permanent or temporary ring. The gills are free or remote from the stem, generally white or whitish. The species grow mostly on grassy places, more often in fields than in woods. *Lepiota* is closely allied to *Amanita,* from which it differs in the absence of the volva.

LEPIOTA AMERICANA Peck. Kabuteng mamulamula (Tag.). Edible. Plate 14.

This mushroom came to the notice of the writer in February, 1933, when a sample batch was referred by a member of the staff of the College of Medicine, University of the Philippines, to the Bureau of Science for determination of its edibility, which was in doubt because of the close resemblance of this mushroom to *Lepiota chlorospora* Copel., called "payong ahas" in Tagalog, a poisonous species. The sample had been taken from mushrooms bought at Paco market, Manila. On tracing the source of the purchase, it was found that this mushroom had been collected in Pandacan, Manila, in a place which had been filled in with all kinds of refuse, generally mixed with discarded straw and manure taken from army stables. It seems that this mushroom is not well known, even in that vicinity, for only one family in that neighborhood collects it by the basket every morning, and sells it at Paco market.

To test the edibility of this mushroom a few specimens were bought at the market and cooked in the Bureau of Science laboratory. The mushroom was found delicious and a bit peppery. It was cooked in the laboratory from time to time, and several members of the division of botany ate it along with their other meals. In taste it is comparable to our most delicious mushrooms. This mushroom, because of its white spores, unlike *Volvaria esculenta* [*kabuteng ginikan* (Tag.)], and *Psalliota* species, such as *Psalliota (A.) perfuscus* [*kabuteng parang na may singsing* (Tag.)], and other species of this genus which also have colored spores, has the advantage of not turning the soup black or dark brown on being cooked. It keeps well in dried form, and when soaked in water before cooking, resumes its original form. No mushrooms of this kind have been seen during the numerous collection trips made by the writer. Possibly it was accidentally brought into the Philippines from abroad with animal feeds, such as hay, for the army horses. A portion of the material used for filling in the place where this mushroom was collected came as refuse from army stables.

This mushroom grows abundantly and appears from May to as late as February, depending on the length of the rainy season.

The cap is white, becoming dull brown on maturity; 5 to 14 centimeters in diameter, convex, with a central elevation when fully grown. When young, it is somewhat conical. The cuticle is at first reddish brown and continuous, but soon breaks into scales, except at the central elevation on the top. The scales are scattered and adhere closely to the surface. The margin of the cap is somewhat inrolled, divided into flaps. The gills are free, white, broad, from 7 to 9 millimeters wide. The stem is 6 to 12 millimeters in diameter above, 8 to 14 millimeters below, hollow, white, slender above the ring, becoming light brown in age. The ring is broad, very conspicuous, 2 to 2.5 centimeters from the cap. Collected in mass, the spores are white.

In appearance this mushroom is very similar to *Lepiota chlorospora,* which is poisonous. It differs however from the latter in that when bruised it turns pinkish to reddish brown, and the spores are white. The spores in mass are greenish.

The Tagalog name, *kabuteng mamulamula* [17] was given it because of the characteristic change in color.

LEPIOTA CANDIDA Copeland. Kabuteng puti (Tag.). Not tested. Plate 15, fig. 2.

The cap is fleshy, flat, with a strongly rounded elevation on top, dry, shining, white, covered with cottony scales, 6 to 8 cenmeters in diameter. The margin is thin, somewhat lined and finely cut into rounded projections. The flesh is white. The gills are free, very crowded, nearly ending in a sharp point at both ends. The stem is 12 to 16 centimeters long, 4 to 6 centimeters in diameter near the top, with a narrow axial hollow, much enlarged but not bulbous in the solid lower part, naked, shining, white. The ring is high up, dropping off at maturity. This mushroom is odorless, and of a mild taste.

This mushroom grows on the ground, singly, in sunny grass. It is found from June to September and is common in Manila. Its Tagalog name is derived from the color of the cap, which is white.

LEPIOTA CEPAESTIPES Fries. Kabuteng may singsing [18] (Tag.). Poisonous. Plate 16.

The specific name *cepaestipes* is derived from the Latin word *cepa,* meaning "onion," and *stipes,* "stem."

This harmless-looking but poisonous mushroom is found in rich soil that is mainly composed of decaying vegetable matter. It is very resistant to drought, appearing very early and lasting

[17] Turning red.

[18] Mushroom with a ring.

until very late in the season. It grows in groups of a few to very many, forming a large mat on the ground.

The cap is 2.5 to 9 centimeters in diameter, thin, soft, at first egg-shaped, then bell-shaped and later expanded, covered with minute, numerous brownish scales, elsewhere white; the margin is striated and splits early. The flesh is white. The gills are free, narrow, thin, close, and white. The stem is 5 to 11 centimeters long, 7 to 9 millimeters in diameter, tapering upward, smooth, of the same color as the cap. The ring is thin, membranous, white, permanent. The spores in mass are white. This mushroom has a mild odor and taste.

This mushroom is very variable in appearance. During the early and late parts of the season it is small, and the color of the cap and of the stem darkens to light brown.

LEPIOTA CHLOROSPORA Copeland (= L. MORGANI Peck). Payong ahas (Tag.); oong ti takki noañg (Ilk.); oong na tai dueg (Pang.). Poisonous. Plate 17.

This is one of the largest mushrooms. It is widely distributed, growing anywhere, from sandy places to well-manured ground. It is hardly ever found in the forest. *Lepiota chlorospora* appears early and late in the mushroom season, generally growing in groups of a few or many individuals, but sometimes singly. It is traditionally known among the country people as poisonous. By mistake it is often included in the collection basket with the edible kinds.

This mushroom is so beautiful and attractive that anybody who knows nothing about mushrooms is apt to collect it for the table. This fact accounts for the many cases of mushroom poisoning in the Philippines. The following incident shows how cases of poisoning often occur through carelessness.

Mr. Macario Ligaya, of the Bureau of Science, an experienced collector of zoölogical specimens, went out one day on a short collecting trip. He was accompanied by a laborer who carried the collecting apparatus, a gun, and a good quantity of firearm ammunition. While on their way, through many fields, the collectors noticed fine, well-flavored mushrooms, *Collybia albuminosa*.[19] They picked them, and at noon cooked them as part of their meal. After resting they again started to collect. The heavy load on his shoulder and on his side, plus the heavy meal he has just eaten, made the laborer lag very much behind on

[19] Tag.: *Kabuteng punso.*

the way. The delicious mushroom dish was still fresh in the man's mind, so the lure of another find made him alert and vigilant. Suddenly he stopped and looked around. He noticed in a spot some white objects. They were mushrooms. Hurriedly, he stooped down and began collecting. He collected a good many to take home.

In the evening they started homeward, and it was already rather late when they got home. He at once unloaded his mushrooms and began cleaning them to cook. He asked his wife to buy wine in order to stimulate the appetite for supper. Fortunately, she had already had her supper, and besides, she was not feeling well that night. The man had to eat alone, and finished all the mushrooms that he and his wife had cooked. It was a very good supper, for the mushroom dish was as delicious as that he had eaten at noon. After leaving the table he rested awhile on a chair and then went to bed. After about two hours or so, while in bed, he began to feel an acute stomach ache. Quietly he tried to endure the pain but at last he had to call his wife. She prepared at once some hot tea, believing that it was only an ordinary case of indigestion. Soon the husband began to have cold perspiration, and to suffer from vomiting and diarrhœa. The symptoms of his trouble were the same as those of cholera. The wife became worried. She went down and reported the case at once to the collector who had been with her husband the whole day. On being told about the distress of the laborer, Mr. Ligaya asked what her husband has taken for supper. She answered that she did not remember anything he ate that night except the mushrooms he brought home. The collector was very positive that the mushroom eaten by the laborer was the *payong ahas,* which is poisonous. The only thing to be done was to call a doctor to relieve the patient from the pain.

Hence it does not pay to collect mushrooms for the table unless one is sure of their edibility. It is said that some persons can eat *Lepiota chlorospora* with perfect safety. Others, however, are susceptible to the poison and may suffer much from it.

The cap of *Lepiota chlorospora* is from 9 to 30 centimeters in diameter, soft and fleshy. At first it is nearly globose, soon becoming expanded, seldom depressed in the middle. It is generally white, but covered by a brown cuticle which breaks up into scales except at the center. When bruised, its color changes to brownish and then to yellowish. The gills are broad, close together, entirely free, at first white, soon becoming green or greenish because of the mass of green spores adhering to them; when the gills get older they assume a yellowish color. The stem is white or nearly so, tinged with brown, smooth, firm, cylindrical, swollen at the base, sometimes tapering slightly upward, 7 to 9 centimeters long and 5 to 9 millimeters in diameter. The spores in mass are green, becoming yellowish green in age. The ring is about 1 centimeter broad, conspicuous, fixed, persistent, split in its own plane, white above until discolored by the spores.

LEPIOTA CRISTATA Fries. Kabuteng tigre [20] (Tag.). Suspicious. Plate 18, fig. 1.

This is a beautiful little mushroom that grows on the ground among grasses, frequently in gardens and lawns. It grows in groups of many or scattered. The color and the distribution of the scales on the cap resemble the stripes of the tiger, hence its Tagalog name.

The cap is fleshy, 2 to 4 centimeters in diameter, sometimes umbonate, silky, at length with nearly granular, dark-brown to rust-colored scales. The gills are crowded, white, free. The stem is hollow, thickened at the base, gradually tapering upward, pale, becoming reddish downward, with little fibrils, 2.5 to 4 centimeters long and 3 to 4 millimeters in diameter. The ring is somewhat membranous, sometimes appendaged, evanescent. The flesh is white. The odor is strong and nauseous.

This mushroom is suspected of being poisonous.

LEPIOTA GRACILENTA Krombholtz. Not tested. Plate 20, fig. 1.

The cap is nearly conical to bell-shaped, becoming umbonate when expanded, powdery, pale pinkish brown at the margin, brownish olive at the top, becoming very dark brown when bruised, 2.5 to 9 centimeters in diameter. The skin covering the cap cracks gradually into fine scales; the margin is entire, and wavy. The gills are crowded, free near the stem, white, becoming brownish when injured. The stem is cylindrical, sometimes compressed and channeled, scaly, of the same color as the cap, nearly hollow, bulbous at the base, 5 to 8 centimeters long, 6 to 11 millimeters in diameter. The ring is membranous, nearly persistent, of the same color as the stem. The flesh is white, with a pleasant odor and savory taste.

This mushroom grows on the ground under trees and is quite common in Manila. It can be found from May to September.

[20] Tiger mushroom.

In England it is considered edible. Its edibility in the Philippines has not yet been tested.

LEPIOTA HISPIDA Lasch. Not tested. Plate 20, fig. 2.

A beautiful mushroom growing on rotten logs in very cold places in the forests. It appears in groups, often united at the base, from May to December. The edibility of this mushroom has not yet been tested.

The cap is nearly convex, plain, umbonate, 2.5 to 4.5 centimeters in diameter, scaly, chestnut-brown to dark brown. The scales are blunt, stiff, soon becoming shaggy and especially dense at the center of the cap. The gills are white and free at the back towards the stem. The stem is cylindrical, more or less swollen at the base, of the same color as the cap, 4 to 8 centimeters long and 3 to 8 millimeters in diameter, scaly, but the scales are rare. The ring is broad, hairy, pale, rosy above and brown below. The hair is evanescent. The flesh is white, tasteless, with a typical mushroom odor. The spores in mass are white.

LEPIOTA LILACEA Bresadola. Kabuteng lila [21] (Tag.). Not tested. Plate 18, fig. 2.

Like *Lepiota cepaestipes,* this is a drought-resistant mushroom, found early in May or even late in February. It is cosmopolitan in habit, growing in very rich soil consisting of decayed vegetable matter, in the lowlands in the forests and in the very heart of the city under acacia trees. In appearance it resembles *L. cepaestipes,* but it is much smaller, and the cap is rough and striated and later the margin is torn. Also, *L. lilacea* grows singly or in groups of very few, while *L. cepaestipes* grows in tufts of many. Only by very careful study of the characters of the two fungi can the beginner distinguish one from the other. The varied color gives this mushroom an attractive appearance. Its edibility has not yet been tested. Its small size, however, makes it not very inviting to the collector of mushrooms for the table.

The cap is 2.5 to 3.5 centimeters in diameter, fleshy, convex-campanulate, plain to depressed, sometimes umbonate, at first of a purple-lilac color, then colorless and covered with dry, beautiful, dark scales. The gills are white, free, somewhat crowded, swollen, rounded toward the stem; the edge of the gills is thready. The stem is equal in diameter throughout, hollow, fibrous, white to flesh-lilac toward the top, becoming darker downward, 2.5 to

[21] Lilac mushroom.

4 centimeters long, 2 to 3 millimeters in diameter. The annulus is membranous, persistent, white above, dark violet below. This mushroom is odorless and tasteless.

The Tagalog name is derived from the color of the fungus.

LEPIOTA METULISPORA Berkeley and Bresadola. Not tested. Plate 19, fig. 1.

This mushroom is quite common in Manila during the rainy season, from June to September. It grows singly, on the ground under shade trees, generally under acacias. Its edibility in the Philippines has not yet been determined.

The cap is fleshy, top-shaped when young, becoming bell-shaped when expanded, covered with yellowish to very pale scales except at the center, 3 to 5.5 centimeters in diameter. The gills are white, somewhat crowded, round and free toward the stem. The stem is equal throughout, 4 to 9 centimeters long, 5 to 7 millimeters in diameter, hollow, and white, yellowish to very pale below the ring; the rest is pale. The ring is cottony, easily evanescent. The flesh is white. This fungus has a typical mushroom odor and a mild taste.

LEPIOTA sp. Kabuteng hugis payong [22] (Tag.). Not tested. Plate 19, fig. 2.

The cap when young is nearly round to egg-shaped, then bell-shaped, later expanded, 5 to 10 centimeters in diameter with a sharp angular elevation on top, covered with grayish brown to reddish-brown skin which later breaks up into shaggy scales except on the top where it remains intact. The stem is 7 to 12 centimeters long, and 4 to 7 millimeters in diameter, cylindrical, tapering upward, enlarged at the base, of the same color as the cap. When injured, it becomes pinkish to almost reddish, a characteristic found also in *Lepiota americana.* The ring is movable and membranous.

This mushroom grows singly, scattered, or in groups of very few, on the ground, often on sandy soil under acacia trees along the road. It is quite common in Manila, most abundant during the months of heavy rains, and can be found from May to October. Its edibility has not yet been tested.

LEPIOTA DENUNDATA Rabenhorst. Kabuteng kolor asufre [23] (Tag.). Poisonous. Plate 21.

The cap is globose to conical when young, becoming bell-shaped to broadly expanded, thin, fleshy, 4 to 7 centimeters in diameter, sulphur yellow throughout, sometimes the center is nearly orange-colored, covered with fine, cottony scales which disappear in age; the margin is deeply striated, especially in age. The

[22] Umbrellalike mushroom. [23] Sulphur-colored mushroom.

gills are free, thin, narrow, few, white, becoming yellowish because of the scales from the cap adhering to them. The stem is hollow, bulbous, elongated at the base, sulphur yellow, 7 to 10 centimeters long, 6 to 11 millimeters in diameter. The ring is thin, early evanescent. The flesh is yellow. The odor is mild and the taste insipid.

This mushroom can be found from May to December.

A batch of this mushroom was sent by the Bureau of Health to the Bureau of Science for examination. According to an investigation conducted by an officer of the Bureau of Health, it was the cause of poisoning of four persons in Pasay, in May, 1934; one of the victims, a child, died.

Genus ARMILLARIA Fries

The generic name *Armillaria,* derived from the Latin word *armilla,* meaning bracelet, is probably given this mushroom because of the prominence of the ring on the stem. This genus is distinguished from *Lepiota* by the fact that the gills are adhering or nearly decurrent, and the flesh of the cap and the stem is uniform in structure. It differs from the genus *Amanita* in the absence of the volva or death cup. There is but one species of this genus known and collected by the author. So far no species of this genus has been reported poisonous.

ARMILLARIA MELLEA Fries. Katuteng pulot pukiutan [24] (Tag.). Edible. Plate 22, fig. 1.

This mushroom is a very active parasite, growing in clusters of few to many on trunks and roots of living trees. It is also found saprophytic on prostrate dead trees. The characters of this mushroom are so variable that a beginner is apt to make a mistake in identification. This mushroom is not found in the lowlands, for it grows in the mountains, where the temperature is cool and the air moist. It is rather tough and not of good flavor. It may, however, be cut into pieces and mixed with other food in cooking.

The cap is 3 to 9 centimeters in diameter, becoming nearly flat, usually slightly umbonate, at first egg-shaped or convex, soon expanded, honey-colored to nearly white, sometimes yellowish or reddish brown; the central portion is sometimes covered with brown scales, the rest naked but lined, sometimes smooth. The flesh is white. The gills are either attached squarely to the stem or extended down the stem, at first white, then stained

[24] Honey-bee mushroom.

with brown or rust-colored spots. The stem is 3 to 14 centimeters long, smooth or nearly scaly, elastic, hollow, spongy, white, becoming darker toward the base. The ring is variable in character, thick and persistent or thin and membranous, sometimes nearly evanescent. The spores in mass are white.

This mushroom can be found from July to December.

Genus COLLYBIA Fries

The generic name *Collybia* is derived from the Greek word *kollubos,* meaning "coin," due to the form and size of the cap which is generally small and frequently regular in form.

The species of this genus are white-spored. The cap is slightly fleshy, the margin rolled inward in youth. The gills are soft, free, interlaced, or with a sudden curve before reaching the stem. The ring and the cup are absent. The stem is either cartilaginous or with a cartilaginous rind, the central portion is fibrous or fleshy, stuffed or tubular. These mushrooms grow on wood or on the ground, often deeply rooted, sometimes arising from the hardened mass of hyphæ. Many of the species are quite firm after drying and when moistened easily revive. So far none of the species has been reported poisonous. *Collybia* sp. and *Collybia albuminosa* are considered among the most delicious mushrooms in the Philippines.

COLLYBIA ACERVATA Fries. Edible. Plate 20, fig. 3.

This mushroom grows in dense groups. The cap is 3 to 6 centimeters in diameter, fleshy, sometimes umbonate, swelling in a rounded form to rarely plane, smooth, partially transparent, lined at the margin in age, pale yellow to pink, later becoming pale. The gills are free, very crowded, straight, pinkish, round toward the stem. The stem is 5 to 10 centimeters long, 3 to 10 millimeters in diameter, hollow, reddish and white at the base, more or less rooted, somewhat compact, often grooved and scaly. The flesh is of the same color as the stem, without odor or taste.

This plant is quite common in the forests, growing on prostrate decayed trunks. It can be found from June to October.

COLLYBIA ALBUMINOSA (Bresadola) Petch. Kabuteng punso or kabuteng pusñgo (Tag.); oong ti bunton (Ilk.); oong na poñgol [25] (Pang.); payungpayuñgan kulog [26] (Pamp.). Edible. Plate 23.

Some of the local names of this mushroom suggest its habit of growing on ant hills. Its apparently spontaneous growth leads many people to believe that thunder and lightning have

[25] Ant-hill mushroom.
[26] Mushroom of the thunder.

something to do with it. This fungus generally grows in groups of many and is often found enormously abundant in a single spot. The writer has seen in Baliuag, Bulacan, over one hundred individuals collected from a single ant hill, under a large bamboo tree. In forests, in thickets, and under wild bamboos, it is found in no less abundance. This mushroom is very large. It seems to develop better in cooler and higher, humid places. In the cool, hilly towns of Cavite Province it grows extremely large. It is cosmopolitan in habit, for it is found almost anywhere, but always associated with, or near, an ant hill. Even under houses this mushroom is found.

This is one of the most delicious mushrooms. It is more or less cartilaginous on the stem and slightly fibrous and soft on the cap. It is glutinous when wet, especially in cooking. In deliciousness it is comparable to *Volvaria esculenta* [*kabuteng ginikan* (Tag.)], altough not as mellow in taste. It has an earthy odor, and when cooked its flavor is similar to that of ginger. This mushroom can be dried and stored away for future use, without suffering any change in its eating qualities, and wetting or soaking in water makes it assume its original form. Unfortunately, due to its cartilaginous and fibrous character, this fungus does not make good material for the powdered product.

Collybia albuminosa is sold in larger quantities, and earlier in the season, in the Manila markets, than *Volvaria esculenta.*

The cap is 4 to 15 centimeters in diameter, tawny, becoming paler and easily broken at the margin, bell-shaped when young, plane when expanded. The stem is 5 to 19 centimeters long, 0.5 to 2 centimeters in diameter, of the same color as the cap, sometimes paler; tapering upward, cartilaginous, straight, rigid, stuffed, prolonged deeply into the ground like a tail. The gills are white, close, free, separated by a white fibrous ring from the stem. The flesh is white, fibrous, soft, elastic.

This mushroom can be found from May to December.

COLLYBIA sp. Mamarang [27] (Tag.); mannagado [28] (Ilk.). Edible. Plate 24.

This mushroom is considered the most delicious in the Philippines. It habitually grows in large numbers, often forming a matlike growth on the ground.

In shape it closely resembles *Collybia albuminosa.* It is, however, smaller and darker.

[27] From the word *parang*, meaning "plain." [28] Increasing in number.

The cap is 4 to 13 centimeters in diameter, dark to ashy, becoming pale toward the margin, covered with very fine ash-colored hair, conical when young, becoming campanulate when expanded, sharply umbonate. The margin breaks easily into lobes. The stem is white, 5 to 15 centimeters long, 4 to 8 millimeters in diameter, tapering upward, cartilaginous, straight, rigid, stuffed, rooted, forming a taillike or spindle-shaped root. The gills are white, close, free, separated from the stem by a fibrous white ring. The flesh is white, fibrous, but soft and elastic. The spores are white and not so abundant when collected on a piece of paper.

This mushroom can be found from early June to October.

COLLYBIA DISTORTA (Fries) Gillet. Kabuteng pilipit [29] (Tag.). Edible. Plate 22, fig. 2.

This common edible mushroom grows on the ground among the grasses and in places where there are many decaying leaves. It grows in tufts of several to many individuals. It can be found from June to September.

The cap is 5 to 10 centimeters in diameter, bell-shaped, then spreading, often irregular, smooth, brownish red, becoming pale in age. The gills are narrow, toothed like a saw, whitish, then spotted with brownish red, assuming a sudden curve before reaching the stem to which they are broadly attached. The stem is 8 to 12 centimeters long, irregular, densely covered with matted woolliness at the base, lined, very often twisted. The flesh is white, odorless, and tasteless.

COLLYBIA RADICATA Relhan. Kabuteng mahabang ugat [30] (Tag.). Edible. Plate 25, fig. 1.

A very common mushroom growing on the ground in woods, groves, or borders of woods. It is edible and can be found from May to December.

The cap is 3 to 7 centimeters in diameter, fleshy, thin, convex to nearly plane, with the margin upturned in old plants and sometimes umbonate, smooth, viscid when moist, often with wrinkles on the surface which extend radially, varying from nearly white in some small specimens to grayish, grayish brown, or amber. The gills are white, broad, rather distinct, just reaching the stem. The stem is of the same color as the cap, though paler, usually white above, 8 to 18 centimeters long, 3 to 6 millimeters in diameter, tapering gradually above, sometimes mealy.

[29] Mushroom with distorted stem. [30] Long-rooted mushroom.

The root is very long, tapering, often attached to some underground dead root.

This mushroom is easily recognized by the more or less flattened cap, and the long stem somewhat enlarged below and tapering off into a long slender rootlike process in the ground. It is from this rooting character that the plant gets its specific name *radicata*.

COLLYBIA VELUTIPES Fries. Edible. Plate 25, fig. 2.

This mushroom is edible. It grows on decaying stumps, logs, and roots, as well as on barks of living trees; it can be found from June to as late as November, depending on the length of the rainy season.

The cap is 2 to 6 centimeters in diameter, convex-expanded, slippery to the touch, smooth, brown, reddish yellow, usually darker at the central portion, yellowish along the margin. The gills just reaching the stem are broad, nearly distant to close, whitish or yellowish, with the edges finely fringed. The stem is 2 to 8 centimeters long, 3 to 7 millimeters in diameter, thick, firm, stuffed, then hollow, becoming velvety with short tawny or blackish-brown hair, yellow at the apex. The flesh is white or tinged reddish yellow, with a mild odor and an agreeable taste. The spores in mass are white. Ring and cup are absent.

Genus LACTARIUS Fries

The generic name is taken from the Latin word *lac*, meaning "milk."

The species of this genus are characterized by their habit of exuding white or colored milk when bruised. The milk is granular and of a resinous nature, and varies in taste from mild to very biting on the tongue. The cap is fleshy and regular. The gills are broadly attached or decurrent, somewhat rigid, with acute edges. Under the microscope the trama, that is, the loosely woven hyphal tissue forming the central substance of the gills or lamellæ, is vesciculose, as if composed of bladders. The stem is very rarely not at the center. The spores are white or yellowish, rarely pinkish in mass. The species of the genus grow on the ground.

In the Philippines the members of this genus are found in the mountains where it is cool and humid.

LACTARIUS VOLEMUS Fries. Kabuteng bundok[31] (Tag.). Not tested. Plate 26, fig. 1.

This mushroom is not found in the lowlands. It is, however, abundant in the mountains, where it is moist and cool. It is

[31] Mushroom in the forest.

found in great numbers on the steep banks on both sides of the road going to Atimonan, in the Quezon National Forest Park, Tayabas. This plant seems to be well adapted to sticky soil. It is one of the most beautiful mushrooms found in the Philippines, because of its form and its variegated color. It can be found from June to November, depending on the length of the rainy season.

The cap is more or less funnel-shaped, with an irregular margin, brownish orange, or much deeper brownish red, sometimes very much lighter, with the surface smooth, but velvety and often decorated with cracks. When bruised, the cap exudes milky fluid. The fluid is sticky, white, and mild in taste. The flesh is white, becoming brownish when bruised. The gills are either distant or somewhat crowded, free, white, becoming dark when bruised. The stem is 2 to 6 centimeters long, and about 1 centimeter in diameter, stuffed, of the same color as the cap. The surface of the stem is covered with fine powder except at the base. It has the same color as the gills.

The edibility of this mushroom has not yet been tested.

Genus RUSSULA Fries

The generic name *Russula* is derived from the Latin word *russulus,* which means "reddish." The caps of many of the species are reddish to bright red.

This genus is closely allied to *Lactarius,* except that *Russula* does not exude milk. The cap is fleshy and regular, then depressed. The gills are fragile, rigid, attached more or less squarely to the stem; the edge of the gills is acute, the trama composed of cells shaped like gall bladders. The stem is fleshy, central. The spores in mass are white or yellow, rarely greenish.

The species of this genus in the Philippines are found in the forests, where the temperature is cool and the air humid.

RUSSULA SANGUINEA Bulliard. Kabuteng kulay dugo [32] (Tag.). Suspicious. Plate 27, fig. 2.

Like *Lactarius,* this mushroom grows in damp, cool places in the mountains. It is found from June to as late as November or December. The blood-red color of this beautiful plant is very attractive in the forest.

The cap is moist, fleshy, firm, obtuse, then depressed and funnel-shaped, blood-red, becoming pale around the spreading

[32] Blood-red mushroom.

acute margin. The gills are white, then cream-colored, decurrent, rarely forked. The stem is reddish, sometimes white. At first it is contracted at the apex, then equal, firm, wrinkled, sometimes channeled. The flesh is white, reddish under the cuticle.

This mushroom has a bitter taste and its edibility is doubtful.

Genus TRICHOLOMA Fries

The generic name *Tricholoma,* derived from the Greek word *thrix,* meaning "hair," and *loma,* "fiber," is due to the characteristic of certain species of this genus of having hairs or filaments on the margin of the cap.

The species of this genus are white. The cap is sticky or dry. The stem is continuous with the cap, spongy, fleshy to fibrous. The ring and volva are absent. The partial veil, if present, is slightly fibrous or cottony. The gills are notched near the stem.

Many of the species of this genus are eaten in the Philippines, although they are not of good flavor. Many members of this genus are extraordinarily large.

TRICHOLOMA sp. Kabuteng higante [33] (Tag.). Edible. Plate 28, fig. 1.

This is an extraordinarily large mushroom. It is a rare plant, found from July to September, depending on the length of the rainy season. It grows on the ground, often under large acacia trees.

The cap is large, up to 27 centimeters in diameter, convex, expanded, white, becoming yellow to dark yellow, nearly brown toward the center, sometimes with more or less upturned and wavy margin. The gills are crowded, white, notched near the stem, or nearly free but close to the stem. The stem is up to 50 centimeters long, 3 to 5 centimeters in diameter, of the same color as the cap, solid, fibery, smooth and tapering toward the base. The base is somewhat swollen. The spores in mass are white.

This mushroom is edible. One plant is enough to provide a meal for a small family.

TRICHOLOMA PANÆOLUM Fries. Kabuteng madaling magbago ñg ayus [34] (Tag.). Edible. Plate 28, fig. 2.

This mushroom commonly grows on the ground, under acacia trees along the sides of the road. It is abundant in Manila, especially during the months of heavy rains. It can be found

[33] Giant mushroom. [34] Mushroom of easily changing form.

from May to December, growing in tufts, sometimes solitary, but generally in groups of many.

The cap is 5 to 10 centimeters in diameter, fleshy, conical to expanded, swollen, generally wavy or here and there depressed, gray, becoming paler and somewhat silky and spotted; the margin is thin, rolled inward, and mealy. The stem is 3 to 7 centimeters long, 0.8 to 2 centimeters in diameter, at the center of the cap, sometimes asymmetrical, whitish gray, fragile, equal or gradually thinner at the base, nearly lined, provided with small fibers. The gills are 4 millimeters broad, white, then gray, very crowded and plain, with a sudden curve as if scooped out at the point of attachment to the stem, sometimes rounded, then decurrent. The flesh is grayish, becoming whitish, with a horn-colored lining at the base of the gills. The spores are whitish or of a pale dingy color in mass.

This mushroom is edible.

Genus PLEUROTUS Fries

The generic name *Pleurotus* is derived from the Greek word *pleuron* meaning "side," and *ous*, an "ear." The name suggests the shape of the mushroom, which is like the outside of an ear.

The cap is generally white among the large species, ashy greenish, yellowish, or reddish white in those of medium size; smaller forms are white-gray or blackish. The stem is lateral, eccentric or entirely wanting, except in larger-stemmed species, which are very few, where the stem is occasionally almost central.

The gills are either not easily detached, narrowly attached, or decurrent. The veil is absent. All species are known to be edible and of pleasant flavor, when properly prepared. Many of the species of this genus emanate light at night like the ordinary firefly, hence the Ilocano name *anandap* and the Tagalog *alitaptap*, the common names for the firefly.

The members of this genus grow in clusters, or aggregates of individuals, constituting attractive complex brackets or combs. They grow on decaying trunks and fallen logs of many trees. No species of this genus are suspected of being poisonous. The type of this genus is *Pleurotus ostreatus*.

PLEUROTUS CANUS Quelet. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 29.

A very common mushroom growing abundantly on rotten trunks of banana. It is very small, but conspicuous, because of its habit of growing in large numbers and its white color. It can be found from May to October.

The cap is 2 to 4 centimeters in diameter, thin, membranous, shelflike, kidney-shaped, the margin often divided in rounded forms, white, gray, striated or lined. The gills are distant, swollen, white, fringed at the edge, touching broadly at the stem. The stem is white, 3 to 6 millimeters long, 1 to 2 millimeters in diameter, curved, solid. The flesh is white, odorless and tasteless.

PLEUROTUS CORNUCOPIÆ (Persoon) Boudier. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 30, fig. 1.

The cap is 6 to 12 centimeters in diameter, fleshy, regular to eccentric, convex, funnel-shaped, dark gray, or yellow, grayish yellow, becoming white. The gills are white, then dirty yellow, crowded, broad, decurrent, sometimes so much so that the stem looks somewhat grooved. The stem is solid, white, finally of the same color as the cap; the base is white, more or less hairy, 1 to 4 centimeters long, 2 to 5 millimeters in diameter. The flesh is white, savory, of somewhat mealy odor.

This plant grows in mushroom beds composed of waste abacá fiber.

PLEUROTUS LIMPIDUS Fries. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 30, fig. 2.

A common mushroom growing in bunches on old trunks of the pandan and the coco palm. At night it gives off a phosphorescent light which resembles that of the firefly.

The plant is glassy white, shining white when dry. The cap is powdery, 2 to 3 centimeters in diameter, inversely egg-shaped, horizontal, narrowed behind into a stemlike base; the margin is sharply turned inward, very thin. The gills are decurrent, crowded, thin, and linear. The flesh is white, with a pleasant odor and an agreeable taste.

PLEUROTUS OPUNTIÆ de Durian and Léveille. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 31, fig. 1.

A beautiful white mushroom, growing on fallen trunks of trees in thick forests. It grows abundantly, appearing like a white cottony mat that covers a large surface of the trunk. On the under side where the gills are located, the stems of many individuals are attached to each other in an overlapping position with a common center.

The cap is 4 to 10 centimeters in diameter, fleshy, glowing white, sharply lobed, becoming torn when old. The stem is short. The gills are snow white, close, decurrent. The flesh is white, tender, with a mild taste, and an odor of disintegrated wood.

This mushroom is edible, and can be found from June to October. It emanates a phosphorescent light in the dark.

PLEUROTUS OSTREATUS Fries. Malaking alitaptap (Tag.); dakkel ñga anandap[35] (Ilk.). Edible. Plate 30, fig. 3.

The specific name *ostreatus* is Latin, meaning "oyster." The Americans call this species "oyster mushroom," due to its oyster-like form.

This mushroom grows on stumps and prostrate trunks, including living trees. It appears in crowded clusters, often with caps that overlap each other. Sometimes the stem is so short that it appears absent; at other times it is very prominent. This is a delicious mushroom, not hard to identify even for the beginner. The young plants only should be used in cooking. After thorough cleaning and washing, they are torn into pieces, dipped in beaten egg, and fried in hot lard.

The cap is 5 to 14 centimeters in diameter, varying from white to gray or brown, fleshy, soft, thick at the center where the stem is attached, becoming thin toward the margin; the surface is moist or dry, smooth, sometimes more or less torn into scale-like appendages. The gills are broad, white, not crowded, narrowed out into veinlike branching lines connecting with each other, decurrent. The stem, when present, is short, firm, white, often thickened upwards, sometimes hairy. The ring and the cap are absent. The spore print on black paper is white to lilac.

PLEUROTUS PORRIGENS Persoon. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 31, fig. 2.

This is a wood-inhabiting fungus, growing on prostrate trunks of trees, especially the bagtikan. At night this beautiful mushroom emanates phosphorescent light. It is edible.

The cap is 2 to 6 centimeters in diameter, fleshy, glowing white, smooth, turning upward and bending back, without stem or stalk. The gills are white, sparse, decurrent. The flesh is white, odorless, with a mild mushroom taste.

This mushroom is found from June to September, depending on the duration of the rainy season.

[35] Large firefly mushroom.

PLEUROTUS PULMONARIS Fries. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 31, fig. 3.

This is also a wood-inhabiting mushroom, being very common in humid forests, where it grows in tufts. This species of *Pleurotus* gives out beautiful light at night.

The cap is 3 to 5 centimeters in diameter, fleshy, lateral, inversely egg-shaped, gray to grayish yellow. The gills are crowded, white, then nearly of the same color as the cap, decurrent. The stem is very short, sometimes lacking, white, provided with a few hairs at the base. The flesh is white and soft, with a pleasant odor and an acid taste.

This mushroom is edible, and is generally found from June to September.

PLEUROTUS ULMARIUS Fries. Alitaptap (Tag.); anandap (Ilk.). Edible. Plate 27, fig. 1.

This mushroom grows in the woods, solitary or in tufts, on decayed wood of bagtikan, often from a crack or wound of a living tree. It can be found from May to December.

The cap is compact, firm, convex, then expanded, moist, smooth or somewhat hairy, white or whitish, becoming dull leather-colored and cracked in age. The gills are broad, with a sudden curve before reaching the stem or just reaching the stem, becoming rounded behind, close to nearly distant, white or whitish. The stem is 3 to 5 centimeters long, 5 to 12 millimeters in diameter, variable, eccentric, sometimes central, stout, solid, firm, whitish, smooth or slightly hairy, straight or curved. The odor and taste are pleasant.

Genus CLITOCYBE Fries

The generic name is derived from the Greek word *clitos*, meaning "sloping," and *cybe*, "head," and refers to the shape and the position of the gills which are decurrent.

The cap is usually fleshy, plane, depressed, or funnel-shaped, rolled inward at the margin. The gills are generally decurrent, sometimes broadly attached to the stem. The stem is fibrous, elastic, spongy, stuffed, sometimes hollow, never cartilaginous. The cup and ring are absent. The spores in mass are white.

CLITOCYBE LUSCINA Fries. Plate 32, fig. 1.

A common mushroom growing on the ground and in groups, generally under bamboo trees. Its edibility in the Philippines has not yet been determined, but in Europe it is considered safe to eat. It can be found from June to September.

The cap is 2 to 3½ centimeters in diameter, fleshy, somewhat sticky when wet, convex, sometimes depressed at the center, dark, turning pale, nearly brown, becoming ashen, hairy at first, then smooth. The gills are fine, crowded, pale, broadly attached or nearly decurrent. The stem is 3 to 5 centimeters long, 4 to 5 millimeters in diameter, somewhat equal to nearly tapering toward the base, more or less fibrous, white, becoming darker at the base, slightly powdery, later smooth. The flesh is white, with a pleasant odor and a mild taste.

CLITOCYBE MULTICEPS Peck. Edible. Plate 33, fig. 1.

This mushroom grows on the ground, usually in grassy places and sometimes under bamboo trees, in clusters of from ten to as many as thirty or more individuals. It is common, often abundant, and may be found from May to October.

The cap is 3 to 5 centimeters or more in diameter, convex or sometimes nearly flat, often irregular from mutual pressure, white, gray, or brownish gray, smooth, dry, fleshy; the flesh is not very thick at the center, and very fine; the surface is smooth or sometimes slightly silky toward the center, moist in wet weather. The flesh is white, with an oily taste which is somewhat disagreeable. The gills are whitish, close together, narrow at each end, and attached to the stem either squarely or slightly extending down the stem. The stem is 8 to 20 centimeters long, 0.8 to 3 centimeters in diameter, cylindrical, firm but more or less elastic, smooth on the outside but sometimes covered with a cottony substance. Ring and cup are absent. The spores in mass are white.

This mushroom is edible.

CLITOCYBE PHYLLOPHYLLA Fries. Kabuteng embudo[36] (Tag.). Not tested. Plate 32, fig. 2.

A very common mushroom that grows on the ground, often in large numbers. It is very soft and easily decays. The plant can be seen from June to November.

The cap is fleshy, 2.5 to 6 centimeters in diameter. The gills are decurrent. The stem is 2.5 to 3.5 centimeters in diameter, spongy to fibrous, stuffed, then somewhat hollow and cream-colored. The apex of the stem is somewhat covered with whitish silk, while the base is hairy to nearly woolly. The flesh is white and tasteless. The odor, if present, is somewhat nauseous.

This mushroom is not known to be edible.

[36] Funnel-shaped mushroom.

Genus SCHIZOPHYLLUM Fries

The generic name is derived from the Greek word *schizo*, meaning "to split," and *philo*, "leaf." The name is appropriately given because of the shape of the fungus, which is that of a leaf, and the gills are split.

This is a very interesting genus, consisting of only a few species, of which only one is known in the Philippines. The members of this genus are flexible and fresh, but tough when dry. The spores are white. The gills are split along the edge and generally strongly rolled back. The cap is thin and leathery. The stem is lateral or absent.

SCHIZOPHYLLUM ALNEUM Linnæus (= SCHIZOPHYLLUM COMMUNE Schroet). Cudet (Ilk.); kuñas or sigdot (Tag.). Edible. Plate 33, fig. 2.

A very common mushroom in the Philippines, growing on woods and bamboos. It is found all year round, although most abundantly during the rainy season. The name *Schizophyllum alneum* has priority over *S. commune*.

The cap is 1 to 3 centimeters in diameter, white, hairy or woolly, or with coarse, white hair, often much lobed at the margin, toward the stem commonly forming a stemlike base. The gills are white, woolly, branching out toward the margin of the cap like the radiation of a fan, deeply split along the edge and strongly rolled backward.

During dry weather this mushroom is much shrunken and curled up, but in rainy weather it expands quickly and looks very beautiful. The spores leave a print that is whitish to pinkish white.

In the Philippines especially the Ilocanos eat this mushroom. It is prepared like the species of *Auricularia*, by soaking in water before cooking. It is rather tough but makes excellent soup.

Genus OMPHALIA (Persoon) Fries

The members of this genus have fleshy or somewhat thin and pliable caps. The stem is central, cartilaginous. The gills are decurrent. The spores in mass are white, rarely yellowish. The plants are mostly small and grow usually on twigs and woods. Few are of sufficient size to be collected for eating; none are, however, known to be poisonous.

OMPHALIA RECLINIS Fries. Not tested. Plate 26, fig. 2.

The cap is 1 to 3.5 centimeters in diameter, membranous, convex, nearly funnel-shaped; the margin is lined or grooved, dark to ash-colored. The stem is short, 1 to 2.5 centimeters long, 2 to 4 millimeters in diameter, tough, cartilaginous, dark, becoming pale to nearly of the same color as the cap. Ring and volva are absent. The gills are narrow, pale to nearly the same color as the cap, decurrent, crowded in young plants but becoming more distant as the cap expands. The spores in mass are white.

This mushroom is quite abundant in the forests during rainy season, growing on decayed wood and old bamboos. It is somewhat tough to leathery. It has a mushroom odor and an agreeable taste.

Genus MARASMIUS Fries

The generic name is derived from the Greek word *maraino*, meaning "to wither" or "shrivel;" a character of this genus is to dry or shrivel instead of decay.

This genus resembles *Collybia*. It differs from it, however, in that it shrivels in dry weather and expands again when moistened. The mealy odor that is common in the genus *Collybia* is absent from this genus. The garlic or onion smell, however, is present in *Marasmius* and absent in *Collybia*. The cap is dry, flexible, somewhat thin. The gills are simple, pliable, nearly distant, with acute, entire edges. The stem is cartilaginous or horny. The species are usually small, thin and epiphytic. Those that appear to grow on the ground are generally rooting on decaying leaves or roots of grasses.

MARASMIUS HÆMATOCEPHALUS Montagne. Kabuteng mukang balat [37] (Tag.). Edible. Plate 34, fig. 1.

This mushroom is common on rotten logs and old bamboos. It grows in large numbers, but never united. It is edible. The plant can be found during the rainy season, from May to November.

The cap is 1 to 2 centimeters in diameter, membranous, conical, convex, folded into plates, blood-red, turning pale yellow to somewhat tawny or brown, later becoming reddish; the margin has more or less rounded projections. The gills are pale, few, strongly distant, broadly attached to the stem at the back. The stem is 3 to 5 centimeters long, 1 to 3 millimeters in diameter, cartilaginous, hollow, smooth, brown, round, and enlarged at the base. The flesh is of the same color as the gills, odorless, and tasteless.

[37] Leather-colored mushroom.

MARASMIUS PILOPUS Kalchbrenner. Plate 34, fig. 2.

A very common mushroom growing on wood and old bamboos in the forests. It is rather small to be collected for the table. It shrivels in dry weather and revives with moisture. It has an odor similar to that of garlic or onion. It can be found all year round, but is most abundant from May to November or December.

The cap is 0.8 to 2.5 centimeters in diameter, leathery, membranous, somewhat convex, blunt or plane to depressed at the center, radially striated or channeled, brownish, turning pale. The gills are broadly attached to the stem, moderately crowded; edge entire. The stem is 2.5 to 5 centimeters long, 1.5 to 4 millimeters in diameter, curved, stuffed to hollow, covered with fine hair, bulbous at the base, tawny to pale yellow.

Genus CANTHARELLUS Fries

The name *Cantharellus* is derived from the Greek word *kantharos,* meaning "vase" or "cup," which the mature cap of this mushroom resembles.

The cap is fleshy or membranous, regular, not at the center, sometimes lacking. The gills are generally forked in pairs once or several times, tough, sometimes irregular, usually narrow, in many species resembling veins, folds, or wrinkles, although in some species they are either thin or broad. The spores in mass are white or yellowish-tinged.

The species generally grow on the ground and sometimes on wood. There are few species in the Philippines.

CANTHARELLUS AUREUS Berkeley and Curtis. Kabuteng damuhan.[38] (Tag.). Edibility not tested. Plate 35, fig. 1.

This mushroom commonly grows on the ground, often on the lawn, in groups and united at the base, from June to October.

The cap is 3 to 6 centimeters in diameter, depressed at the center to funnel-shaped, yellowish to watery brown, light wood brown when dry; the margin is wavy or with rounded division. The stem is thin, 0.5 to 2 centimeters long, 0.5 to 1.2 centimeters in diameter, of the same color as the cap, hollow, compressed. The gills are decurrent, narrow, blunt, irregularly forked, ridgelike, distant, of the same color as the cap. The spores in mass are white to yellowish. This mushroom is odorless and tasteless.

The edibility of this mushroom has not yet been tested.

[38] Mushroom in the grass.

Genus PANUS Fries

The generic name *Panus* was taken from the Latin where it connotes "tumor." Pliny used the name for a fungus inhabiting a tree, as do the members of this genus.

The species of this genus are white-spored, fleshy, leathery, and tough. After drying, they revive when soaked in water. The texture is fibrous. The flesh varies from tough to somewhat fleshy in some species. The cap is usually covered with hair or a few scales. The gills have entire edges. The stem is eccentric, lateral, or lacking.

Panus is closely allied to *Lentinus*, differing principally in the gills which are somewhat soft at first and are not provided with teeth on the edge.

PANUS RUDIS Fries. Kulatkulat na morado [39] (Tag.). Plate 36, fig. 1.

This mushroom is common in woods, especially in areas where stumps abound. It grows on stumps and prostrate trunks of trees. It is edible but rather tough and hairy. The plant is odorless and at times somewhat bitter.

The cap is 2 to 7 centimeters in diameter, irregular, depressed at the center or nearly vase-shaped; the margin is lobed and broken in age. The stem is eccentric or somewhat lateral, tough, hairy, pale tan, or pinkish to reddish brown.

This mushroom can be found from May to September.

Genus LENTINUS Fries

The members of this genus are abundant in the Philippines, and almost every one of the species grows on wood. Many are edible. The flesh, however, is rather tough in most cases. The very young tender plants should be used for cooking. Many of them are wood-rotting fungi.

The cap is fleshy, leathery, flexible, or hard and persistent. The stem is soft to hard, central, eccentric or lateral. The ring is present in some species. The gills are decurrent, not easily detached, thin or membranous, and sometimes rather tough; the edge is acute, usually serrate or irregular.

The members of this genus generally grow in tufts of many, although some are found solitary.

This genus is almost identical with *Panus*, except that the gills are plane. It is distinguished from *Pleurotus* by the hard flesh and the wavy gills.

[39] Lilac-colored mushroom.

LENTINUS AURACARIÆ Hariot and Patouillard. Kulatkulat bundok (Tag.). Edible. Plate 35, fig. 2.

A common mushroom in the forests, growing on old wood, especially on stumps, from May to December. Its favorite host is the bagtikan. The young and tender plants are edible; later in age they are too tough. Cooked in soup, this mushroom is delicious. Many species of *Lentinus* are found in the Philippines, and none of them are known as poisonous. This mushroom grows in groups, each group containing several mushrooms. Sometimes a few of them are united at the base of the stem.

The cap is 8 to 12 centimeters in diameter, leathery, membranaceous, tawny to pale, depressed at the center; the margin is entire when young, torn in age. The gills are numerous, crowded, squarely attached to the stem or nearly decurrent; the edge is entire. The stem is 3 to 4.2 centimeters long, 0.8 to 1.2 centimeters in diameter, stout, solid, hard outside. The spores in mass are white.

LENTINUS ELMERIANUS Lloyd. Kulatkulat bundok (Tag.). Edible. Plate 37, fig. 1.

This mushroom grows on putrescent wood, frequently on bagtikan. It is edible when young and tender. When old, it is tough and leathery and lacks flavor. This fungus is common in the mountains and can be found from May to November.

The cap is 6 to 10 centimeters in diameter, fleshy, later leathery, tough, rigid, funnel-shaped, regular and even, becoming torn in age, yellow to pale, covered with small appressed scales. The gills are fine, numerous, close, decurrent. The stem is 2 to 4 centimeters long, 3 to 6 millimeters in diameter, brown to dark brown, stuffed to hollow, hardened on the surface. The ring is absent. The spores in mass are white.

LENTINUS EXILIS Klotzsch. Kulatkulat kauayan (Tag.). Edible. Plate 38.

This mushroom has the best eating qualities of all the species of the genus *Lentinus*. Cooked in soup, it is more delicious than many other edible mushrooms in the Philippines. The flesh, however, is rather tough, so that only the young and tender plants are recommended for cooking. Because of its toughness and its place of abode, the Tagalog name of this plant was taken from the word *makunat,* meaning "tough," and *kauayan,* which means "bamboo." This mushroom is very common and popular everywhere. It is sold in the market in large quantities, and at a lower price than *Collybia albuminosa* or *Volvaria esculenta.* It grows on wood, but more generally on burned stumps and roots of bamboos, in groups, with the stems often united at the base.

A large mushroom. The cap is rigid, funnel-shaped, regular, even at the margin but broken in age, pallid, white to pale brown at maturity. The stem is pale brown to brown, 5 to 9 centimeters long, 0.8 to 2 centimeters in diameter, solid but pithy inside, somewhat hard outside. The gills are somewhat crowded, very decurrent, nearly equal in length, of the same color as the cap.

This mushroom can be found from May to December.

LENTINUS FUSCO-PURPUREUS Kalchbrenner. Kulatkulat na may balahibo[40] (Tag.). Plate 39, fig. 1.

This mushroom grows on rotten logs and stumps. It is common in the forest but very rare in the lowlands. It can be found from May to November.

The cap is 4 to 6 centimeters in diameter, hairy, leathery, convex, purple-brown, darkish brown, then all dark brown, sunken in the center, becoming funnel-shaped. The gills are fine and crowded, lighter in color than the cap. The stem is 5 to 8 centimeters long and 5 to 9 millimeters in diameter, hairy.

This mushroom smells like rotten wood, is tasteless, and too tough to be edible.

LENTINUS INFUNDIBULIFORMIS Berkeley. Kulatkulat bundok (Tag.). Plate 36, fig. 2.

A very large mushroom growing on putrescent wood, especially on bagtikan, frequently in moist places in the forests. It is found almost the year round, but is more common from May to December. It is hairy and rather tough. The specific name *infundibuliformis,* meaning funnel-shaped, refers to the form of the mushroom itself.

The cap is 7 to 15 centimeters in diameter, papery, rigid, regular and even when young, becoming wavy and irregular in age, pallid tawny, covered with dark hair on the surface. The gills are crowded, very fine, nearly equal, pale, decurrent. The stem is a continuation of the cap downward, dark tawny, covered with dark hair, 8 to 17 centimeters long, 0.8 to 1 centimeter in diameter, becoming curved on the lower portion.

LENTINUS PRÆRIGIDUS Berkeley. Kulatkulat bundok[41] (Tag.). Edible. Plate 40, fig. 1.

A common mushroom, found in the forest from May to September. It grows on rotten logs in groups of several to many. The plant is edible but tough.

The cap is 5 to 12 centimeters in diameter, powdery to hairy, tough, funnel-shaped, pale cream, darkening towards the stalk.

[40] Tough, hairy mushroom.

[41] Mushroom in the woods.

The stem is 1.5 to 4 centimeters long, and 6 to 9 millimeters in diameter, rather short, rust-colored, darkening toward the base. The gills are bright rust-colored, deep, decurrent, and somewhat far apart.

LENTINUS RAMOSII Lloyd. Kulatkulat bundok (Tag.). Edible. Plate 37, fig. 2.

A wood-rotting mushroom, attacking dead and living trees and very common in the forests. Its favorite host is the bagtikan. This mushroom has the habit of growing in groups, often united at the base. It is attached to the host with well-developed roots. This fungus is edible, and can be found from May to October.

The cap is often torn, membranous, thin, pliable, smooth, pale to cream-colored, 2.5 to 8 centimeters in diameter. The gills are fine, numerous, crowded, thin, decurrent, with even edges. The stem is a continuation of the cap, smooth, stuffed, hard on the surface, often eccentric, 3 to 7 centimeters long, 4 to 7 centimeters in diameter, of the same color as the cap.

LENTINUS SAJOR-CAJU Fries. Kulatkulat na may singsing[42] (Tag.). Edible. Plate 40, fig. 2.

A common mushroom that grows on dead wood and roots of dead trees. It is a wood-rotting fungus found both in the lowlands and in the forests. It grows in groups of many, often united at the base of the stem. It is edible and tender when young, becoming tough in age. It is a very early mushroom, appearing from the middle of April to December.

The cap is smooth, somewhat soft to leathery, sunken at the center, then funnel-shaped, at first white, then grayish yellow, brownish, and finally tawny-brown, 4 to 10 centimeters in diameter. The gills are white, decurrent. The stem is uniform in width, smooth, of the same color as the cap, 2 to 5.5 centimeters long, 4 to 6 millimeters in diameter. The ring is present, but movable. The flesh is white, odorless, and tasteless.

LENTINUS SQUARROSULUS Berkeley and Curtis. Kulatkulat na may kaliskis[43] (Tag). Edible. Plate 39, fig. 2.

This mushroom is found in tufts. It grows on prostrate trunks and rotten boards. It is edible, but a little tough. It can be found from May to December. It is more common in the forests than in the lowlands.

[42] Tough mushroom with a ring. [43] Tough scaly mushroom.

The cap is membranous, leathery, slender, funnel-shaped, white, becoming light brown in age, covered with few, acute, curved scales that make the surface a little rough, 3 to 6 centimeters in diameter. The stem is slender, solid, woody, from 2 to 3.5 centimeters long. The gills are very slender, crowded, two-forked, decurrent, of the same color as the cap. The flesh is white, without odor or taste.

THE PINK-SPORED AGARICS

The spores of this group in mass are rosy pink, salmon-colored, or reddish. Many species of this genus are edible. *Volvaria esculenta* (Tag. *kabuteng ginikan*), which belongs to this group, is considered one of the most delicious mushrooms in the Philippines.

Genus VOLVARIA Fries

The generic name *Volvaria* is taken from the Latin word *volva*, meaning "wrapper." The members of this genus when young are surrounded by a sheathlike envelope that eventually becomes the cup or the volva in the mature plant.

The genus is characterized by the rosy or reddish spores, the presence of the volva and the absence of the annulus. The stem is easily separable from the cap at the junction; in this respect it is similar to *Amanita*, *Amanitopsis*, and *Lepiota*. The gills are usually also free from the stem. The species grow on many rotten plants, such as banana, abacá, rice straw, and wood, on richly manured ground and on leaf moulds. The species are soft in texture and decay easily.

VOLVARIA CINERESCENS Bresadola. Kabuteng bulok na kahoy [44] (Tag.). Not tested. Plate 41, fig. 1.

This beautiful little mushroom grows from June to December, on well-rotten wood in moist places. It is found single, but sometimes in groups of several.

The cap is 2 to 3.5 centimeters in diameter, fleshy, slender or bell-shaped in youth, becoming convex at maturity; the margin is lined or grooved. The gills are free, crowded, swollen, rounded at the back, dilutely flesh-colored. The stem is 4 to 5 centimeters long, 3 to 6 centimeters in diameter, white, solid, stuffed and cylindrical, slightly swollen at the base, gradually

[44] Mushroom on rotten wood.

narrowing upward. The volva is membranous, loose, with irregular margin, white inside, ash-colored outside. The spores in mass are flesh-colored, becoming tawny. The flesh is white and odorless.

VOLVARIA ESCULENTA Bresadola. Kabuteng ginikan or kabuteng saging (Tag.); oong ti garami or oong ti saba (Ilk.); oong na punti or oong na dayami (Pang.). Edible. Plate 42.

This beautiful mushroom is found almost any place where decayed vegetable matter, such as that of banana or abacá, rice straw, corn stalks, or bagasse accumulates. It is a scavenger plant, occurring in large numbers behind houses and in back yards where waste of all kinds is thrown. In regions like the Bicol provinces, where there is precipitation almost all year round, this mushroom grows in abundance on piles of decayed trunks or remnants of abacá. In the forests it is often found under trees, where plenty of well-decayed leaves and wood have accumulated.

This mushroom is the one cultivated in the Philippines. Its good eating qualities, the ease of securing material for culture, and its adaptability to the climate of this country, help to encourage the people in its cultivation on a large scale. For taste, it is excelled by few mushrooms. It is mellow and soft, especially when cooked in the button stage or just after it has opened. The odor depends on the kind of substratum it is grown on; if it is grown on banana it has a banana odor; if on rice straw, it has the odor of rice, and so on. It can be dried easily and stored without detriment to its taste and flavor. It can also be canned or bottled. In the Philippines even poor families keep this mushroom at home for their use, rather than to sell it in the market, where it commands a good price, bringing as much as 5 centavos a large piece in the Manila markets.

The cap is 4.5 to 16 centimeters in diameter, brownish, almost plane, sometimes umbonate, then convex. When old it is fragile and bears fine hairlike scales on the surface. The flesh is white, turning brown when dried. The gills are free, thin, white, becoming brown after long exposure to air. The stem is 5 to 14 centimeters long or much longer, 0.6 to 2 centimeters in diameter, solid, fleshy, white, tapering towards the top and becoming pale brown when old. The volva is distinct, mummy brown. The ring is absent. The spores in mass are pale brown, nearing dark pink.

VOLVARIA PRUINOSA Graff. Edible. Plate 43, fig. 1.

The cap is 3 to 6 centimeters in diameter, at first round to half round, becoming flat when expanded, fleshy, soft, white, smooth, shiny, with a thin, white margin through which can be seen the rosy color of the spores beneath. The gills are free from the stem, fleshy, fragile, well-rounded, pale, soon becoming rosy in color. The stem is white, erect, 4 to 6 centimeters long, with a slightly enlarged base, on the base with a small volva; the diameter at the base is 7 to 10 millimeters, and near the middle, 5 to 6 millimeters. The cup is white, roundish, 9 to 11 millimeters in diameter. The spore print is rose-brown.

This mushroom grows on the ground, sometimes on sandy places near the beach under the shade of pandan trees. It is also very common in Manila. It can be found from June to October.

Genus PLUTEUS Fries

Pluteus is a Latin word, meaning "shed for the sentinel." The name is given to the species of this genus because of the similarity of the cap to a turret or sentry box used in the army for the guard.

The members of this genus have pink spores. The genus resembles *Volvaria,* but the cup is absent. The ring is also lacking. The stem is fleshy to fibrous, not cartilaginous, separated easily from the cap. The gills are free, soft, and rounded at the back.

PLUTEUS CERVINUS Fries. Not tested. Plate 41, fig. 2.

This mushroom is edible in the United States, but not in Europe. Its edibility in the Philippines has not yet been tested. It grows on the ground under trees and banana plants, and can be found from July to October. This mushroom resembles *Volvaria esculenta* very much, except that in the latter the volva is present, whereas it is absent in *Pluteus cervinus.* Neither mushroom has a veil or a ring.

The cap is fleshy, at first bell-shaped then expanded, somewhat sooty to brown, sometimes dark yellow, nearly fragile, 4 to 11 centimeters in diameter; the surface usually is smooth, but showing dark radiating fibrils, sometimes more or less scaly. The gills are free, not crowded, broad, at first white, then becoming pinkish with the maturity of the spores. The stem is solid, firm, nearly equal in diameter throughout, stuffed, ghastly white, smooth or sometimes scaly, often enlarged at the base, 6 to 11 centimeters long, 5 to 11 millimeters in diameter. The spores in mass are pink to pinkish brown.

PLUTEUS LONGISTRIATUS Peck. Kabuteng kahoy[45] (Tag.). Not tested. Plate 43, fig. 2.

This mushroom grows on decaying logs, in damp places, generally in the forest. It collapses easily and soon decays.

The cap is very thin, convex when expanded, pale brownish gray to brownish ashy, plicated or grooved, 2.5 to 5 centimeters in diameter, minutely scaly on the disc at the cuticle; at length the cuticle breaks off in tiny particles. The stem is equal in diameter throughout, solid, thick, and fibrous, 3 to 5.5 centimeters long, 2 to 4 millimeters in diameter. The gills are free, close, rather broad, white, then pale flesh-colored due to the spores, almost uniform and crowded near the stem. The spores in mass are pinkish.

THE YELLOW-SPORED AGARICS

The color of the spore print on a white sheet of paper is either light yellow, rusty, rusty brown, or some shade of yellow.

While there are members of this group that are edible, no doubt there are some that are poisonous. As the edibility of none of them has not been established in the Philippines, it is necessary to be cautious in collecting any member of this genus for the table.

Genus CORTINARIUS Fries

The generic name *Cortinarius* is derived from the Latin word *cortina,* meaning "veil."

This genus is distinguished by the presence, in the younger stage, of a cobweblike veil which connects the edge of the cap with the stem. The veil is superficial in nature, not touching the gills. There is also frequently a universal veil which, on collapsing, leaves a ring or sheath on the stem. The cap is fleshy and decays easily. The stem is spongy to fleshy, sometimes rigid and somewhat cartilaginous. The gills are dry and lasting, and when young may be white, yellow, gray, olive, blue, violet, purple, red, or brown, but at maturity they become discolored due to the cinnamon or rusty brown spores that are sticking on them. The gills are either attached to the stem

[45] Mushroom on wood.

with a sudden curve before reaching the stem, or running down the stem.

CORTINARIUS COLLISTEUS Fries. Kabuteng kalauangin (Tag.). Suspicious. Plate 44, fig. 1.

This is a very beautiful plant. When fresh it is cinnamon in color, but paler at the margin of the cap, and in drying it becomes brick-colored. It occurs on wood, old bamboos, and on decaying leaves.

The cap is 3 to 10 centimeters in diameter, half-round at first, then convexly expanded, with a broad circular elevation at the center. The gills are moderately crowded, broadly attached to the stem, at first pale brown, then cinnamon-brown. The stem is slender, often curving, nearly cartilaginous, 4 to 8 centimeters long,. and 5 to 9 millimeters in diameter. The veil in youth cover the gills without touching them, connecting the cap and the stem. The cortina or universal veil is white, never leaving a ring on the stem, in age the remnants of the cortina remaining hanging on the margin below the cap. The spores in mass are cinnamon-brown.

This mushroom grows separately or in clusters of several to many, from June to October. It has a mild odor and taste. The Tagalog name applies to the character of this mushroom of becoming easily rust-colored, because of the spores that are sticking on the surface.

Genus GALERA Fries

The generic name is derived from the Latin word *galerus,* meaning "cap," and has reference to the shape and position of the cap on the stem.

The cap in youth is bell-shaped or egg-shaped, conical when expanded, fitting straight against the stem. The stem is smooth, a little paler in color than the cap, sometimes lined or grooved, cartilaginous, hollow, with mealy whitish particles on the upper part, often very fragile. The gills are either narrowly or broadly attached to the stem, or just reaching the stem.

The species are generally small, slender, and fragile. They grow on the ground.

GALERA TENERA Fries. Kabuteng payat ang tangkay [46] (Tag.). Not tested. Plate 44, fig. 2.

This slender mushroom is common on lawns and pastures from June to December. It grows scattered and appears on the ground in a more or less spontaneous manner.

[46] Mushroom with a slender stalk.

The cap is bell-shaped, 1 to 2.5 centimeters in diameter, pale when moist, rust-colored or brown, becoming light brown as it dries off in the sun, generally smooth, although occasionally some specimens are covered with very fine, short silky hairs. When the cap is damp, it is usually slightly lined or grooved; the lining disappears as the cap dries. The stem is 7 to 12 centimeters long, 1.2 to 3.5 millimeters in diameter, slender, straight, fragile, hollow, nearly of the same color as the cap, usually shiny and more or less lined toward the top. The ring and the cup are absent. The gills are attached to the stem, somewhat broad, dark brown, more or less toothed at the edge. The spores in mass are dark rust-colored.

Genus NAUCORIA Fries

This genus agrees in structure with *Collybia*, but has rusty-colored spores. The cap is more or less fleshy, convex or conical, becoming flat; the margin at first is incurved and usually even. The stem is nearly cartilaginous, hollow, or stuffed. The gills are free, or broadly attached to the stem, never decurrent.

The members of this genus grow on the ground or on dead wood, sometimes rooting. They are usually small, and in the Philippines none of them are known to be edible.

NAUCORIA SEMIORBICULARIS Fries. Kabuteng kinalauang[47] (Tag.). Plate 45.

The cap is fleshy, convex, plane to umbonate, silky, pale yellow to somewhat dull yellowish brown, 3 to 4.5 centimeters in diameter. The gills are nearly crowded, free from the stem to curving out before reaching the stem, pale, then rust-colored. The stem is stuffed, rounded, nearly equal, white above, darker below, approaching the color of the cap, powdery, somewhat enlarged at the base. The spores in mass are rust-yellow. The flesh is white, odorless, and tasteless. This mushroom is terrestrial in habit and is found from May to December.

Genus PLUTEULUS Fries

The spores in mass are rusty yellow. The gills are free, not dissolving in wet weather. The stem is slender, distinct, nearly cartilaginous. The cap is putrescent, thin, sticky when wet. Veil, ring, and volva are absent.

PLUTEULUS COPROPHILUS Peck. Plate 46, fig. 1.

This mushroom grows in tufts, like grass, or in company but not joined, on decaying straw piles, on composite heaps, or on

[47] Rusty mushroom.

dung, especially on lawns, fields, and under trees where manure has been thrown. It can be found from May to November.

The cap is broad, fragile, at first conical then expanded, depressed on the disc, viscid when moist, marked with fine lines on the margin, whitish, later rosy gray or pinkish light brown, 3 to 6 centimeters in diameter. The gills are free, narrow, crowded, pale, rusty light brown, dotted by the rust-colored spores. The stem is straight or bending near the base, slender, hollow, pure white, rarely tinged with pink, smooth or rather beset with small scales, equal or tapering upward, 6 to 12 centimeters long, 2 to 5 millimeters in diameter. The flesh is thin, semitransparent. The spores in mass are rust-colored.

Genus PHOLIOTA Fries

The generic name is taken from the Greek word *pholio,* meaning "scale," and refers to the scaly character of the cap in many of the species.

The genus *Pholiota* is similar to *Armillaria* in structure, except that the spores are yellow. The species of the genus *Armillaria* have white spores. The members of the genus *Pholiota* grow on wood or on the ground. The cap is fleshy, and may be slippery, wet, dry, scaly, or naked. The ring is present, persistent, membranous. The gills are usually broadly attached to the stem, or decurrent, sometimes just reaching the stem, dull yellowish brown at first, becoming dark brown.

PHOLIOTA AURIVELLA Fries. Plate 46, fig. 2.

A beautiful mushroom that grows on the ground, either solitary or in groups of several. This plant is found from July to September, under trees near the forest.

The cap is 5 to 10 centimeters in diameter, bell-shaped in youth, becoming convex-plane in age, covered with woolyarnlike fibers of orange yellow to pinkish yellow; the rest is white, the margin near the gills is still bearing remnants of the veil even when it is already opened. The flesh is white. The stem is cylindrical, solid, stuffed, of the same color as the cap, 4 to 7 centimeters long, 6 to 8 millimeters in diameter. The ring is present, woolly, evanescent. The gills are free, close, numerous, white in the button stage, becoming pink and finally dark yellowish brown at maturity. The spores in mass are rust-brown.

THE PURPLE-BROWN-SPORED AGARICS

The members of this subdivision are characterized at maturity by the spores in mass appearing purple-brown, dark brown, or nearly black. The ripened spores on the gills give the characteristic color to the latter. Many members of this group are economically important, like the species of the genus *Psalliota*, many of which are considered among the most delicious mushrooms there are in the market.

Genus PSALLIOTA Fries

The cap is fleshy. The stem is fibrous, fleshy, easily separated from the cap. The ring is present on the stem, disappearing in some species. The gills are free, whitish at first, then frequently pink and at length deep purple-brown. All the species are terrestrial. The spores at maturity are either purple-brown or blackish, with a purple tinge when collected in mass.

All the species of this genus are edible. A large number of them are found in the Philippines, yet very few have been identified and studied.

It is always best to cook these mushrooms in the button stage, when they are mellow and tender and do not darken the soup. In youth the spores are white, becoming pink-brown on maturity.

PSALLIOTA ARGYROSTICTA Copeland. Plate 47, fig. 1.

The cap is at first conical, later convex-plane, shiny white, always naked, somewhat fleshy, with unchanging gray flesh, 2.5 to 4 centimeters in diameter. The gills are free, almost round at both ends, 3 millimeters deep, gray at first, later dark. The stem is 3 to 4.5 centimeters long, 3 to 5 millimeters in diameter, strongly attached to the cap, gradually tapering upward, solid or nearly so. The ring is membranous, lasting but a short time. The flesh is odorless, with an agreeable taste. The spores in mass are pink-brown.

This mushroom is edible. It can be found in grassy places under trees, from June to September.

PSALLIOTA CAMPESTRIS Fries. Kabuteng parang na puti (Tag.). Edible. Plate 48, fig. 1.

The specific name *campestris* is derived from the Latin word *campester*, meaning "belonging to a plain."

This delicious mushroom is quite scarce in the Philippines, although if it is found at all it is found in large numbers. It grows on the ground, in grassy places in the open field, sometimes under trees, and appears from about May to September.

This mushroom is at first white and smooth, later covered with some brown rough scales. The cap is half-round to bell-shaped, 3 to 6 centimeters in diameter, quite thick and fleshy. The gills are free, in youth pink, covering the veil, slowly becoming pinkish brown upon maturity. The veil becomes the ring that is attached around the stem; a portion of the veil is left attached on the gills, just below the margin of the cap. The stem is stuffed, stout, cylindrical, with a little enlargement at the base.

This mushroom is canned, and is imported from Europe as "champignon," and from the United States as "mushroom."

PSALLIOTA CAMPESTRIS Linnæus var. **EDULIS** Vittadini. Kabuteng parang [48] (Tag.). Edible. Plate 48, fig. 2.

This mushroom has excellent eating qualities. It is found from June to about November.

The cap is 4 to 6.5 centimeters in diameter, at first somewhat globular, then round-convex, finally expanded and nearly flat; the surface at first is nearly smooth, with a soft silky appearance, due to the numerous loose fibers, more or less scaly in age, white to creamy white or light brown; the margin of the cap extends somewhat beyond the ends of the gills. The flesh is white. The gills are free, close, rounded toward the stem, pink, becoming purple-brown as the spores mature, at first covered by the inner veil, later the veil is separated. The stem is white or whitish, nearly cylindrical or somewhat tapering toward the lower end, 3 to 6 centimeters long, 1 to 1.8 centimeters in diameter. The inner veil from which the ring is formed is silky, white, thin, very frail, a portion often being left at the margin of the cap; the ring formed from the veil on the stem is also very frail, evanescent. The volva is absent. The spores in mass are dark brown or nearly black, with a purplish tinge.

PSALLIOTA CAMPESTRIS Linnæus var. **UMBRINA** Fries. Oong ya balit [49] (Pang.). Edible. Plate 49, fig. 1.

The cap is 5 to 12 centimeters in diameter, compact, fleshy, convex to nearly half-round, becoming umbonate when expanded, at first covered with a thin layer of fine fiber, at length torn into a fringed sharp-pointed scalelike form. The gills are very crowded, free, white, pale yellow to flesh-colored, later tobacco-colored to dark, round at the back. The stem is 3 to 6 centimeters long, 1 to 2.5 centimeters in diameter, stuffed with cottony materials, later becoming slightly hollow, nearly equal, sometimes tapering toward the apex; below the ring the color is

[48] Mushroom in the open plain. [49] Mushroom with stripes.

similar to that of the cap, sometimes a little paler, and covered with fine fibrils, at length becoming smooth; the upper portion is white to nearly tile-colored, somewhat powdery on the surface. The ring is white on the upper part, brown below, broad, more or less permanent. The flesh is white, pale yellow to dilute brick red. It has a pleasant odor and an agreeable taste.

This mushroom is one of the most delicious, growing on the ground from May to September. It is often seen under acacia trees.

PSALLIOTA COMTULA Fries. Payungpayuñgan malagu (Pam.). Edible. Plate 49, fig. 2.

The cap is fleshy, convex, flattened, silky to smooth on the surface, white to clay-colored. The center is somewhat purple to pale brown, 2 to 4 centimeters in diameter. The gills are crowded, swollen, round and free, white, flesh-colored to very pale brick-colored, with white edges. The stem is stuffed, cylindrical, generally thickening towards the base, covered with a thin layer of very fine fibrils, 3 to 5 centimeters long, 2.5 to 5 millimeters in diameter. The ring is medium in size, bent upward, thin, white, lasting but a short time. The flesh is spongy, smooth, juicy, grayish white, with pleasant odor and taste.

This mushroom grows on grassy places, often under bananas, from June to September. It is edible.

PSALLIOTA LUZONIENSIS Graff. Kabuteng parang na maitim-itim (Tag.). Edible. Plate 50, fig. 1.

This terrestrial mushroom is often found solitary, and sometimes in groups of few. It is edible and has a slight earthy odor. The Tagalog name has reference to the color and place where it is found—*maitim,* meaning "dark," and *parang,* "plain."

The cap is fleshy, convex to expanded, clothed completely with delicate red-brown fibers, except for the central portion which is solid brown, soft, smooth, with a very thin margin, 7 to 8.5 centimeters in diameter. The margin occasionally shows remnants of the membranous veil. The flesh is white and thin. The gills are free, fine, crowded, at first white, soon assuming the color of the cap. The stem is 6 to 12 centimeters long, 6 to 8 millimeters in diameter, somewhat slender, solid, fibrous throughout, white to light brown, smooth except above the annulus where it is slightly finely woolly. The ring is membranous, persistent to evanescent, well up on the stem. The spores in mass are dark purple brown.

[30] Beautiful mushroom.

PSALLIOTA MERRILLII Copeland. Kabuteng parang na bulik[51] (Tag.). Plate 47, fig. 2.

A rather large mushroom, growing in open plains from June to November. It is found in group of few, sometimes single. It is edible but not as palatable when cooked as *Psalliota campestris* or *Psalliota perfuscus*. This species was first found and described by Dr. E. B. Copeland, former Dean of the College of Agriculture, University of the Philippines, and the specific name was given it in honor of Dr. E. D. Merrill, former Director of the Bureau of Science.

The cap is scaly, sometimes naked, white, becoming brown, shiny, nearly fleshy, cut off or round at the top when young, 8 to 12 centimeters in diameter. The stem is whitish, turning brown, stout, abruptly enlarged at the base, somewhat contracted at the top, 9 to 11 centimeters long, 7 to 10 millimeters in diameter. The ring is high up on the stem, white on both sides, very torn and often hanging. The gills are free, crowded, somewhat sharp at the edge, at first salmon-colored, finally turning black. The spores in mass are dark brown or nearly black, with purplish tinge.

PSALLIOTA PERFUSCUS Copeland. Kabuteng parang na may singsing[52] (Tag.). Edible. Plate 50, fig. 2.

Unfortunately this very delicious mushroom is not known by the people. It is found in great abundance in grassy places, in lawns, on polo fields, and on golf links. The writer has collected this mushroom very regularly for the kitchen during the mushroom season. It is as delicious as the common *Psalliota campestris*. It is best cooked in the button stage, for then the soup is not colored by the white spores as it is by the brown spores when the mushroom is mature. People should be encouraged to utilize this delicious food which otherwise goes to waste every year. It is found from June to about September, but is most abundant during June and July. This plant frequently forms a fairy ring (Plate 5).

In youth the whole plant is snow white. The cap is early expanding, scaly, depressed at the center, 3 to 5 centimeters in diameter; the margin is wavy, often torn. The gills are free, close, blunt on both ends. The stem is firm, smooth, nearly hollow, 3 to 4 centimeters long and 3 to 5 millimeters in diam-

[51] Spotted mushroom in the open plain.

[52] Mushroom in the open plain with a ring.

eter. The ring lasts but a short time and is located well up on the stem. The spores in mass are dark brown, with a purplish tinge.

Genus STROPHARIA Fries

The characters of the members of this genus resemble those of *Armillaria* and *Pholiota,* except in their having purple spores. The cap is sometimes provided with a delicate superficial membrane and may be scaly and slippery or dry, with fine hair. The stem is fleshy and provided with a ring. The ring may be membranous, or fibrous to cottony. The gills are more or less brownish.

Most of the species grow on wood, but a few grow on the ground.

STROPHARIA SEMIGLOBATA Fries. Kabuteng kalabau na may singsing[53] (Tag.). Not tested. Plate 51, fig. 1.

This is a common and widely distributed mushroom, growing on animal dung and on richly manured ground, in pastures and other grassy places, from June to October.

The cap is yellow, fleshy, hemispherical, smooth, erect, shining when dry, 1 to 5 centimeters in diameter. The stem is yellow, paler above, darker below, equal, hollow, tense and straight, smooth, smeared with the glutinous veil, 3 to 11 centimeters long. The ring is wet, thin, incomplete, distant above the middle of the stem. The gills are pale purplish, attached squarely against the stem, very broad and plane, clouded with purple patches of adhering spores. The spores are blackish purple. The flesh is pallid.

The edibility of this mushroom has not yet been tested. In America, however, it is considered edible.

THE BLACK-SPORED AGARICS

The members of this group have black spores in mass. Many of the species are edible, although they are small. All except a few species grow on the ground, on livestock dung, or on richly manured soil. They are very resistant to drought, being the first mushrooms found in the season.

Genus COPELANDIA (Bulliard) Bresadola

The cap is fleshy, bell-shaped. The gills are nearly swollen, broadly attached, sometimes decurrent, covered with small wart-

[53] Mushroom on carabao manure with a ring.

like protuberances. The stem is at the center, hollow, slender. The veil is evanescent. The spores in mass are black.

The species of this genus are dung dwellers, sometimes found on heavily manured ground. They decay easily.

This genus was erected in honor of Dr. E. B. Copeland.

COPELANDIA PAPILONACEA (Bulliard) Bresadola. Kabuteng taing kalabau[54] (Tag.). Not tested. Plate 51, fig. 2.

The plant is very common in the field, generally in pastures, and can be found from May to as late as February.

The cap is fleshy, somewhat hemispherical, smooth, whitish to gray-white, sometimes nearly pale yellow, cracking on the surface when dry and becoming scaly, 1.4 to 3 centimeters in diameter. The gills are loose, crowded to somewhat distant, swollen, just reaching the stem, dark gray, blotted with black dots. The stem is stuffed, cylindrical, equal, smooth, somewhat similar in color to the cap, darkening toward the base, mealy on top and smooth below, 4 to 12 centimeters long, 3 to 4 millimeters in diameter. The veil is pale and evanescent. The flesh is grayish white.

Genus COPRINUS Persoon

The name *Coprinus* is derived from the Greek word *kopros*, meaning "dung," and was given this genus because of its usual habitat.

The members of this genus are recognized by the black spores, and by the gills that dissolve at maturity into black or inky fluid. The cap is fleshy or membranous, at first cylindrical or egg-shaped, usually scaly, with the margin originally straight and pressed closely against the gills. The stem sometimes has a ring. The gills are free, broadly attached to the stem, or attached to a collar. They are very thin and parallel-sided, at first white, then becoming dark. The spores are black, violet-black, chocolate, or dark brown. The species grow in tufts or solitary, on the ground, or dung, or on rotten wood.

COPRINUS COMATUS Fries. Kabuteng kampanilla[55] (Tag.). Edible. Plate 52, fig. 1.

This is an early mushroom in the season, appearing from May to December. It grows on decayed vegetable matter, especially on decayed leaves and wood, in cool damp places in the forests. It is found singly or in groups.

The cap is slender, fleshy, somewhat silky, at first almost round, bell-shaped, later expanded, 3 to 6 centimeters in diameter. The apex is nearly smooth, dirty white, with the margin

[54] Mushroom on carabao dung. [55] Bell-shaped mushroom.

often approaching rosy lilac, soon becoming black. The gills are very crowded, linear, silky fibrous, with the base often swollen. The stem is 10 to 15 centimeters long, 0.7 to 1.2 centimeters in diameter. The ring is membranous, very movable, evanescent. The flesh is white, smooth, watery, without odor or taste.

COPRINUS CONFERTUS Copeland. Kabuteng taing kabayo [56] (Tag.). Edible. Plate 52, fig. 2.

The cap is 3 to 6 centimeters in diameter, fleshy, at first conical, later, when expanded, depressed, grayish black, with a structural line and a yellowish brown or straw-colored disc, and covered with whitish cottony flakes. The margin is entire or cleft in a few places, becoming torn in age. During dry weather the cap is thick. In rainy days, however, it is very thin, clothed with a silky evanescent net. The stem is white, smooth, hollow, 12 to 15 centimeters long, and 7 to 13 millimeters in diameter, slightly swollen at the base. The gills are grayish black, free from the stem, crowded, lance-shaped. The spores in mass are black.

COPRINUS PLICATILIS Curtis. Kabuteng may pliegues [57] (Tag.). Edible. Plate 53, fig. 1.

This mushroom grows on horse dung and heavily manured ground in pastures. It is found from May to November.

The cap is membranous, plicate, dark brown, bluish gray to ashen, 2.5 to 5 centimeters in diameter, at first egg-shaped to bell-shaped, then expanded, at length depressed at the center. The stem is hollow, slender, cylindrical, rarely crooked, the base somewhat swollen, white, somewhat silky, shiny, 6 to 9 centimeters long, 2 to 4 millimeters in diameter. The gills are somewhat distant, linear, free, white to gray black. The flesh is very thin, white, odorless.

Genus PANÆOLUS Fries

Panæolus, a Greek word meaning "all variegated," was given as a name to this genus because the gills of its members have patches of different color.

The cap of the species of this genus is fleshy, conical, not expanded, viscid when wet, shiny when dry, with the margin exceeding the gills in length. The stem is usually smooth, cottony, scaly, often long, firm, generally hollow. The veil generally consists of interwoven threads, sometimes quite compact, especially when the plants are young. The gills are broadly attached to the stem or just reach the stem, and are marked with

[56] Mushroom on horse manure. [57] Plicated mushroom.

different colors due to the sticking spores. These mushrooms grow in richly manured grassy places and on livestock dung.

Several species of *Panæolus* are known to be poisonous, so that care should be taken in collecting for the table. The effect of poisoning from *Panæolus* takes place soon, about fifteen or twenty minutes after the mushrooms are eaten. The symptom consists in general weakness of the body, sometimes affecting the sight. The effects of the intoxication are said to pass off within four hours. As soon as the effect of poisoning is felt, emetics should be administered to the patient to prevent the complete absorption of the poison in the body.

PANÆOLUS CAMPANULATUS Linnæus. Kabuteng kampana[58] (Tag.). Not tested. Plate 53, fig. 2.

A very common mushroom, growing on animal dung, especially on that of horses, carabaos, and cattle, or on grassy places in heavily manured grounds. It sometimes grows singly, but mostly in groups of several to many. It is found from the latter part of May or June to November.

The cap is 2.5 to 4.5 centimeters in diameter, fleshy, conical to bell-shaped, sometimes umbonate, not fully expanded, smooth, white, somewhat shiny, not translucent, gray, clay-colored, becoming reddish, when dry wrinkled or cracking, then scaly; the margin is occasionally fringed with the remains of the veil. The gills are ascending to follow the conical shape of the expanded cap, loose, somewhat crowded, attached to the stem, gray-olive, sooty, black-spotted. The stem is 5 to 14 centimeters long, 3 to 5 millimeters in diameter, pithy, stuffed, cylindrical, sometimes channeled, frail, almost equal, a little broader at the base, of the same color as the cap, first white then black and powdery. The flesh is grayish, colorless, and tasteless.

Genus PSATHYRELLA Fries

The generic name *Psathyrella* is a dimunitive taken from *Psathyra* which was derived from the Greek word *psathuros*, meaning "friable." This name has reference to the character of the cap of the members of these two genera to crumble into pieces.

The cap of the species of this genus is membranous, thin, and grooved. The margin does not extend beyond the edge of the gills, in youth lying straight against the stem. The gills are free or broadly attached to the stem, uniform, black. The spores are black.

[58] Bell-shaped mushroom.

The genus resembles the purple-brown agaric *Psathyra*, but is much thinner. The species grow on rich ground, sometimes on very much deteriorated wood.

PSATHYRELLA DISSEMINATA Fries. Kabuteng malantahin[59] (Tag.). Edible. Plate 53, fig. 3.

This is a very common and widely distributed species in the Philippines, occurring from June to November in rich soil or on decaying wood. The cap is fleshy, whitish or yellowish, becoming gray, or wood-ashy in color, scurfy, then smooth, deeply marked with grooves, 1.5 to 3 centimeters in diameter. The stem is fragile, often curved, slightly scurfy, then smooth, 3 to 6 centimeters long, 1.5 to 3 millimeters in diameter. The gills are whitish, then blackish, broadly attached to the stem. The plants are crowded in large tufts, often growing on decaying wood, but may also be found on the ground, especially about decaying stumps, in lawns, and similar places where decaying roots are buried. The spores in mass are black. The odor approaches that of rotten wood, but the taste is agreeable.

POLYPORACEÆ

The hymenium (the spore-bearing surface) in the members of this family lines the surface of the tubes, pores, or network. These mushrooms are usually round or angular, sometimes wavy or torn. They may be fleshy, leathery, or woody. The stem is central or eccentric. Sometimes the fruiting body is sessile, that is, without a stem, or the hymenium is inverted in position. In these forms the hymenium is superior, and in the other forms, inferior.

Many members of this family are soft, and no doubt a number of them are edible; others are hard and inedible. Many of them are very destructive to trees, causing decay. A good many are called "shelf fungi" because of the position in which they are attached on the host. This family differs from the Agaricaceæ in having tubes, pores, or reticulations instead of gills.

Genus BOLETUS Dillenius

The generic name is derived from the Greek word *bolos*, which means "clod;" in the members of this genus the shape of the cap is like that of a lump of earth.

In general appearance *Boletus* resembles the agarics, except that it has pores instead of gills. Many of the species of this

[59] Mushroom that wilts easily.

genus are found in the Philippines. They are generally abundant in the cooler mountain regions, although several are found in lowlands in places where the soil is largely composed of decayed wood and leaves. No doubt many of them are edible, and nothing has been so far heard of mushroom poisoning caused by any species of this genus. It would be of great interest and of much economic value to try the edibility of these mushrooms. In some countries outside the Philippines many of the boleti are considered a delicacy. In Baguio, Mountain Province, many members of this genus abound.

The entire plant is soft and fleshy and decays soon after reaching maturity. The stratum of tubes on the under side of the cup is easily peeled off. All the species grow on the ground. Some change color when bruised or cut. It is important to note this character as well as the taste when the plant is fresh, for the identification of the species.

BOLETUS BADIUS Fries. Kabuteng ahas [60] (Tag.). Not tested. Plate 54, fig. 1.

A common mushroom found everywhere in the lowlands and in the mountains. It grows on rotten leaves and wood, often on decayed sawdust under acacia trees. The mushroom can be found from June to October. The people consider it poisonous.

The cap is dark brown or olive-brown, with a slight green shimmer, 10 to 20 centimeters in diameter, hemispherical when young, then convex, plane, smooth, thin along the margin, sticky in damp weather; the surface cracks easily. The tubes are numerous and the pores distinct, sulphur yellow, adhering together. The stem is stout, cylindrical, stuffed, and soft, 7 to 12 centimeters long, 7 to 13 millimeters in diameter, of the same color as the cap. The flesh is cream-colored, turning blue when cut. This mushroom is not deeply rooted in the ground, and the roots are numerous but rather fine.

BOLETUS CASTANEUS Bulliard. Kabuteng mukang tinigkal (Tag.). Note tested. Plate 55.

This mushroom is generally found in the mountains where the temperature is cool and the air moist, appearing from June to about October. It is quite common in the mountainous towns of Cavite, although more abundant around Baguio, Mountain Province. This mushroom is considered edible in other countries. Its edibility in the Philippines, however, has not yet been tested. The Tagalog name has reference to the shape of the cap, which appears like a clod of soil.

[60] Snake mushroom.

The cap is convex to expanded, then becoming flattened to nearly depressed at the top, firm, pale brown to dark brown, 4 to 9 centimeters in diameter. The tubes are crowded, white to pale sulphur. The pores are round, adhering to one another, white and hardly noticeable in youth, later becoming wide and lemon-yellow. The stem is firm, cylindrical, swollen at the base, often slightly furrowed, of the same color as the cap, loosely stuffed, 4 to 8 centimeters long, 1 to 1.8 centimeters in diameter. The flesh is white, becoming pinkish red when opened, with an agreeable odor.

BOLETUS EDULIS Bulliard. Edible. Plate 54, fig. 2.

The cap is strongly convex, smooth, not sticky, usually brownish to chesnut-brown, sometimes gray, becoming reddish, 5 to 15 centimeters or more broad. The tubes are short, narrow, round, nearly free, yellow, later becoming green. The pores are very small, round, of the same color as the tubes. The stem is more or less stout, sometimes slender, cylindrical, rarely bulbous at the base, for the most part equal, at times tapering, of the same color as the cap, 5 to 12 centimeters long, 2 to 4 centimeters in diameter. The flesh is white, becoming reddish when peeled off, compact, smooth, with a pleasant odor and taste.

This mushroom grows on the ground and is quite common in Baguio, Mountain Province.

Genus DAEDALEA Persoon

This genus resembles *Trametes,* except in the firmer, thick dividing walls of the pores, which, when fully developed, are irregularly wavy or complicated in form, often becoming torn or toothed.

The members of this genus occur in woods, on stumps, and trunks. They cause rot by penetrating the tissues of the wood.

DAEDALEA FLAVIDA Léveille. Kabuteng kapis[61] (Tag.). Not edible. Plate 56, fig. 1.

A wood-inhabiting mushroom, causing rot on trees. It is very common in the Philippines. Its hard texture renders it unfit for food.

The cap is leathery to corky, hemispherical, naked, furrowed, light yellow; the margin is nearly sharp. The stem is lateral, often very short or absent. The pores are large, at first rounded, becoming much contorted, elongated, deep, wavy, pale

[61] Shell mushroom.

yellow. The thick flexible walls or partitions resemble gills, and are pale yellow, obtuse, and somewhat hairy.

This mushroom is 5 to 30 centimeters in diameter, and 3 to 21 centimeters high, and its stem is 6 to 12 millimeters in diameter. It is found all year around.

Genus GANODERMA Karsten

The members of this genus are quite numerous in the Philippines. They grow on trunks of trees, causing wood rot. They are among the most common wood-destroying fungi in the Philippines. Many of the species attain extraordinary size.

The cap is somewhat beaked and shelflike when attached to the tree, covered with a hard shiny coating. The members of this genus are sessile, but sometimes a short stalk is present. The tissue is for the most part brown. The tubes are rarely single but composed of many layers.

None of the species are edible.

GANODERMA MANGIFERÆ Léveille. Kabuteng punong manga[62] (Tag.). Not edible. Plate 56, fig. 2.

The cap is 8 to 15 centimeters in diameter, 1 to 2 centimeters thick, corky to woody, sessile, hemispherical to broadly lengthened; one side shiny, appearing varnished, marked with furrows that have a common center, the other side smooth yellow; the margin is openly blunt, sterile. The pores are tiny, angular, dull, yellowish white.

This mushroom is found all year round. It is too hard to be edible.

Genus HEXAGONA Fries

The Latin generic name refers to the shape of the pores.

The members of this genus are abundant in the Philippines. They are easily recognized by their shelflike attachment on the host and the honeycomb formation of the pores. They are sessile, somewhat corky to woody, persistent, and reviving. The flesh is not formed in layers. The pores are regular and firm.

HEXAGONA APIARIA Persoon. Kabuteng hugis bahay bubuyog[63] (Tag.). Not edible. Plate 57, fig. 1.

The cap is nearly corky, kidney-shaped, a little hollow, thin, 6 to 10 centimeters in diameter, 5 to 10 millimeters thick, generally smooth, but sometimes the surface is densely shielded with coarse, dark hairs which are movable on old specimens. The pores are wide, regular, usually greenish blue, covered with

[62] Mushroom on mango tree. [63] Mushroom resembling the beehive.

tiny trichomes (very fine sharp hairs) that are hardly visible to the naked eye.

This mushroom is attached to the host in a shelflike manner. It can be found all year round, but is more developed during the rainy season.

Genus POLYPORUS (Micheli) Fries

The generic name *Polyporus* was derived from the Greek words *polus* and *poros*—the former meaning "many" and the latter, "pore." The species of this genus are characterized by the presence of many pores.

The members of this genus are annual or perennial, usually growing on wood, causing destruction of their hosts. Many of them are found in the Philippines. The cap is woody to corky, or nearly soft. The stem is central, lateral or absent, and may be either single or branched. The pores are round or angular, entire, torn, or toothed.

POLYPORUS SANGUINEUS Linnæus. Kabuteng mapula[64] (Tag.). Not edible. Plate 57, fig. 2.

This is a beautiful blood-red mushroom growing all year round, on rotten wood, generally in the forests. It is found in groups of many. It is tough but not poisonous.

The mushroom is somewhat kidney-shaped to shell-shaped, shiny, with furrows that have a common center. It is 3 to 12 centimeters in diameter, porous, and the pores are barely visible to the naked eye. Sometimes they are very conspicuous near the center, disappearing toward the margin. The stem is only 4 to 6 millimeters long. Sometimes it is absent.

POLYPORUS SULPHUREUS Fries. Edible. Plate 58, fig. 2.

The specific name *sulphureus* is a Latin word, meaning "sulphurlike." This mushroom is a wound parasite. It starts to grow on wounds or dead branches, thence gaining entrance to the heartwood of the main stem, where it causes the characteristic heart rot. It can be found from May to November.

The cap is reddish yellow or orange, becoming paler with age, powdery, imbricated, sessile, sometimes with a very short stalk. The flesh is light yellowish, then white, often exuding a sulphur-yellow liquid when broken, with a typical mushroom odor and a bitter taste. The mass is 9 to 25 centimeters in diameter.

[64] Red mushroom.

Genus FOMES Karsten

Fomes is a Latin word meaning "touch-wood tinder"—indicating that probably many species of this genus were used as tinder in the old days in some countries.

The cap at first is woody, hardened, rarely soft. The substance is interwoven, woolly, covered with a rigid hardened exterior coating, without any encircling bond, but at length deeply furrowed concentrically. The species are perennial and grow on wood. Many of them are found in the Philippines.

FOMES PACHYPHLOEUS Patouillard. Not edible. Plate 58, fig. 1.

A very common, large mushroom, growing on dead trunks of trees and sometimes on living trunks, attaching itself in a bracketlike formation. This mushroom sends out mycelial bodies through the wood and causes serious rotting. Because of its toughness the Igorots grind this mushroom before cooking. It is palatable when cooked, but too hard to call edible.

The cap is broad, ranging from 15 centimeters to an enormous diameter, toward the front is carried out into a cushionlike form. The flesh is corky-woody, rust-colored, becoming chocolate-brown to dark brown in age, sometimes smooth but generally roughened by the furrowed spaces along the margin; these furrows have a common center; the cuticle is thick and soon cracks. The tubes are not very distinct, rust-colored to brick-colored, 1.5 to 3 centimeters long; the pores are minute, nearly round, pale yellow to rust-colored.

This mushroom is found all year round. Its favorite host is the bagtikan tree.

Genus TRAMETES Fries

Several species of this genus are found in the Philippines. They grow on wood in a more or less overlapping formation, resembling that of a tiled roof. They are annual or perennial. The cap is woody or corky, shelflike or twisted, sessile. The tubes do not form a distinct layer and the pores are somewhat spherical, more or less elongated radially, entire, often unequal in depth, and provided with a thick dividing wall.

TRAMETES ASPERA Junghuhn. Kabuteng hugis abaniko[65] (Tag.). Not edible. Plate 58, fig. 3.

A common white bracket mushroom growing all year round on dead wood. It is a wood-destroying fungus, considered too tough to be edible.

[65] Fanlike mushroom.

The surface of this fungus is very rough to the touch because of the fine long fibers that are lying flat on the surface. The cap is 6 to 14 centimeters in diameter, concentrically zoned, white, sometimes greenish, becoming grayish in age. The pores are about 7 millimeters deep, radially elongated, pale tan. The flesh is whitish, compact, thick, very firm and corky.

HYDNACEÆ

The plants belonging to this family vary greatly in size, consistency, and form. Some of them are very large. They are either fleshy, woody, corky, or membranous. Their outstanding character is that of the fruiting surface, which covers the body in numerous processes, either in the form of spines, teeth, warts, coarse granules, or folds. These features are always directed toward the earth. Many of the Hydnaceæ are shelf-like in form. They grow on trees or on the ground. They often have a central or eccentric stem, with a more or less circular cap. Some of them are more or less rounded masses, which grow from trees with very long spines that extend downward. Others have ascending branches from which the spines depend; still others form sheets, spreading over the surface of logs and sticks.

Genus HYDNUM Linnæus

In this genus the fruiting surface is awl-shaped or in the form of spines. It is either simple or with the tips more or less branched. The plants grow on the ground or on wood. The spines vary greatly in form; some are provided with a more or less regular cap and a stem, others are shelving or bracket-shaped, and the rest are just spreading out over the surface of the wood.

HYDNUM ERINACEUS Bulliard. Kabuteng may mahabang balahibo [66] (Tag.). Edible. Plate 59, fig. 1.

This is one of the most beautiful mushrooms, growing on rotten logs in cool, damp places in the forests. It is edible, but rather rare.

This mushroom is yellowish white, 10 to 20 centimeters broad above the fiberlike spines, fleshy, somewhat flexible, roughened, and nearly sponge-shaped. At the end it is tapering, appearing somewhat stalked, and more or less rooted. The tip is acute, 2 to 6 centimeters long, and 2 to 5 millimeters wide at the end.

[66] Mushroom with long hair.

In age, this fungus becomes cream-colored to yellowish tawny. The flesh is white, tenacious, and hollow. It has a strong mushroom odor.

HYDNUM VELUTINUM Fries. Not tested. Plate 59, fig. 2.

The cap is nearly even, leathery, convex, often depressed at the center, hairy, without zones, yellow or rust to nearly brick-colored, 5 to 7 centimeters in diameter. The spines are decurrent, dark brown, becoming pink at the end, 4 to 6 millimeters long. The stem is short, enlarged at the base, hairy, 2.5 to 4 centimeters long, 1 to 14 millimeters in diameter at the apex, 1.2 to 2 centimeters at the base, sometimes more or less rooted, of the same color as the cap. The flesh on the stem and the underside of the cap is somewhat leathery, soft on the upper portion of the cap.

This is not a common mushroom in the Philippines, and its edibility has not yet been tested. It grows on old stumps and prostrate trunks and can be found in moist cool places in the mountains.

CLAVARIACEÆ

THE CORAL FUNGI

The Clavariaceæ are characterized by a spore-bearing surface which may cover more or less the entire spore-bearing body. Many members of this family are fleshy. They are often much branched, or corallike. Some are club-shaped. All species that are sufficiently fleshy or delicate are edible. All of the branched forms are good to eat. Many members of this family are bright-colored and very beautiful.

Genus CLAVARIA Bulliard

The generic name is taken from the Latin word *clava,* meaning "club," in reference to the shape of many of the members of this genus.

This is economically the most important genus of the family, for it includes numerous edible species. The fruiting body is erect and fleshy, or somewhat leathery. It is either branched, simple, or club-shaped. The hymenium is even and borne on both sides, but absent from the stemlike portion of the simple club. Most of the members of this genus grow on the ground.

CLAVARIA CRISPA Wulfen. Oong n̄ga repollo [67] (Ilk.). Edible. Plate 60, fig. 1.

This mushroom resembles a cabbage. It is whitish or pale yellow, and very much branched. The branches are ribbon-

[67] Cabbage mushroom.

like, broad, entangled, 2.4 to 4 centimeters wide; the apex is tinged yellowish, crisped, slightly zoned. The stem is whitish, becoming blackish with age, stout, and rooting. The flesh is whitish or yellowish, fleshy, and brittle. The whole plant is 8 to 58 centimeters in diameter.

This mushroom is edible. It has a pleasant smell and agreeable taste. It is quite common in Baguio, Mountain Province, growing on the ground under pine trees.

CLAVARIA STRICTA Persoon. Kabuteng bulaklak nang bato (Tag.). Edible. Plate 61, fig. 1.

This mushroom is found growing in most places, including the city of Manila, on trunks and roots of trees, especially on acacia trees. It can be found from June to September.

The plant is from 6 to 11 centimeters high and 10 to 15 centimeters broad, consisting of a mass of crowded branches in an upward position. These branch several times and form pointed teeth at the end. The color is white to creamy.

This mushroom is edible. It has a corallike form, hence its Tagalog name.

CLAVARIA ZIPPELII Léveille. Kabuteng may sañga-sañga [68] (Tag.). Note tested. Plate 60, fig. 2.

A treelike mushroom, growing on the ground in damp places, generally in the forest. It has many branches. It can be found from June to September.

The trunk is 6 to 11 millimeters in diameter. The branches are generally in pairs, indented at the base, 3 to 6 millimeters in diameter, 5 to 10 centimeters long; at the end of each branch are long needlelike points resembling the leaves of pine trees, 1 to 2 millimeters wide, 2 to 4 centimeters long. The whole plant is 15 to 20 centimeters high, yellow, darkening in age.

TREMELLACEÆ

The members of this family are more or less gelatinous in consistency. They are covered on the surface by the whole fruiting layer. Sometimes this layer is confined to only one side. When dry the plants are rigid and horny, regaining their original form when moistened or soaked in water. They grow on rotting wood, such as prostrate trunks and branches of trees, varying in color from gray, yellow-orange, and reddish, to brownish. They assume various forms, are often very irregular, leaflike, or strongly folded and uneven.

[68] Many-branched mushroom.

Genus AURICULARIA Bulliard

The generic name *Auricularia* is derived from the Latin word *auricula*, meaning "ear"—the likeness of this mushroom.

The fruit body when moist is gelatinous to leathery, cartilaginous to horny when dry, cup-shaped, sometimes asymmetrical. The fruiting surface is smooth, decorated like a network or folded into plaits, and normally located on the lower side. The genus *Auricularia* is found generally throughout the Philippines, as well as the world over. It is commonly called *taiñgang-daga*, meaning "rat's ear," in Tagalog, and "Jew's ear" in American, while in Panay it is called *dolongan sang kahoy*, meaning "ear on the wood."

Species of *Auricularia*, generally the *Auricularia auricula-judæ*, are sold in the market. They are imported from China in a dried form. The taiñgang-daga is almost indispensable in many of the Chinese dishes in restaurants and chop-suey houses.

Although the native *Auricularia* is found in abundance in the Philippines, its commercial value is little appreciated in this country, where people prefer to buy these mushrooms imported instead of collecting them in the fresh condition.

With but slight variations, the edible members of *Auricularia* are distantly and vaguely ribbed and plicated, swollen, somewhat jellylike, and of a violet color when moist.

AURICULARIA AFFINIS Léveille. Taiñgang-daga (Tag.); dolongan sang kahoy (Panay). Edible. Plate 61, fig. 2.

Auricularia affinis is rather common. Its eating qualities are as good as those of *A. polytricha* and *A. auricula-judæ*. It is thinner, however, not so cup-shaped, smoother, and lighter in color. Like the rest of the taiñgang-daga, this mushroom is found all the year round, growing on prostrate trunks and branches of trees, although it is more abundant during the rainy season.

This mushroom can also be dried. If it has been dried, soaking in water before cooking will make it soft and tender.

AURICULARIA AURICULA-JUDÆ (Linnæus). Dolongan sang kahoy (Panay); taiñgang-daga (Tag.). Edible. Plate 62.

This fungus grows on stumps, fallen trunks, and dead branches of trees. In taste it does not differ much from the other members of *Auricularia*. Those imported from China are mainly *A. auricula-judæ*. In England this plant was formerly used as a remedy for dropsy and for sore throat. It is very popular in Chinese chop-suey houses, where it is hardly ever lacking in a soup dish. This mushroom is found all year round, although it is most abundant from May to September. In the forests, where there are plenty of fallen trees, this species can be collected by the basketful.

The fruit body is grey, then olivaceous or reddish brown, finally dark brown, cup-shaped, half-round, concave, then ear-shaped, turning plicate, transparent, hairy. The flesh is whitish, gelatinous, then cartilaginous and tough. Soaked in water, it revives, assuming its original size and form.

AURICULARIA DELICATA Lloyd. Taiñgang-daga (Tag.); dolongan sang kahoy (Panay). Edible. Plate 61, fig. 3.

This very common *Auricularia* grows on prostrate trunks and branches of trees, generally on the bagtikan. It can be found all year round in the forests, although it is more abundant during the rainy season. It does not grow to a large size, and is very much smaller than many of the taiñgang-daga. It is, however, thicker, paler, and more gelatinous than any of them. The main character that distinguishes this species from the rest is the prominent venation. It is from 4 to 8 centimeters in diameter. The stalks is very short and often wanting.

In edibility this mushroom is considered the best. When cooked, it is very tender. It can be easily dried and stored for future use.

AURICULARIA MESENTERICA Persoon. Taiñgang-daga na may balahibo [69] (Tag.). Edible. Plate 63, fig. 1.

Meso is a Greek word meaning "middle," *enteron*, "intestine;" this species is named then from a fancied resemblance to a mesenteric membrane.

This mushroom is found in the same abundance as *Auricularia auricula-judæ*. It grows on stumps, fallen trees, and old bamboos. It is edible but tough. When dried and soaked in water it revives. This species is found all year round, but in greatest abundance during the rainy season.

The fruit body is dark brown or tawny, often cup-shaped, then bent backward, overlapping like a tiled roof, entire or lobate, grouped in concentric formation. The hymenium is in upward position, pale or brownish, then brownish violet, wrinkled, powdery with the spores. Flesh dark brown, gelatinous, then cartilaginous.

[69] Hairy Auricularia.

AURICULARIA POLYTRICHA (Montagne) Saccardo. Taiñgang-daga (Tag.); dolongan sang kahoy (Iloilo Vis.). Edible. Plate 63, fig. 2.

This is another species very common in the Philippines, growing on dead trunks and dried branches of trees. *A. polytricha* assumes a large size, measuring from 6 to 14 centimeters in diameter. This mushroom is rather thin, gelatinous, becoming leathery when dry, having round projections at the margin, with or without a very short stalk.

This mushroom is edible, and can be collected in large quantities, especially during the rainy season. It can be dried and stored.

Order GASTEROMYCETES

The members of this order are distinguished from the other orders by the fruiting surface being enclosed within a membrane or *peridium* until the spores are mature. This peridium, or wall, consists of one to three layers. When more than one layer is present, the outer layer is called the *exoperidium*, the inner the *endoperidium*. The contents of the peridium are collectively known as *gleba*.

Family PHALLOIDEÆ Fries

A great majority of the stink-horn fungi are characterized by a very offensive odor. Some of them at maturity are shaped like a horn. They grow on the ground or on decaying organic matter. The spawn or mycelium is in the form of strands, which are usually much branched and matted together. From these cords the fruit form arises. The fruit body is at first enclosed in an oval or globose peridium commonly called the egg. The peridium ruptures at the apex, allowing the young plant to develop. The remaining peridium forms the volva. The gleba, which is a soiled mass of spores, is moist and sticky, and attached to a stem or trellised receptacle. The receptacle is hollow.

Among the stink horns are a number of interesting genera. Some of them are very beautiful, although they possess offensive odors. None of the members are edible.

Genus DICTYOPHORA Desvaux

This genus is given the name *Dictyophora,* meaning "net bearer," because of the net that is borne by its members.

The stem or receptacle possesses a very coarse mesh, so that not only the surface but also the substance within is reticulated, pitted, and irregularly perforated. In this genus an outer layer of the receptacle or stem separates and elongates, breaks away from the lower part of the stem, is carried aloft, and hangs as a beautiful veil. This veil is very conspicuous in some species.

DICTYOPHORA DUPLICATA (Bosc) E. Fischer. Kabuteng may pandong (Tag.); oóng ti uleg (Ilk.). Poisonous. Plate 64, fig. 1.

This mushroom when young has the shape of a large egg, nearly round or sometimes flattened. It is 3.5 to 4.5 centimeters in diameter, white, and more or less furrowed below, like a peeled orange. The upper portion is smooth, flesh-colored to pale brown. The center of the base is provided with a large bunchy root. The whole plant when fully expanded is 15 to 18 centimeters high. The apical cap is 3 to 4 centimeters long and 3 to 4.5 centimeters in diameters, strongly chambered by anastomosing plates over which the olive-colored mass of spores is spread. Between the stem and the cap and hanging down from the top is a beautiful light rosy-pink veil. The veil extends below the cap for 3 to 5 centimeters. The stalk is 2.8 to 4 centimeters thick, nearly cylindrical, hollow, with chambered walls. It is provided with a volva at the base. The odor of the slimy spores is very offensive, and attracts flies.

This mushroom grows on the ground and can be found from May to September. It is poisonous.

DICTYOPHORA sp. Kabuteng may pandong (Tag.); oóng ti uleg [70] (Ilk.). Poisonous. Plate 64, fig. 2.

A beautiful mushroom growing in thickets, generally under wild bamboo trees. Like other phalloids, it takes the form of an egg when young. At first, it has a pleasant smell, but later it has a very offensive odor. It can be found from June to December.

This plant is from 10 to 14 centimeters tall. The cap is 4 to 6 centimeters long, 4 to 5.5 centimeters in diameter, conical, carved on the surface into a network and covered by the olive slimy mass of spores. The stalk is 2 to 4 centimeters wide, nearly cylindrical, hollow, with a corrugated surface. The Ilocano name has reference to the veil, which resembles the skin of the snake after molting. The Tagalog name refers to the veil borne by the fungus itself.

This mushroom is closely similar to *Dictyophora phalloidea* in many respects, except that it has the thread composing the veil much coarser than that in the latter, and in *Dictyophora*

[70] Snake mushroom.

phalloidea the veil is a continuation of the cap itself, while in *Dictyophora* sp., it starts under the cap.

DICTYOPHORA PHALLOIDEA Desvaux. Kabuteng may pandong (Tag.); Oóng ti uleg (Ilk.). Poisonous. Plate 65.

This is one of the largest and most beautiful phalloids in the Philippines, growing on the ground, especially under bamboo trees in the forest. When young or just opened it has a pleasant smell, but in age, as it begins to rot, it has a very bad odor, resembling that of a decomposing animal carcass. This mushroom grows from June to December.

This plant arises from a large egglike body. It is white and furrowed below, like a peeled orange. The upper part is smooth, pale to deep flesh-colored. On the center below is a large fleshy root with lateral branches. The size of the egg is 3 to 4.5 centimeters in diameter. The full-grown plant reaches the height of 15 centimeters. The cap is broadly bell-shaped, curved into a network on the surface, over which the brownish olive slime is spread. On top, at the apex of the cap, the color is much paler. The cap is 4 to 5 centimeters long and 3.5 to 4.5 centimeters broad. The rosy-pink-blue netlike veil is a continuation of the cap and often reaches the ground. The size of the meshes is 2 to 4 millimeters, except towards the margin, where they become much smaller. The stalk is 2.5 to 3.5 centimeters in diameter, nearly cylindrical, hollow, and with chambered walls.

Genus CLAUTRIAVIA Lloyd

This genus is characterized by having the surface of the cap convoluted into very fine folds. The mass of spores, called gleba, covers the fold and permeates the interspaces.

CLAUTRIAVIA MERULINA Lloyd [= PHALLUS MERULINUS Berkeley]. Kabuteng may pandong (Tag.); oóng tí uleg (Ilk.). Poisonous. Plate 66.

This species has the general appearance of a *Dictyophora*. The difference is in the cap, for, instead of being a plain or reticulate membrane with the gleba on the outer surface, it consists of minutely convoluted folds, the gleba permeating the depression between the folds. The cap is conical, olive-colored because of the mass of spores covering the surface. The stem is white and cylindrical, slightly tapering toward the top. The cap is in the form of a sheath covering the end of the stem at the base, dark gray. The net is very coarse, but a little finer below.

Genus PHALLUS Persoon

The cap is in the form of a disc, attached by the apex to the end of a hollow, cylindrical, spongy, porous, stemlike receptacle, and covered on the outside with a sticky mass of spores. The egg is globose or egg-shaped, torn above into irregular rounded projections by the developing receptacle, leaving a volva at the base.

The members of this genus grow on the ground.

PHALLUS TENUIS Lloyd. Kabuteng dilau na mabaho[71] (Tag.); oóng ti uleg (Ilk.). Poisonous. Plate 67.

A cylindrical mushroom, resembling a young seedling just broken off from the seed. The cap and the stalk are yellow, the cup is white. When dried, the specimen appears like a thin skin, similar to that of a snake after molting. This plant has only a very rudimentary veil, and often even this is lacking. The odor of the young plant is quite pleasant, but the matured and decaying fungus, like other phalloids, emits a very offensive odor. It grows on the ground from June to September.

The whole plant is 10 to 12 centimeters long, 0.8 to 1.2 centimeters in diameter. The cap is very thin, 9 to 13 millimeters in diameter and 2 to 2.5 centimeters long. The egg is about 3 centimeters long and 2 centimeters wide.

Genus MUTINUS Fries

The egg is white, round, oval or oblong, splitting into two or three round lobes. The receptacle is hollow, cylindrical, or spindle-shaped. The cap is apical, broadly attached to the stem, covered on the surface with a sticky mass of spores.

This genus differs from *Phallus* in having the cap wholly attached to the stem, while in the latter the cap is attached by the apex to the end of the receptacle by a narrow disc.

MUTINUS BAMBUSINUS (Zollinger) E. Fischer. Kabuteng pula na mabaho[72] (Tag.); oóng ti uleg (Ilk.). Poisonous. Plate 68.

This mushroom grows commonly on rotten leaves and in rich soil, often near bamboo stumps. It can be found from June to December. It is beautiful but not edible.

The plant is from 6 to 8 centimeters high and 1 to 1.6 centimeters thick at the center. The volva is white, 2 to 3 centimeters in diameter, 2.5 to 4 centimeters long. The cap is gradually tapering upward to a pointed end, and joined at the base with the stalk, at first covered with green mucus, which soon be-

[71] Yellow fœtid mushroom.
[72] Red fœtid mushroom.

comes red. The stem is elongated, spindle-shaped, cellular, rosy red above, fading downward until it becomes white below. Sometimes the plant branches out at the cap. In youth it has the shape of an egg. It is white, covered with a thick mucous membrane.

Genus ANTHURUS Kalchbrenner

The pouchlike peridium is composed of three layers; the outer layer is scurvy and thin, the middle one thick and gelatinous, and the inner thin, shiny, and smooth. The receptacle is short, cylindrical, hollow, bearing apically three to eight simple, brittle arms that are originally united apically and often breaking at maturity. The gleba is borne on the inner surface of the arms, moist, sticky, approaching olive color.

The species of this genus are quite rare. They are all poisonous and emit a very offensive odor.

ANTHURUS BROWNII Mendoza. Kamay ng patay[73] (Tag.). Poisonous. Plate 69.

The fruit body in youth is inversely egg-shaped, white, rough, 3 to 5 centimeters in diameter. The receptacle is stalked, short, cylindrical, hollow, up to 5 centimeters long, about 4 centimeters in diameter, thin, white throughout, broader at the top than below, divided into arms; the arms are white, 3.5 to 6 centimeters long, finely wrinkled on the interior, longitudinally sutured at the outside, united in youth, soon breaking off at the apex. Several fingers are two-branched at the extremities. The mucilaginous gleba is borne on the inner surface of the arms.

This mushroom is extremely fœtid. It is found in sandy soil mixed with decayed organic matter, where it appears from June to about November.

The Tagalog name refers to its appearance when the volva is removed, showing only the receptacle and the segments.

LYCOPERDACEÆ

PUFFBALLS

The puffballs are generally more or less round or inversely egg-shaped, and when young they are solid throughout. Within the walls of the spore-bearing body practically all the tissues differentiate at maturity into a mass of countless, dry, colored spores. Some of the smaller kinds at maturity develop a mouth, or opening, at the apex. When disturbed by a physical force

[73] Dead man's fingers.

they appear to send out smoke, due to the very numerous spores that burst out in a dark cloud through the mouth or opening. Many of the larger puffballs develop no terminal aperture or mouth. In this case spores are liberated only with the general breaking of the wall itself. Besides the wall, the only portion of the fruiting body that does not take part in the formation of the spores in the true puffball is the sterile base. This sterile base in certain species persists in characteristic form until the following season. The puffballs are found in woods, fields, and pastures. Many species are very small, but some are gigantic. When young, and practically up to the time of attaining full size, nearly all puffballs possess white flesh, and so long as this inner tissue is white, the puffballs are edible. However, when bruised or attacked by insects or bacteria, the flesh becomes yellowish, purplish, or otherwise discolored, rendering this fungus unfit for the table.

Genus BOVISTA Persoon

These plants are round or nearly round. They are attached centrally at the base. The outer covering is thin and fragile, flaking off at maturity and leaving exposed the smooth, thin, swollen, metallic-looking inner coating which opens by an apical mouth. Soon it becomes detached from the ground and is blown about like a light ball pouring out the spores. The spores are dark brown, or purplish brown in mass.

These mushrooms are found in open fields, pastures, and lawns. All the species when young are edible. This genus differs from *Lycoperdon* in the absence of a sterile base.

BOVISTA PILA Berkeley & Curtis. Parapara (Ilk.); tombong (Tag.). Edible. Plate 70, fig. 1.

The Ilocano and Tagalog names of this mushroom refer to its likeness to the roundish, white embryo plant that is inside the coconut. It is common in grassy fields, pastures, and lawns, from May to October. It is edible when young. The Ilocanos cook it with vegetables. For better cooking, the plant is sliced, coated with flour, then fried in butter or shortening. It is soft and palatable, and the taste is like that of calf brain.

The plant is round or nearly so, irregularly pointed downward, 0.8 to 3 centimeters in diameter, attached abruptly below by a simple, small mycelium strand which breaks at maturity. The outer covering is very thin, about 0.25 millimeter thick, pure white, tending to become pinkish or grayish yellow when handled. The surface is delicately powdered, becoming more or less irregularly channeled, flaking off in patches at maturity. The inner wall when exposed is smooth and shining, more or less bronze-colored and splotched with blackish or gray areas, the effect being a metallic appearance like burnt copper. It soon opens at the top by an irregular pore or by extensive splitting and flaking.

Genus CALVATIA Fries

The plants are large, round, flattened or toplike, in appearance, or of some other similar form. The sterile stalklike base is either present or absent. The outer covering is thick, woven, or divided into small spaces. The inner covering is thin, delicate, not opening by a pore but falling away irregularly in scales and plates, soon exposing the densely woven mass of threads called *capillitium.* The sterile base is concave above, persisting a long time as a cup-shaped remnant. This genus is easily distinguished from *Lycoperdon* by the irregular scaling away of the outer wall at maturity, and in most species by the fragility of the capillitium. The genus includes the large puffballs. The latter are important as food and should be used whenever found in the young stage. The ripe *Calvatia* applied to a bleeding wound is said to stop the flow of blood.

CALVATIA LILACINA Fries. Tombong (Tag.); parapara (Ilk.). Edible. Plate 70, fig. 2.

This mushroom is very common in grassy fields and in pastures. It grows very abundantly and can be collected by the bushel during favorable rainy weather in June and July. It may be found from May to December, and sometimes much later in the mushroom season, when there are occasional heavy rains. This is the largest puffball in the Philippines. The writer ate plenty of this mushroom while it was still very young and white inside. The plant is sliced in fine pieces, thinly coated with flour, and fried in shortening or butter. It is soft and tastes like calf brain.

The plant is broadly inversely egg-shaped or top-shaped, 5 to 10 centimeters high and 5 to 8 centimeters in diameter, contracted below into a stout, cellular, stemlike base; the covering is white, polished, becoming yellowish brown or dark gray with age, and soon breaks away in papery patches. The peridium or the whole spore body is thin and evanescent above, bursting by a large opening when mature. The sterile base remains persistent a long time as a cup-shaped remnant.

This mushroom forms a fairy ring.

Genus LYCOPERDON Linnæus

The generic name *Lycoperdon*, derived from the Greek words *lukos*, meaning "wolf," and *perdon*, "dung," probably was given to this mushroom by the people in a country where wolves abound.

These plants are comparatively small, globose, inversely egg-shaped or top-shaped. The base in most of the species is filled with a sterile, honey-combed tissue. The wall is composed of two layers—an outer layer which becomes broken up into spinelike tufts or warts, and an inner, smooth layer which opens spontaneously when mature by a small apical mouth or by the gradual falling away of the upper surface. The gleba, or internal tissue, is composed of minute chambers. It is white when young, changing as the plant ripens through yellowish or olive to brown or purplish.

LYCOPERDON PYRIFORME Schaeffer. Tombong (Tag.); parapara (Ilk.). Edible. Plate 71, fig. 1.

This is a small puffball which grows in dense clusters on decaying wood and well-disintegrated vegetable matter. It is common in the forest. The color is white or light brown, and the surface is covered with minute wartlike scales. The stem is very short or almost lacking, but there are always netlike strands of mycelium extending from the base of the mushroom into the rotten wood. The plant is 3 to 4.5 centimeters broad and 3 to 5 centimeters high, usually much smaller. It is edible and can be cooked like other puffballs.

Genus SCLERODERMA Persoon

The fruit body is sessile, or prolonged with a short stemlike base. The wall is firm, leathery or corky, smooth, warted, scaly or granular, breaking irregularly, and in a more or less stellate manner. The gleba is traversed by sterile veins and finally becomes powdery. All the species of this genus are terrestrial.

SCLERODERMA GEASTER Fries. Parapara (Ilk.); tubó (Tag.). Tough. Plate 71, fig. 2.

The plant is 3.5 to 7 centimeters in diameter when closed, up to 10 centimeters when open, nearly round, often irregular, with a rounded projection on top, not infrequently growing more than half buried in the ground; at the base it is connected with strands of cottony mycelium; the covering is hard and rigid, about 6 millimeters thick when fresh, and 1 to 3 millimeters thick when dry, white when young, later turning yellow, dull yellow to straw-colored, and then cracking into scales, splitting up irregularly at maturity into a varying number of lobes which curl back as they dry and expose the dark spore mass which is brown when fully mature. The stem is absent.

The specific name is taken from the way in which the covering cracks up, resulting in a more or less stellate form resembling that of the genus *Geaster*.

This is the only true puffball that is never edible.

Genus GEASTER Micheli

Geaster is taken from the Greek words *ge*, which means "earth," and *aster* "star"—referring to the starlike appearance of the mature plant.

The species of this genus are terrestrial, very common, and generally found in great numbers in thickets and under bamboo trees, generally in the forests. They are interesting because of their starlike form. None of them are edible.

GEASTER HYGROMETRICUS Persoon. Bituing lupa[74] (Tag.). Not edible. Plate 72.

The specific name is taken from the Greek words *hygros*, "moisture," and *metron*, "measure," and refers to the absorption by this species of moisture from the air.

The plant when expanded is 1.5 to 3.5 centimeters in diameter and up to 3.5 centimeters tall, excluding the basal cap. The outer covering is gray or grayish brown, the inner brownish, and becoming deeply cracked, round, tough, leathery, cartilaginous, soon splitting almost to the base into five to seven acute lobes in a stellate manner. The spore sac is sessile, egg-shaped, round, woolly, gray or brown, opening spontaneously when mature by a small special mouth. The aperture is narrow, irregularly torn. The spore mass is dark brown.

These fungi are strongly sensitive to moisture, and in moist weather recurve and, standing on their tips, lift up the inner ball. In dry weather they curve in closely, clasping the ball. This process is repeated every time there is a change in moisture. This mushroom is very common in the forests, growing on decayed leaves and rubbish, often under wild bamboo trees. It is found in groups of many, from May to March. It is not edible.

[74] Earth star.

Family NIDULARIACEÆ Fischer

THE BIRD'S-NEST FUNGI

The fruiting body in the members of this family is funnel-shaped or round, leathery or fleshy-leathery. The opening is the entire top, exposing one to many roundish "peridioles" or eggs. Three or four eggs are usually attached by a cord to the wall of the fruiting body. The typical members of the family are popularly known as "bird's-nest fungi."

Genus CYATHUS Haller

The name *Cyathus* is taken from the Greek word *kuathos*, "wine cup," and refers to the cuplike shape of the members of this genus.

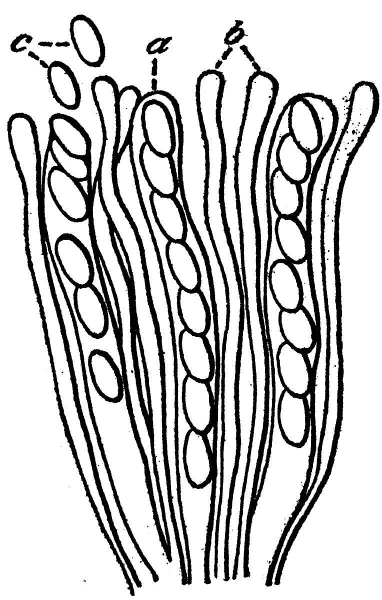

FIG. 5. Cross section of the fruiting body of Ascomycetes. *a*, Ascus; *b*, paraphyses; *c*, spores; highly magnified.

The fruit body is cylindrical to bell-shaped, with a wall which consists of three distinct, closely connected layers. This wall is closed at first, with a membranous covering, which finally ruptures and disappears. The numerous peridioles are compressed, depressed in the middle, and attached to the inner wall of the peridium by a short cord, technically called "funiculus."

CYATHUS STRIATUS Hoffmann. Pugad ñg ibon [75] (Tag.). Not edible. Plate 73.

A very common fungus found all year round, but most abundant during the rainy season. It grows in groups, generally on rotten bamboo and old rotten boxes. The Tagalog name refers to its nestlike appearance, caused by the egglike structures inside.

The fruiting body is reddish brown or iron-rust-colored, covered externally with sharp hair, inversely conical or bell-shaped, 8 to 13 millimeters high, 6 to 9 millimeters in diameter; the apex at first is incurved and closed in by a pale membrane,

[75] Bird's nest.

then opens and shows the lead-colored, grooved, inner surface. The peridioles or eggs are whitish and nearly round.

Class ASCOMYCETES

The use of the microscope is necessary in determining the distinguishing characters of the class Ascomycetes, because most of them cannot be seen by the naked eye. These distinguishing characters (text fig. 5) are the "asci" (sing. "ascus") which are club-shaped or cylindrical and typically contain eight "ascospores." Some members of this class, because of their size and economic value, should be included among the mushrooms herein described. The morels, *Xylaria* and *Peziza*, are but a few examples.

Order DISCOMYCETES

The fruiting body in this order is generally in the form of a cup. At first it is closed, but it soon opens and expands with growth, often finally becoming convex, and either sessile or borne on a stalk. It is almost always simple, but may be compound, as in *Morchella* (Plate 74, fig. 1). The hymenium is spread over the upper surface of the cap as a distinct membrane.

Genus MORCHELLA Dillenius

Morchella is from the German word *Morchel*, which means "morel."

The morels are all edible, and they are usually easy to recognize. The plants consist of two distinct prominent parts, the cap and stem. The cap is nearly globose or elongated, blunt or sharply pointed at the apex. It is always marked by rather broad pits covering the entire surface. These pits are separated from each other by ridges forming a network. The arrangement of the pits on the surface is regarded as characteristic of certain species. The fruiting body is yellow to brown. The stem is usually quite stout, though it varies to some extent in some of the different species in proportion to the thickness of the cap. The stem is marked in some of the species by large wrinkles or folds extending irregularly but with considerable uniformity over the surface. The surface is further minutely roughened by whitish or grayish elevations, giving it a granular appearance. Sometimes these granules are quite evenly distributed over the surface, and in some species they are more or less separated into small areas by narrow lines.

The morels should always be carefully washed before cooking. Soaking for some time in salt water will improve them and insure the absence of any insects that might be within the pits. Fried in butter or fat, they are delicious.

MORCHELLA ESCULENTA Persoon. Kabuteng hugis utak[76] (Tag.). Edible. Plate 74, fig. 1.

The specific name *esculenta* is a Latin word, meaning "edible." The common name has reference to the indentation of the fungus, which is like that of a brain.

The plant is from 5 to 15 centimeters high. The stem is 1 to 3 centimeters thick, hollow, and the cap is broader than the stem, more or less oval or rounded in outline. In this species the pits are irregularly arranged, so that they do not form rows, and the ridges separating them do not run longitudinally from the base toward the apex of the cap. The flesh is waxy and brittle. The taste and smell are pleasant.

This mushroom appears from May to September, and is abundant during the wet months. It is found on the ground in the forest where it is cool and moist.

Genus PEZIZA (Dillenius) Linnæus

The fruit body is sessile, or sometimes narrowed below into a short stemlike base, even, provided with little knots or nodules, or veined, at first closed, then expanding until cup-shaped, disc-shaped, or sometimes plane or even convex. The exterior is warted, scurfy, or fairly smooth. The plants are fleshy and brittle. All the larger species are probably edible.

PEZIZA POSTULATA (Hedwig) Persoon. Kabuteng hugis kopa[77] (Tag.). Plate 74, fig. 2.

A quite common cup-shaped mushroom, found growing on charcoal and burned areas. The edibility of this species in the Philippines is not yet determined. However, in the literature none of the species of *Peziza* are reported poisonous. This mushroom is frequently found in Manila from June to September.

This mushroom is pale brown to chocolate-brown. When young it is much lighter in color outside than inside. At first it is closed and nearly round, then it gradually expands, reaching a diameter of from 3 to 6 centimeters. It is regular or much distorted. The margin is irregular or with small round projections. The plant is quite tender and brittle.

[76] Brainlike mushroom.

[77] Cuplike mushroom.

PEZIZA SULCIPES Berkeley. Plate 75, fig. 1.

The disc is stalked or nearly so, cup-shaped, 1 to 3 centimeters in diameter and about 1 centimeter deep, sometimes more shallow, on the other side often marked with several concentric rings near the margin, which is fringed with very fine, short, yellowish hairs; the surface is deep orange to nearly scarlet, fading with age. The stem is often short, so that the cup appears to be without a stalk, but sometimes it reaches a length of 3 centimeters, and 1 to 2.5 millimeters in diameter.

This fungus is very common in the forest, growing on old wood and bark. It can be found from May to December.

PEZIZA TRICHOLOMA Montagne. Kabuteng kopang pula [78] (Tag.). Plate 75, fig. 2.

A very common mushroom, growing on wood and bark of trees, especially on dried branches.

The fruiting body has a stem that is 2 to 3 centimeters long and 1.5 to 2.5 millimeters in diameter. Sometimes the stem is very short, so that the fungus looks sessile. The margin of the cap reaches a diameter of 1 to 2 centimeters and a depth of 1 centimeter or more. It is densely covered with numerous long whitish or pale-brown hairs that are tapering upward. The cup is deep red, fading in drying.

This mushroom is very similar to *P. sulcipes* in appearance. It differs, however, in that *P. sulcipes* is deep orange-colored, and covered with only very fine, short, scanty hairs, while *P. tricholoma* is deep red in color and covered with abundant, long hairs.

PEZIZA VESICULOSA Bulliard. Kabuteng kopang maputiputi [79] (Tag.). Edible. Plate 76.

This mushroom grows in groups or scattered, and is generally found on rich sticky soil. At first it is hemispherical, and early distorted in outline, later expanded, with the margin broken into irregular round projections. The plant is whitish outside and pale brown inside, 3 to 6 centimeters in diameter. The stalk is absent. The flesh is soft and white, and has a pleasant odor and taste.

This mushroom can be found from May to October.

Genus XYLARIA Hill

The generic name *Xylaria* is taken from the Greek word *xylon,* meaning "wood," and refers to the texture of the members of this genus.

[78] Red-cupped mushroom. [79] Light-colored cup mushroom.

The fruit body is black, erect or ascending, cylindrical, club-shaped or threadlike, often compressed, simple or branched, corky or leathery.

The species of this genus usually grow on or near wood.

XYLARIA BIFORMIS Lloyd. Plate 77, fig. 1.

A queer-looking mushroom, resembling the anther of a deer or the horn of a beetle. It is very common in moist places, growing on rotten wood in the forest. It can be found all year round, but is most abundant from May to October.

The whole plant is 3 to 12 centimeters long and 0.3 to 1 centimeter in diameter. The stem is more or less twisted, rather rugged, short, and reaches about 1 centimeter in length. The antherlike branches are 0.5 to 3 centimeters long, and 1 to 5 millimeters in diameter, tapering towards the end. The color is brown to dark brown. This mushroom is tough and when dried becomes brittle.

XYLARIA DEALBATA Berkeley and Curtis. Plate 77, fig. 2.

Another club-shaped mushroom, which grows on rotten wood, generally the bagtikan, and very common in the forests. It can be found from May to December.

At first it is straw-colored, becoming dark in age. It is cylindrical, blunt at the end, more or less rugged or rough, and somewhat tough. The whole plant is 3 to 10 centimeters long, 0.8 to 1.5 centimeters in diameter. There is no well-defined stem. The base is provided with a round structure for attachment. This mushroom has no definite shape, although it is commonly cylindrical. Sometimes it is cut abruptly near the top, but a growth of short cylindrical forms is continued upward.

This mushroom is too tough to be edible.

XYLARIA EUGLOSA Fries. Plate 78, fig. 1.

A club-shaped mushroom, often found in the forests growing on rotten wood and sometimes on living trees. It is tough, becoming hard and brittle in age. It can be found from May to December.

This mushroom is at first smooth, clay-colored, later rough, dark brown, and blackening. The inside tissue is white to ash-colored. The stem is short, often not distinct. It is enlarged at the base. The whole plant is 4.5 to 6 centimeters long, 0.8 to 1.4 centimeters in diameter.

XYLARIA PISTILARIS Lloyd. Kabuteng maitim na daliri (Tag.). Plate 79, fig. 1.

This is a common, large mushroom that is found in groups, sometimes growing together at the base of prostrate trunks and stumps. In appearance it resembles a black finger, hence its Tagalog name. It is found from June to September.

This mushroom is tough to woody in texture. The whole black fingerlike fruiting body is called *stroma.* At the tip and the portion near it, where the process of growth has just been taking place, the color is white or pale. Later the whole surface becomes entirely black. The inside part of the plant is white. It is 14 to 15 centimeters long and 4 to 8 centimeters in diameter.

XYLARIA RIDLEYI Massee. Plate 78, fig. 2.

This species grows on rotten wood in humid places in the forests. It is common in the Philippines. When young, it is white inside, becoming dark or sooty in age. Sometimes the inside portion disintegrates and later disappears, leaving only the walls that are usually split. The whole plant is 2 to 5 centimeters long, 3 to 7 millimeters in diameter. It is club-shaped and blunt at the end. The lower portion is rough and rugged and assumes a stemlike form. Oftentimes the whole plant forms into biceps, uniting at the base and at the tip.

This mushroom is too tough to be edible.

Genus DALDINIA de Notaris

The distinctive character of this genus is the zonate arrangement of the stroma (the cushionlike fruiting body) which consists of white or pale pithy layers alternating with narrow black carbonacious layers. These zones are of different textures and color. When young and growing, the members of this genus are covered with an iron-rust-colored conidial layer. This is the usual condition during dry weather. In maturity this layer disappears and the surface becomes black, smooth, and shiny.

DALDINIA CONCENTRICA (Bolton) Cestadi and de Notaris. Kabuteng matigas at mabilog [80] (Tag.). Plate 79, fig. 2.

This is a hard mushroom, very common and abundant on old trunks of trees and rotten bamboos. It is found all year round.

This fungus is usually roundish, not stalked, varying from 2 to 3.5 centimeters in diameter. It is brown at first, then black,

[80] Round, hard mushroom.

and easily recognized by the concentrically-zoned flesh. It appears often in groups, although generally single.

This mushroom is too hard and brittle to be edible.

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[The author makes no claim of having covered all mushrooms found in the Philippines. Additional information on mushrooms in the Philippines can be obtained from the publications listed below. Although these publications are largely from foreign countries, they are useful locally in that many mushrooms growing in the Philippines are also found in other countries. Substantial literature on Philippine mushrooms is very limited; the most valuable references are those of Graff and of Copeland.

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ILLUSTRATIONS

[Plate 12 is a water-color drawing by Victoriano V. Marasigan; Plates 38 and 65 are water-color drawings by Gerardo Garcia and Plates 23, 24, and 55, by Pedro L. Ramos. Plates 14, 16, 21, 42, 62, and 68 are reproduced from oil paintings by Pedro L. Ramos; Plate 17 is from an oil painting by Bienvenido Alcantara.]

PLATE 1. SPAWNS.

FIG. 1. Commercial spawn in bottle form.
2. Commercial spawn in brick form.
3. Natural or virgin spawn.

PLATE 2

Button stage of *Lepiota cepaestipes.*

PLATE 3

Tragedy in a coffee plantation. *Pleurotus* sp. attacking a coffee tree.

PLATE 4

Lentinus sajor-caju, living on a dead tree.

PLATE 5

Fairy ring of *Psalliota perfuscus.*

PLATE 6. IMPORTED MUSHROOMS.

FIG. 1. *Pleurotus ostreatus,* from China.
2. *Auricularia* spp., from China.
3. *Cortinarius Shiitake,* from Japan.

PLATE 7. MUSHROOM CULTURE.

FIG. 1. Mushroom culture in Ilocano and Pangasinan provinces.
2. Waste of abacá fiber, palay straw, banana trunks, and empty rice sacks piled together as a bed.

PLATE 8

Volvaria esculenta, growing on a stack of rice straw.

PLATE 9

Volvaria esculenta, growing on decayed rice straw and animal dung.

PLATE 10. SPORE PRINTS.

FIG. 1. Spore print of a purple-brown-spored agaric, *Psalliota perfuscus.*
2. Spore print of a white-spored agaric, *Lepiota cepaestipes.*

PLATE 11

Amanita manilensis.

PLATE 12

Amanita muscaria.

PLATE 13

FIG. 1. *Amanita phalloides.*
2. *Amanitopsis fulva.*

PLATE 14

Lepiota americana.

PLATE 15

FIG. 1. *Amanitopsis vaginata.*
2. *Lepiota candida.*

PLATE 16

Lepiota cepaestipes.

PLATE 17

Lepiota chlorospora.

PLATE 18

FIG. 1. *Lepiota cristata.*
2. *Lepiota lilacea.*

PLATE 19

FIG. 1. *Lepiota metulispora.*
2. *Lepiota* sp.

PLATE 20

FIG. 1. *Lepiota gracilenta.*
2. *Lepiota hispida.*
3. *Collybia acervata.*

PLATE 21

Lepiota denundata.

PLATE 22

FIG. 1. *Armillaria mellea.*
2. *Collybia distorta.*

PLATE 23

Collybia albuminosa.

PLATE 24

Collybia sp.

PLATE 25

FIG. 1. *Collybia radicata.*
2. *Collybia velutipes.*

PLATE 26

FIG. 1. *Lactarius volemus.*
2. *Omphalia reclinis.*

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FIG. 1. *Pleurotus ulmarius.*
2. *Russula sanguinea.*

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FIG. 1. *Tricholoma* sp.
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PLATE 29

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2. *Pleurotus limpidus.*
3. *Pleurotus ostreatus.*

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FIG. 1. *Pleurotus opuntiæ.*
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3. *Pleurotus pulmonaris.*

PLATE 32

FIG. 1. *Clitocybe luscina.*
2. *Clitocybe phyllophylla.*

PLATE 33

FIG. 1. *Clitocybe multiceps.*
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PLATE 37

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2. *Lentinus ramosii.*

PLATE 38

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PLATE 39

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2. *Lentinus sajor-caju.*

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FIG. 1. *Psalliota campestris* var. *umbrina.*
2. *Psalliota comtula.*

PLATE 50

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PLATE 51

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PLATE 52

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2. *Coprinus confertus.*

PLATE 53

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PLATE 54

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Boletus castaneus.

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PLATE 57

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PLATE 59

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PLATE 60

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FIG. 1. *Dictyophora duplicata.*
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PLATE 65

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Cyathus striatus.

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FIG. 1. *Peziza sulcipes.*
2. *Peziza tricholoma.*

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PLATE 77

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2. *Xylaria dealbata.*

PLATE 78

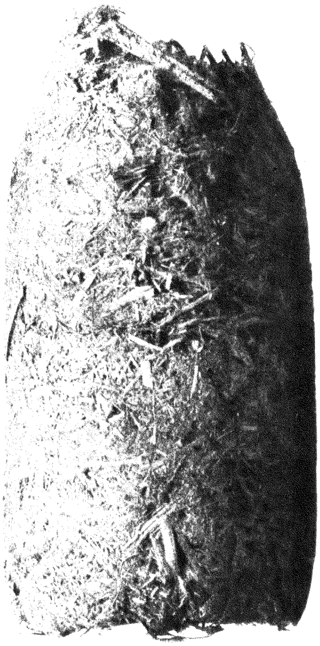
FIG. 1. *Xylaria euglosa.*
2. *Xylaria ridleyi.*

PLATE 79

FIG. 1. *Xylaria pistilaris.*
2. *Daldinia concentrica.*

TEXT FIGURES

FIG. 1. Structure of a gill mushroom.
2. Cross section of a very small portion of a gill. *a,* Hyphæ; *b,* basidia; *c,* sterigmata; *d,* spores; *e,* cystidium; highly magnified.
3. Portion of the structure of agarics, showing the arrangement of gills. *a,* Gills free; *b,* gills adnate; *c,* gills sinuate; *d,* gills decurrent.
4. Portion of the structure of agarics, showing the different formations of the caps. *a,* Convex; *b,* campanulate or bell-shaped; *c,* conical.
5. Cross section of the fruiting body of Ascomycetes. *a,* Ascus; *b,* paraphyses; *c,* spores; highly magnified.



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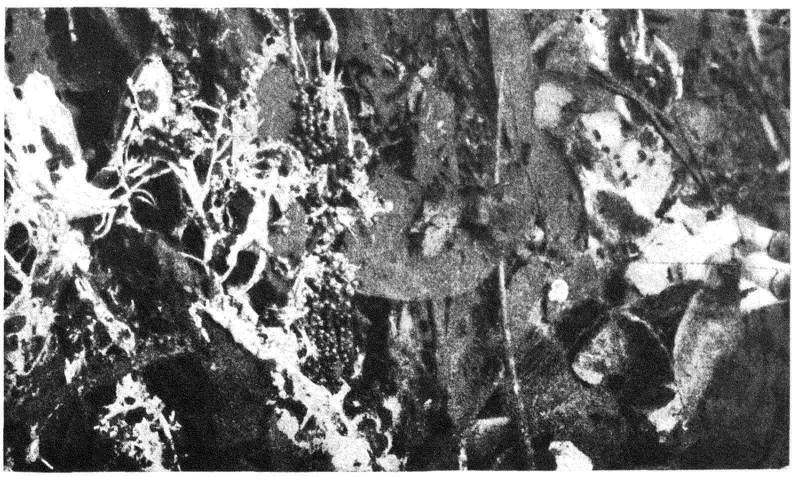

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PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

PLATE 5.

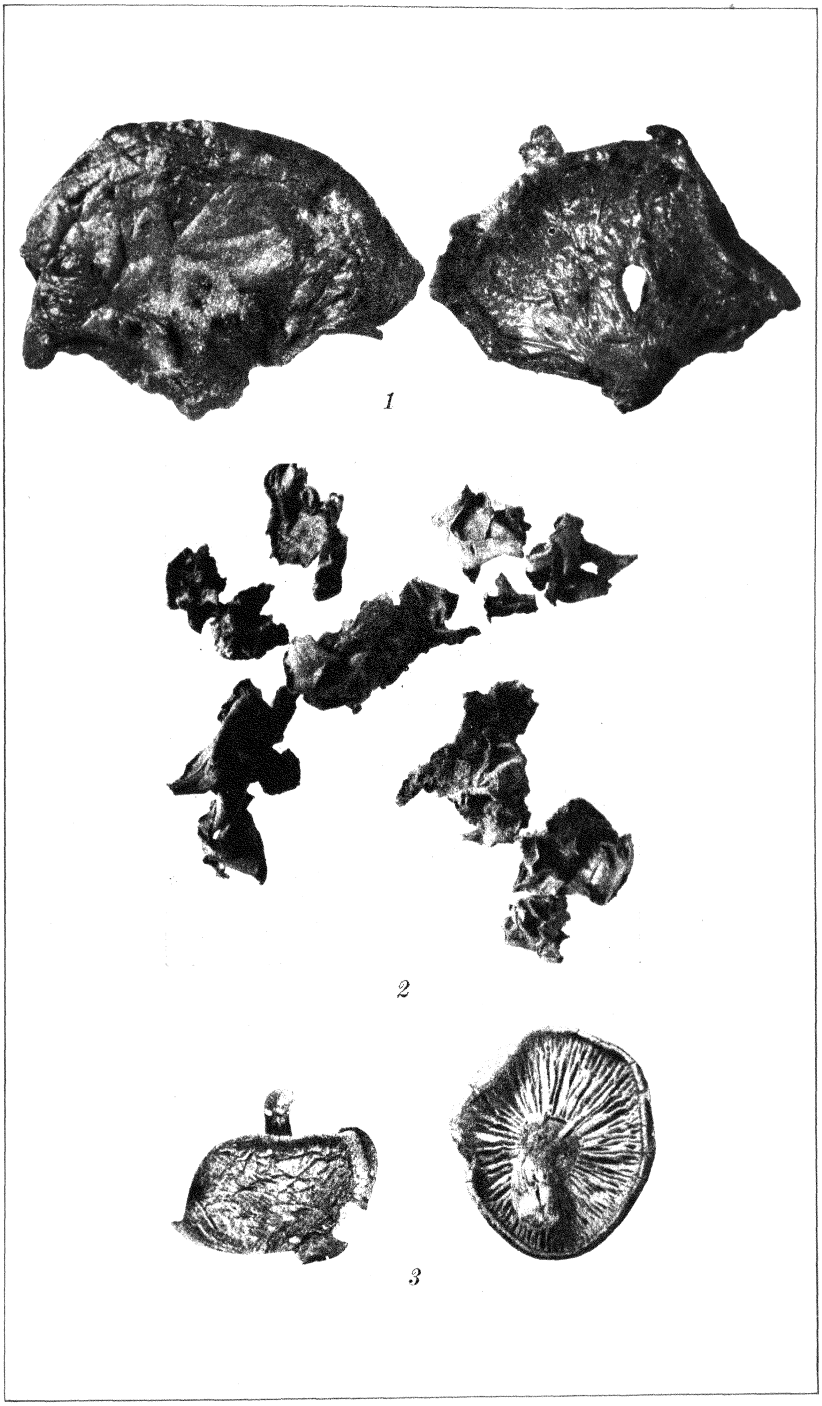
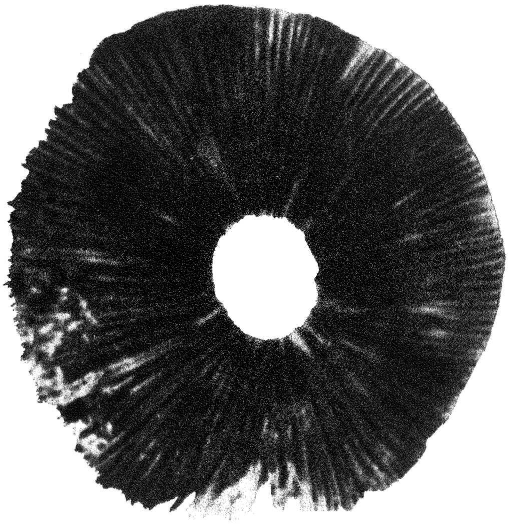


PLATE 6.

PLATE 7.

PLATE 8.

PLATE 9.



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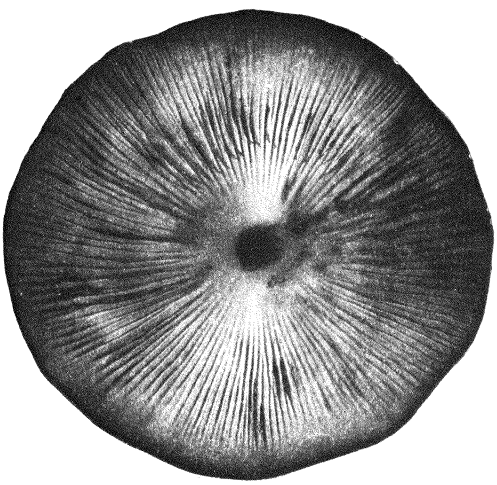

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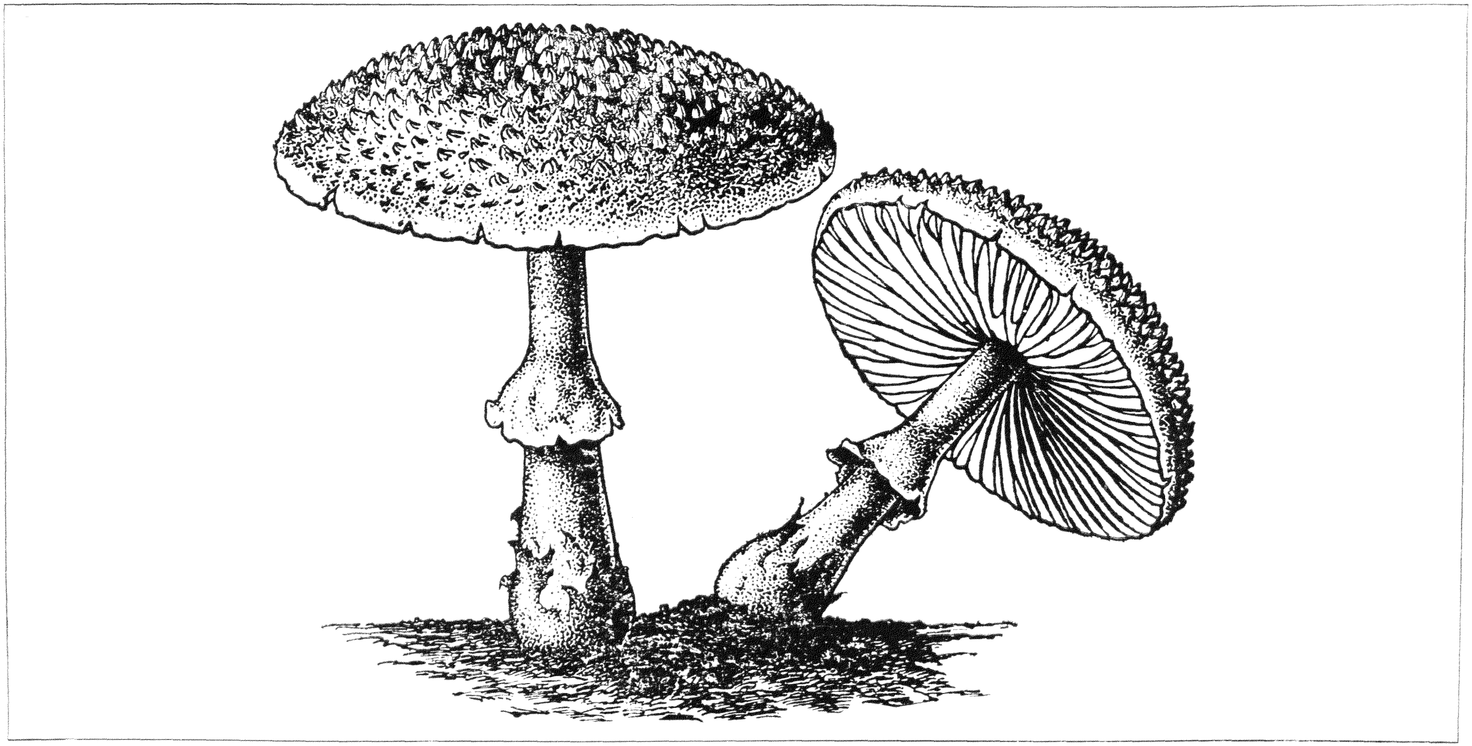

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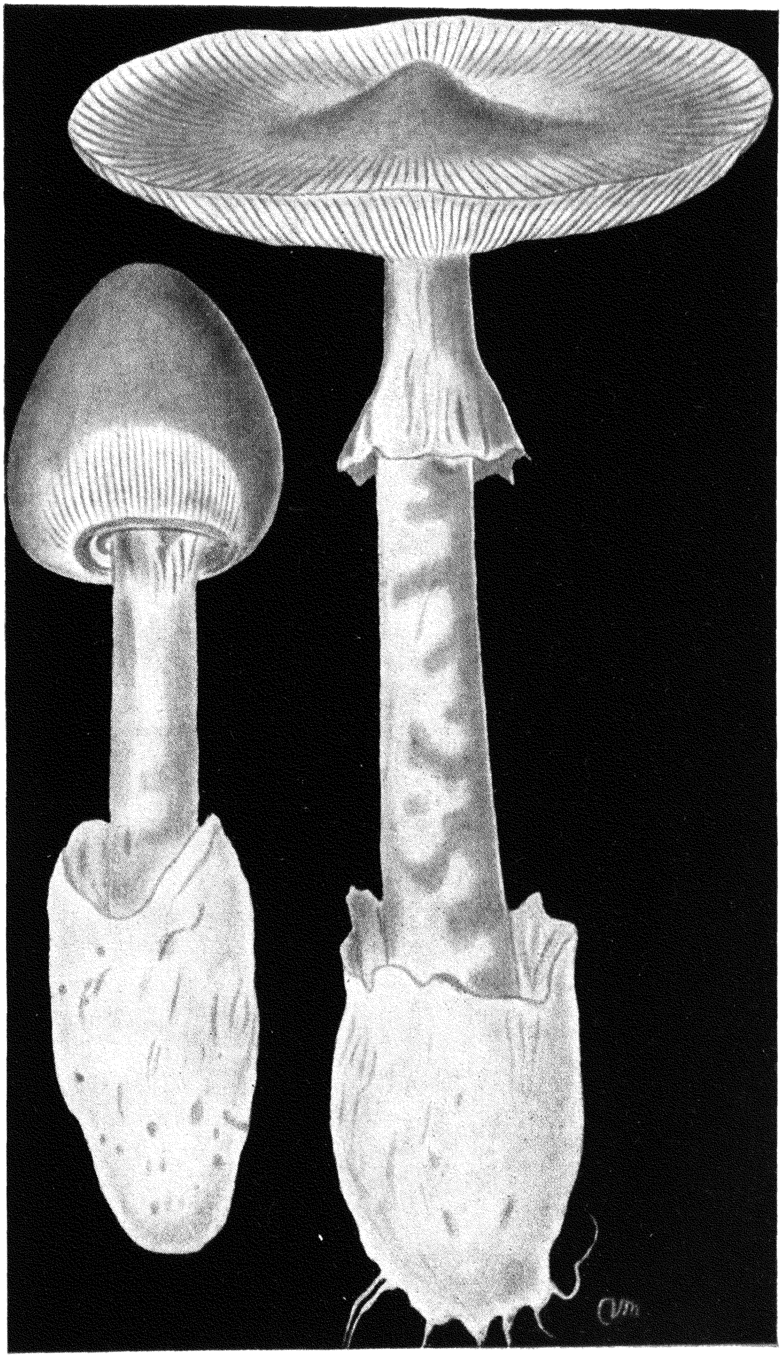

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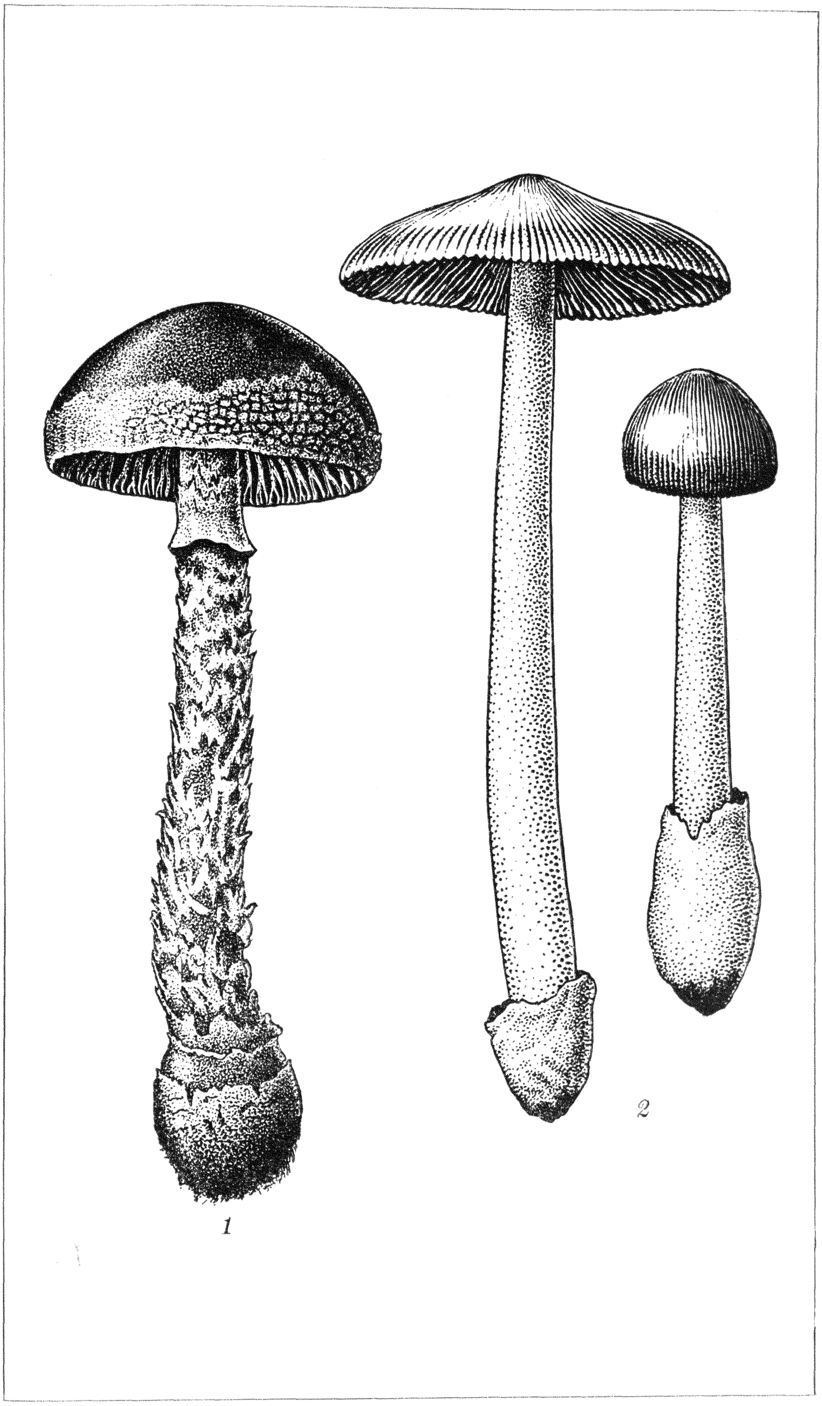

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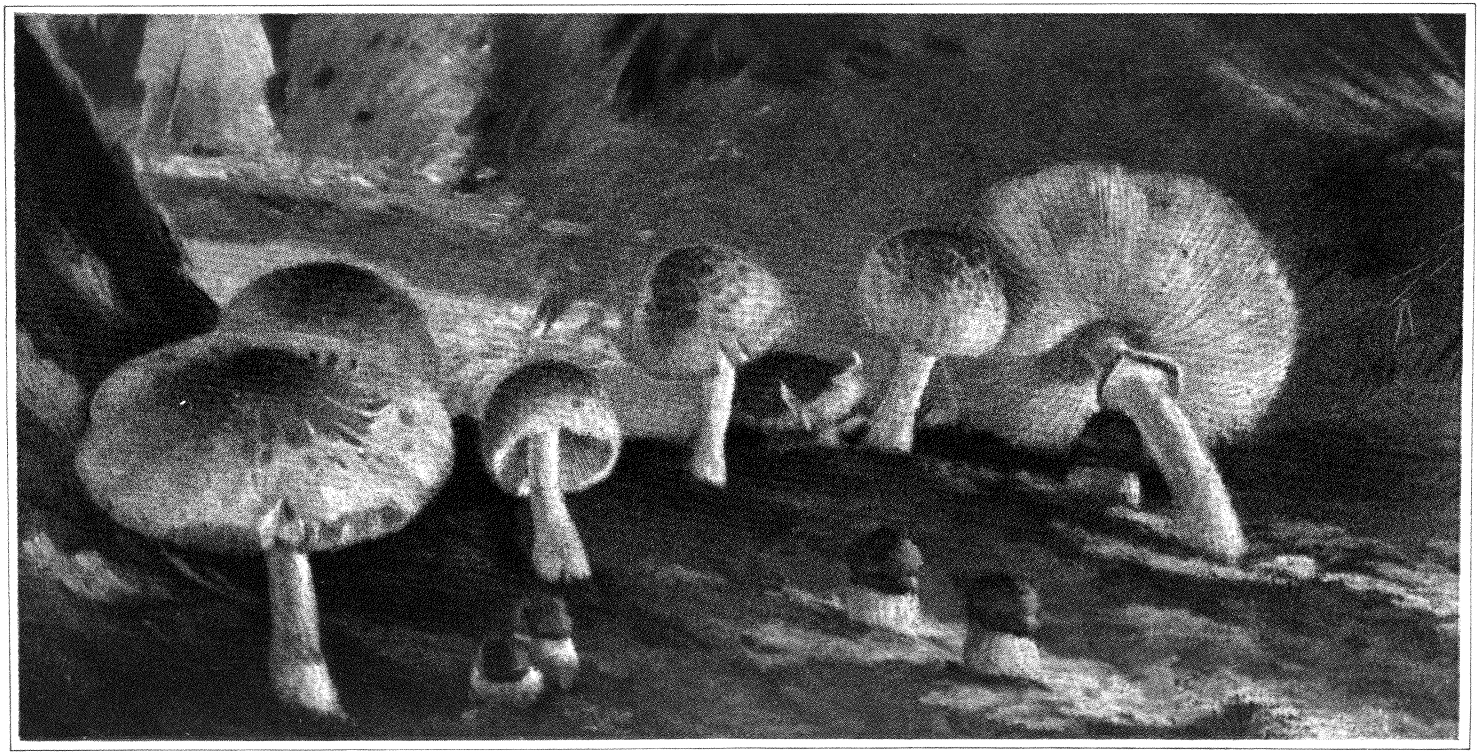

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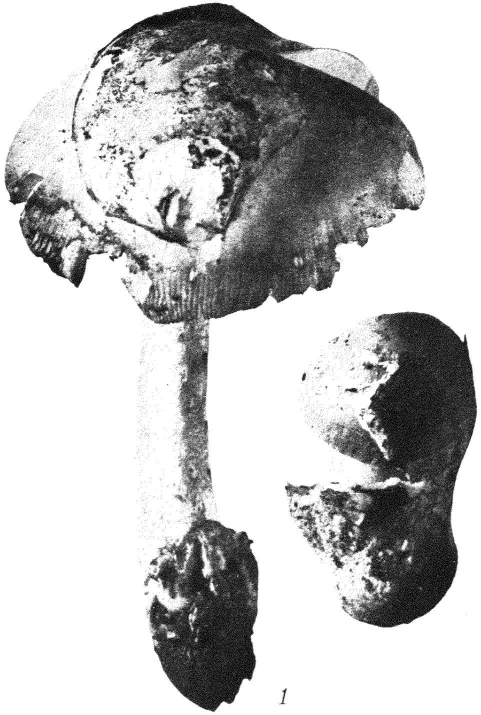

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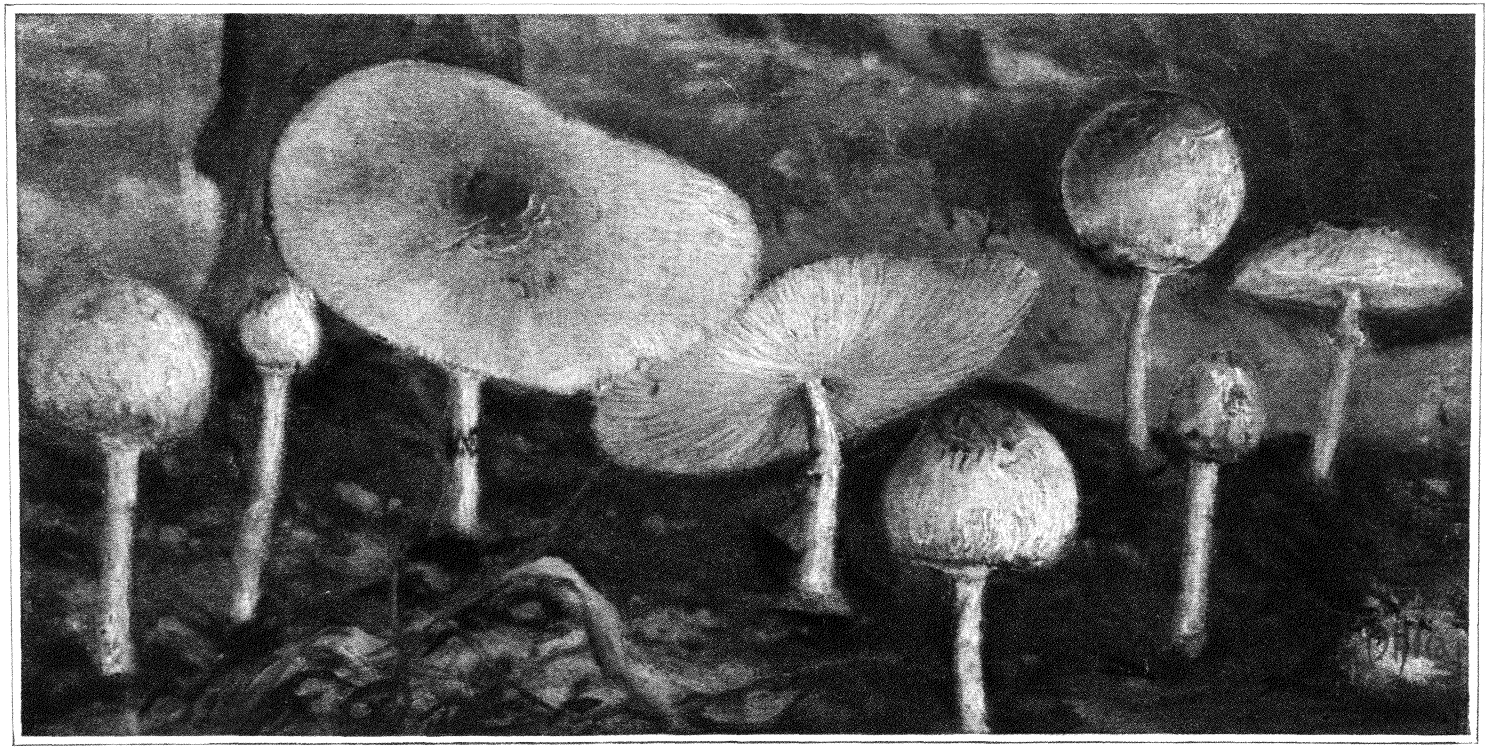
PLATE 15.

PLATE 16.



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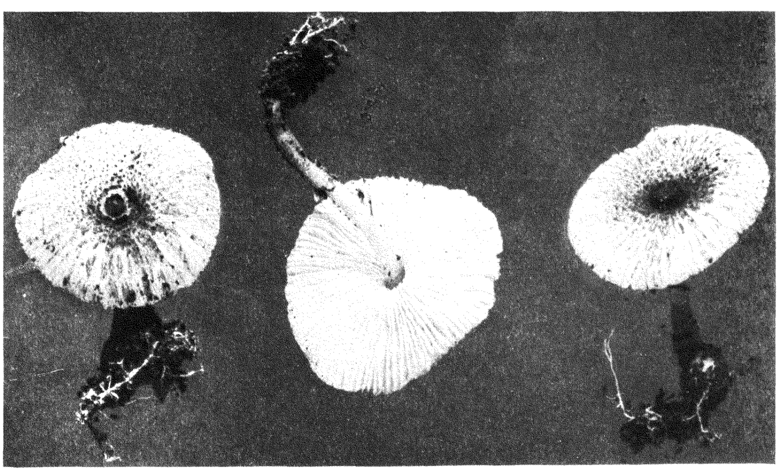

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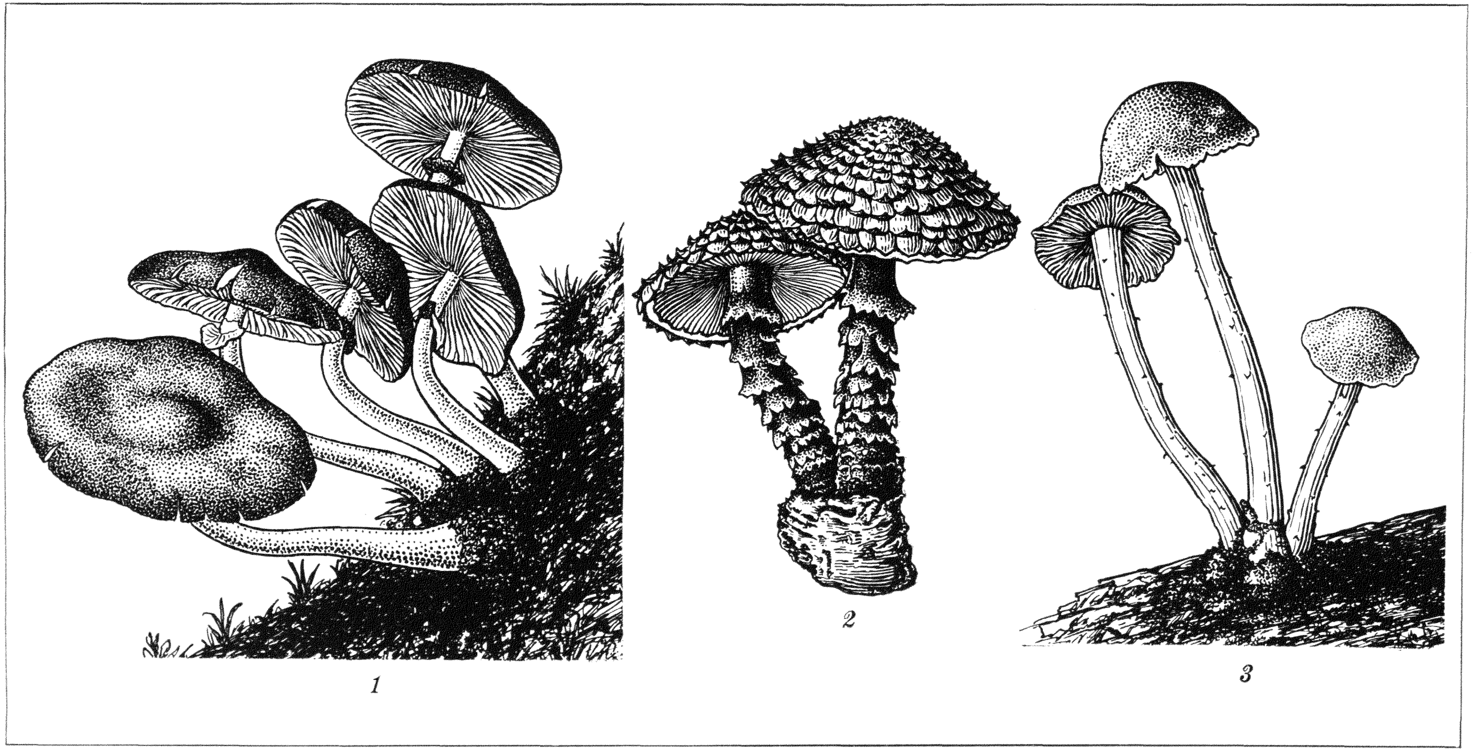
PLATE 18.

PLATE 19.



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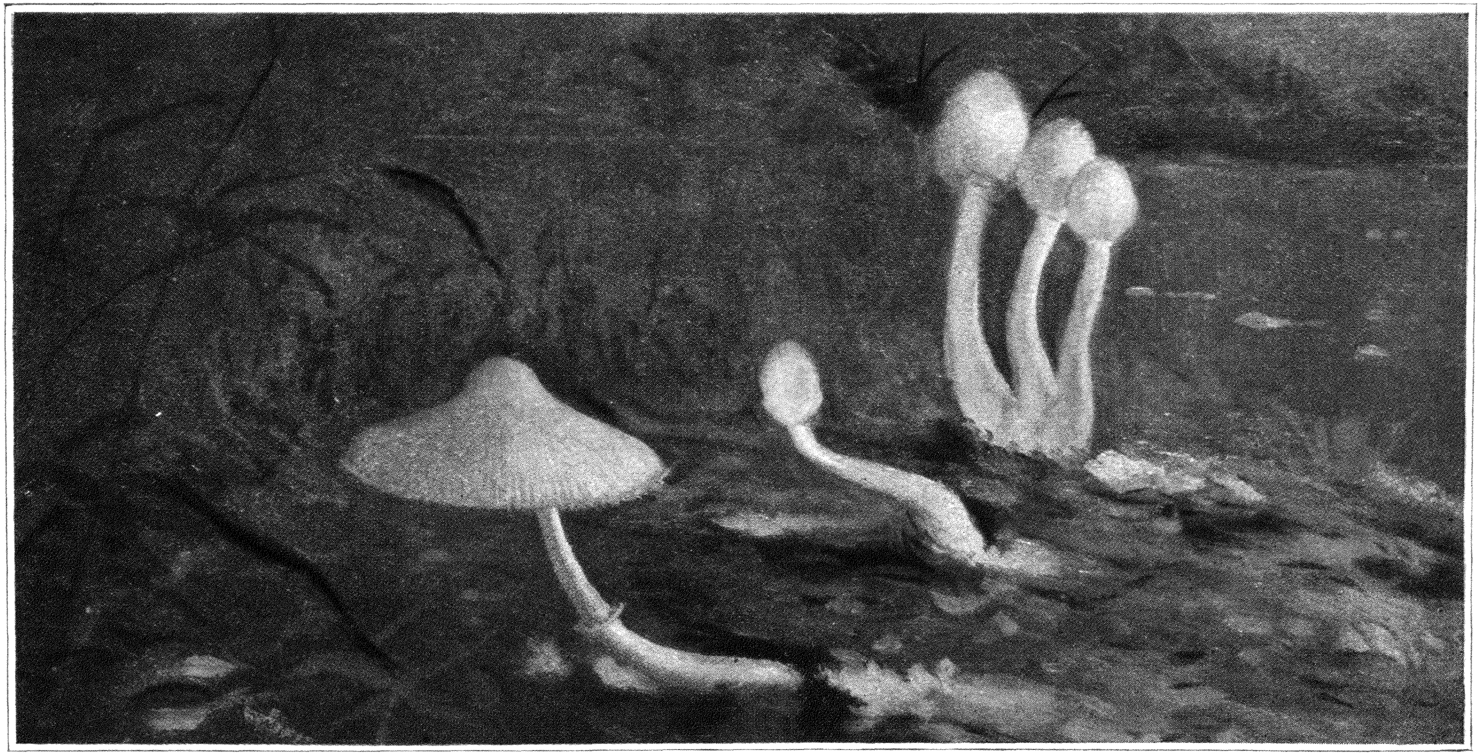

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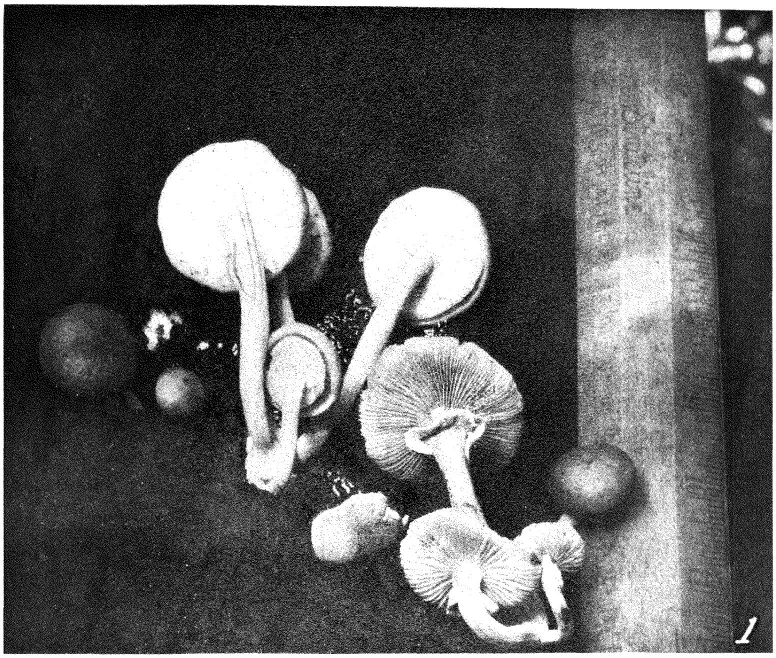

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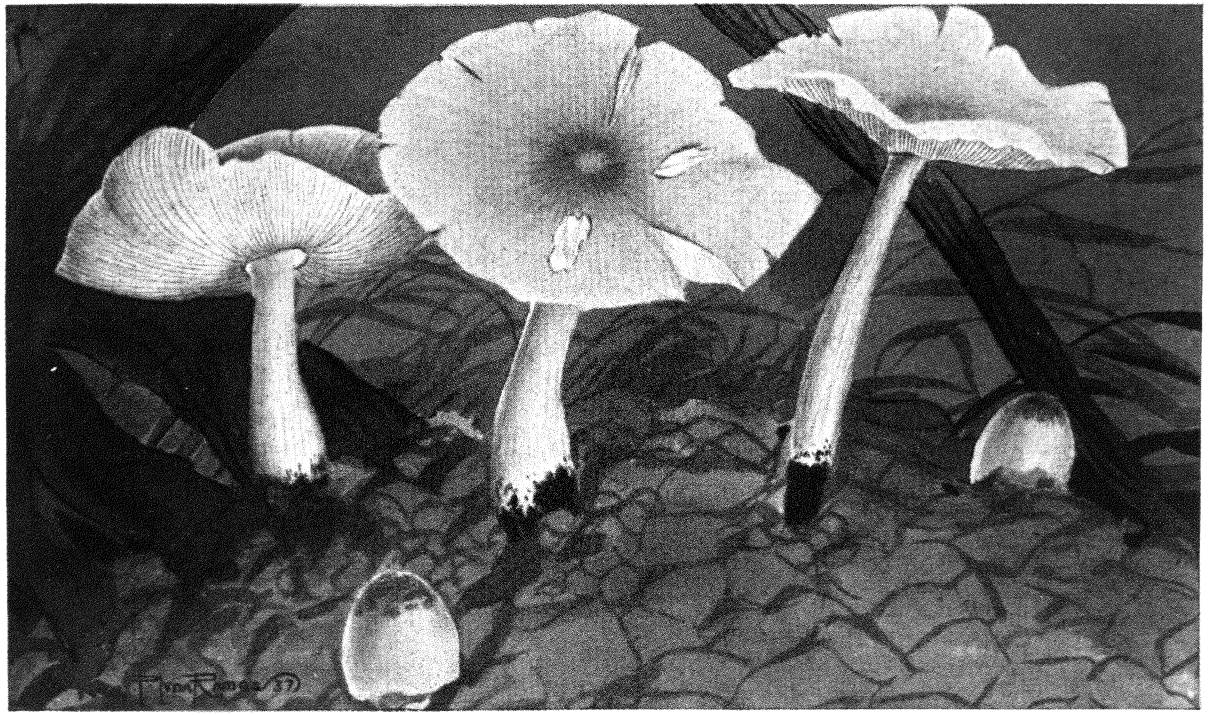
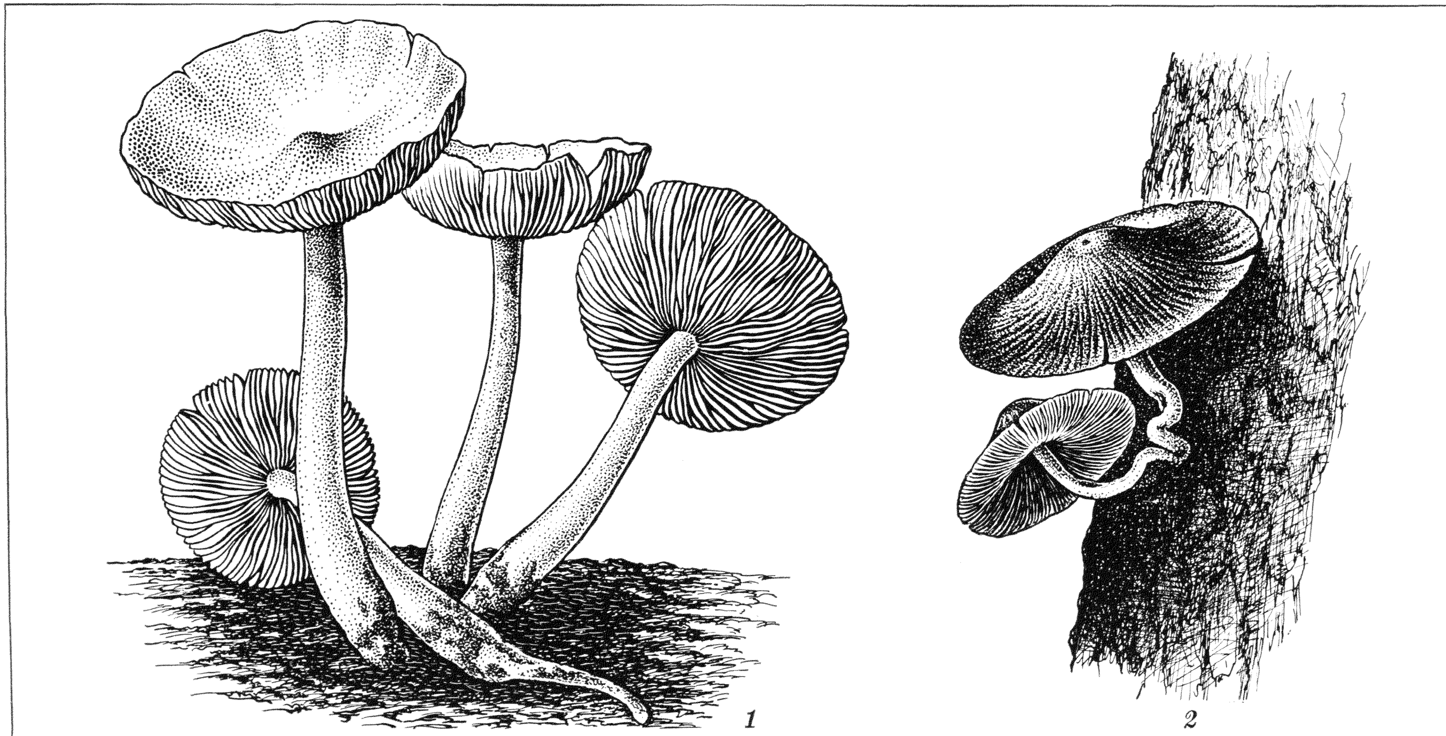


PLATE 23.

PLATE 24.



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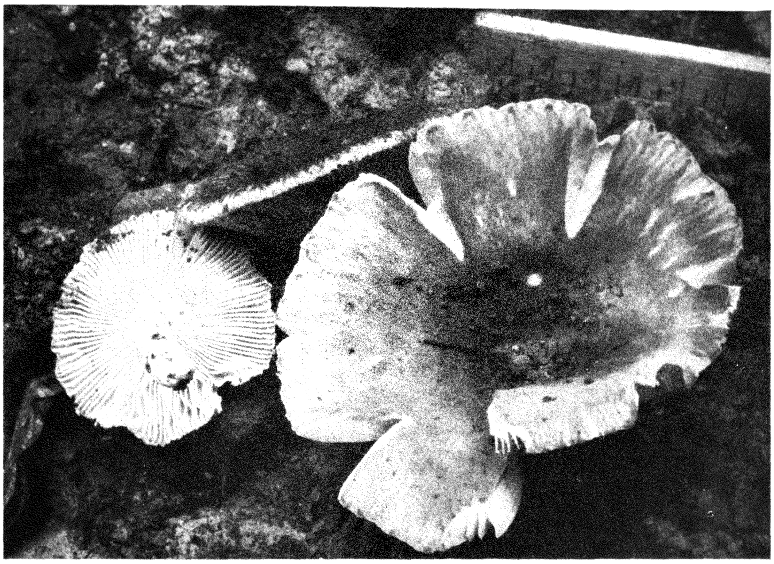

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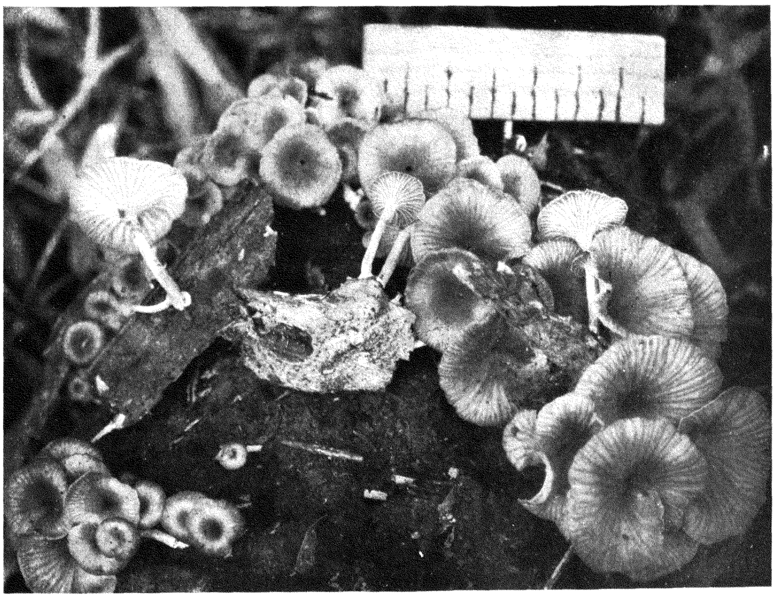

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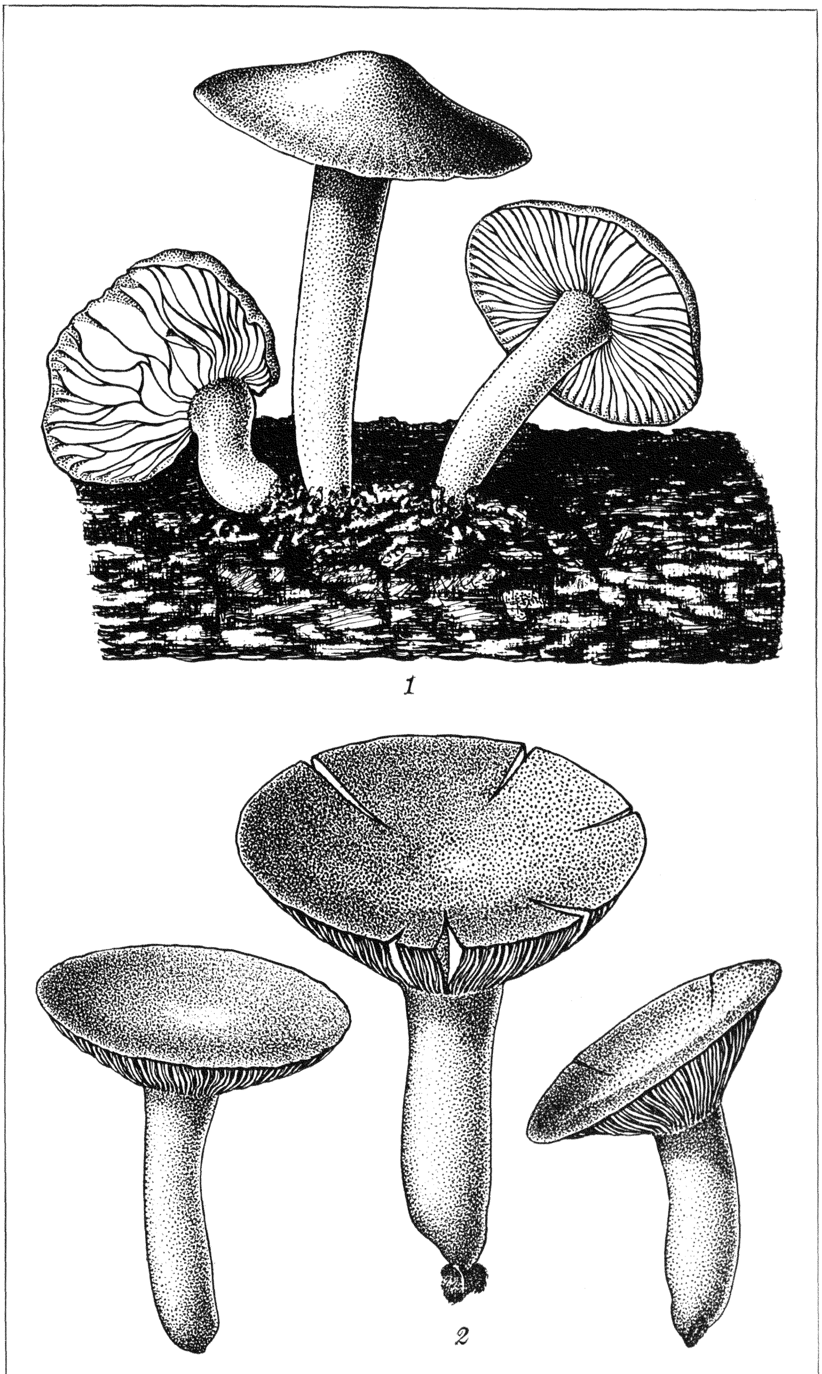

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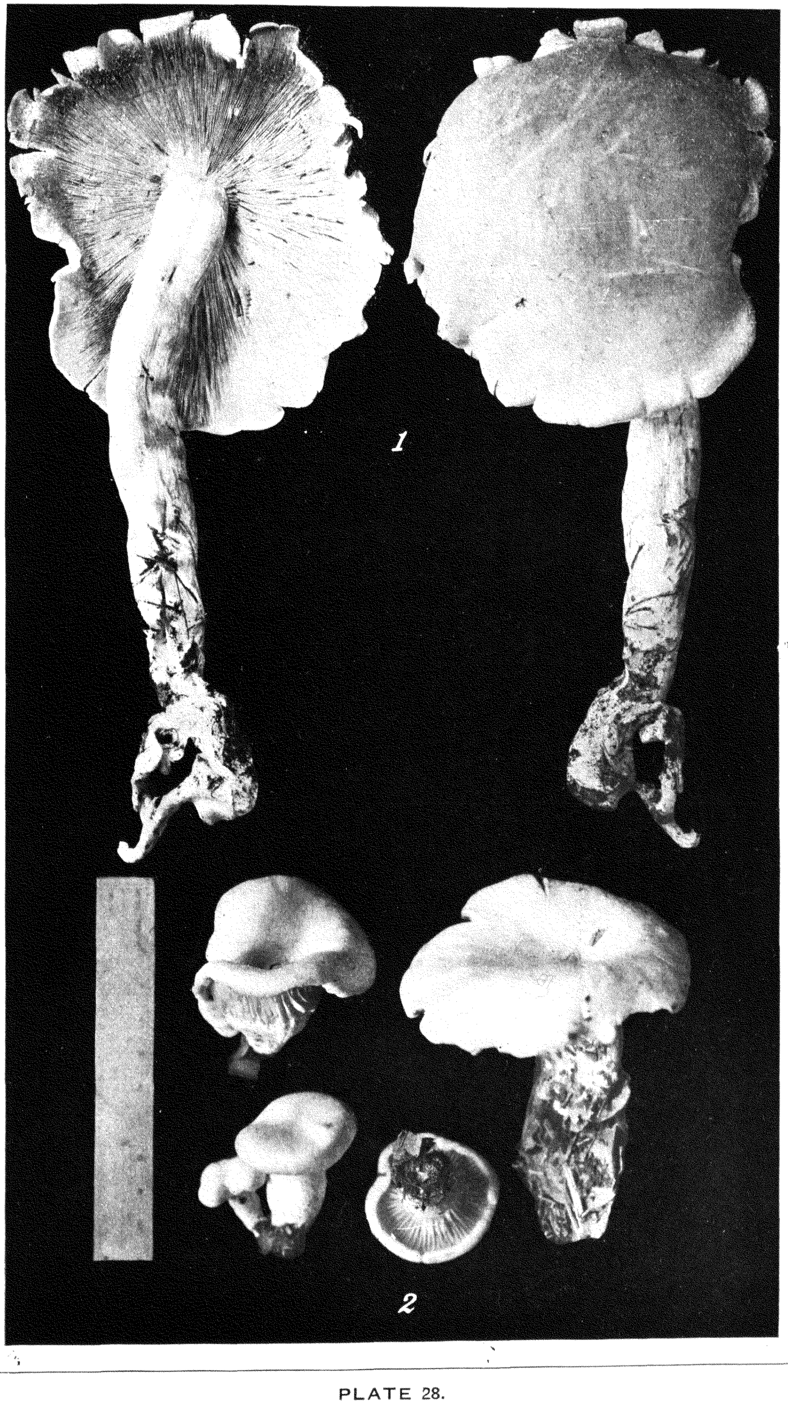

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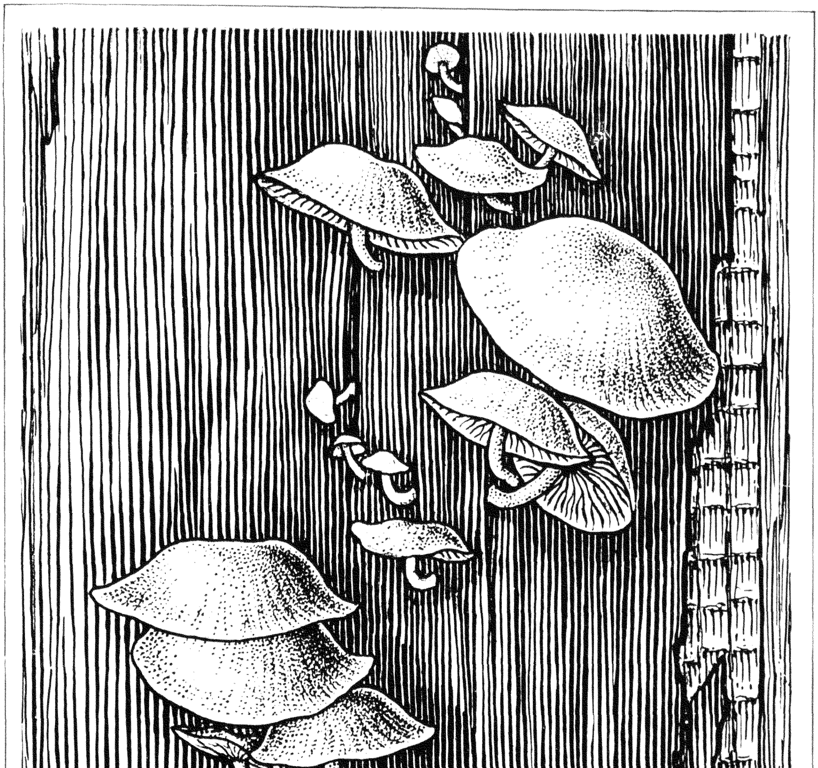

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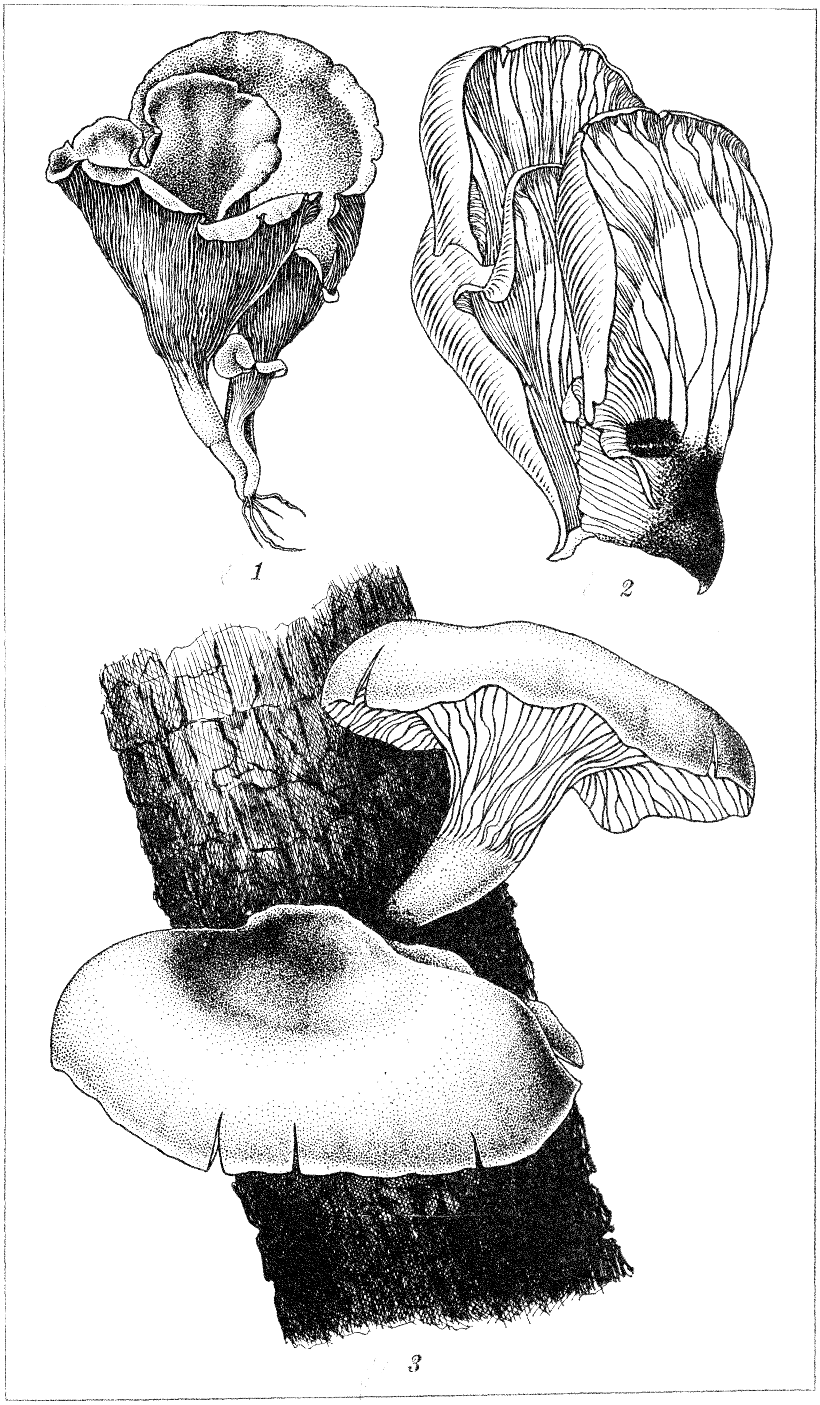

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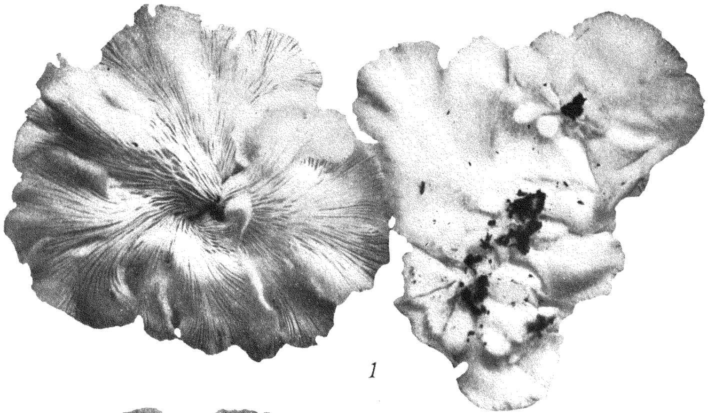

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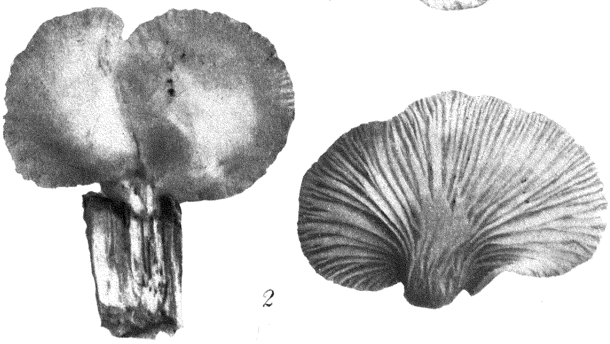

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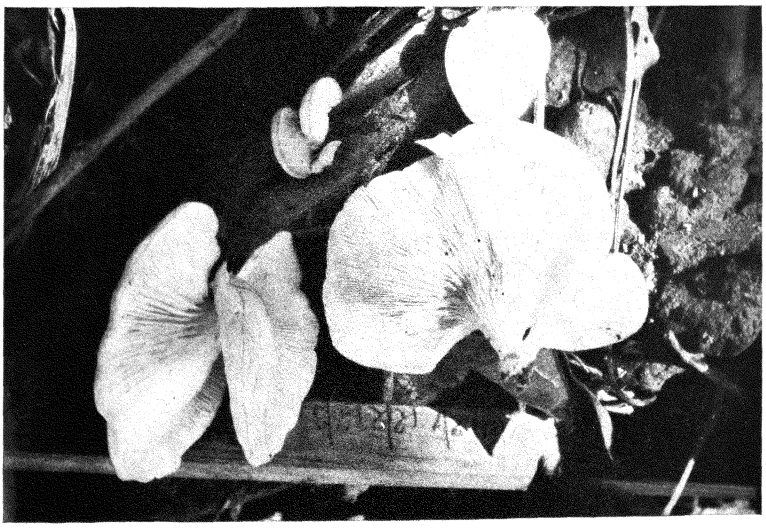

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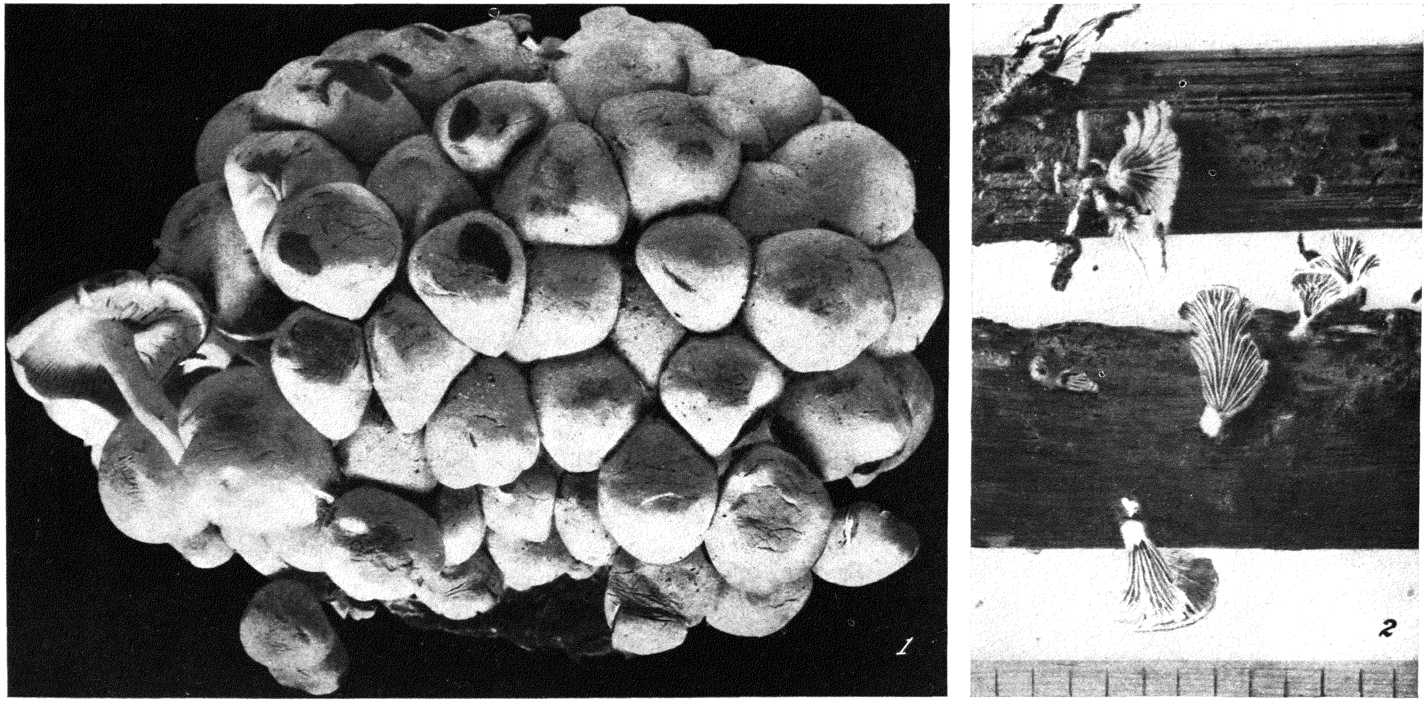
PLATE 31.

PLATE 32.



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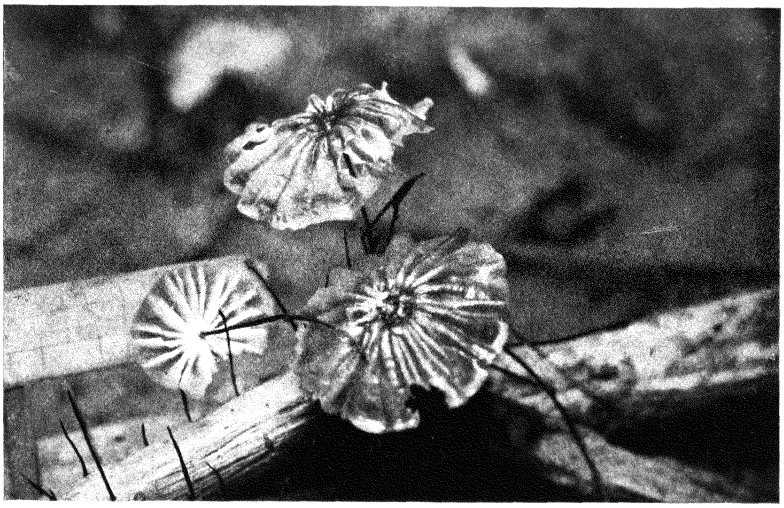

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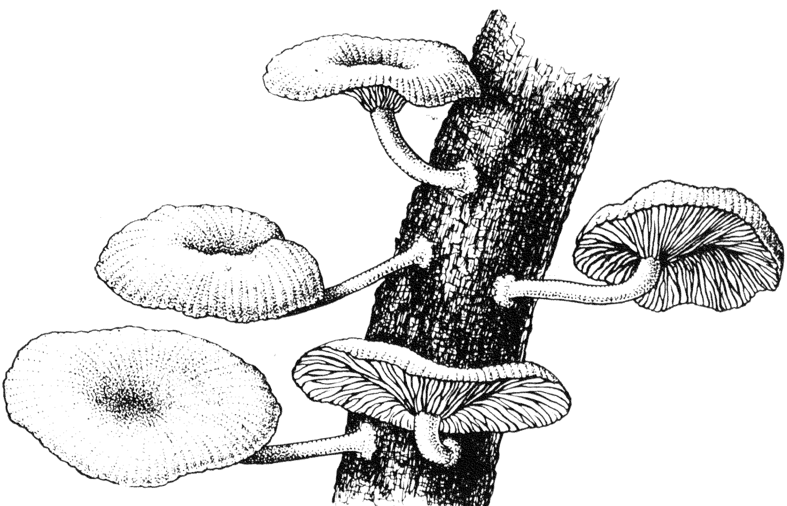

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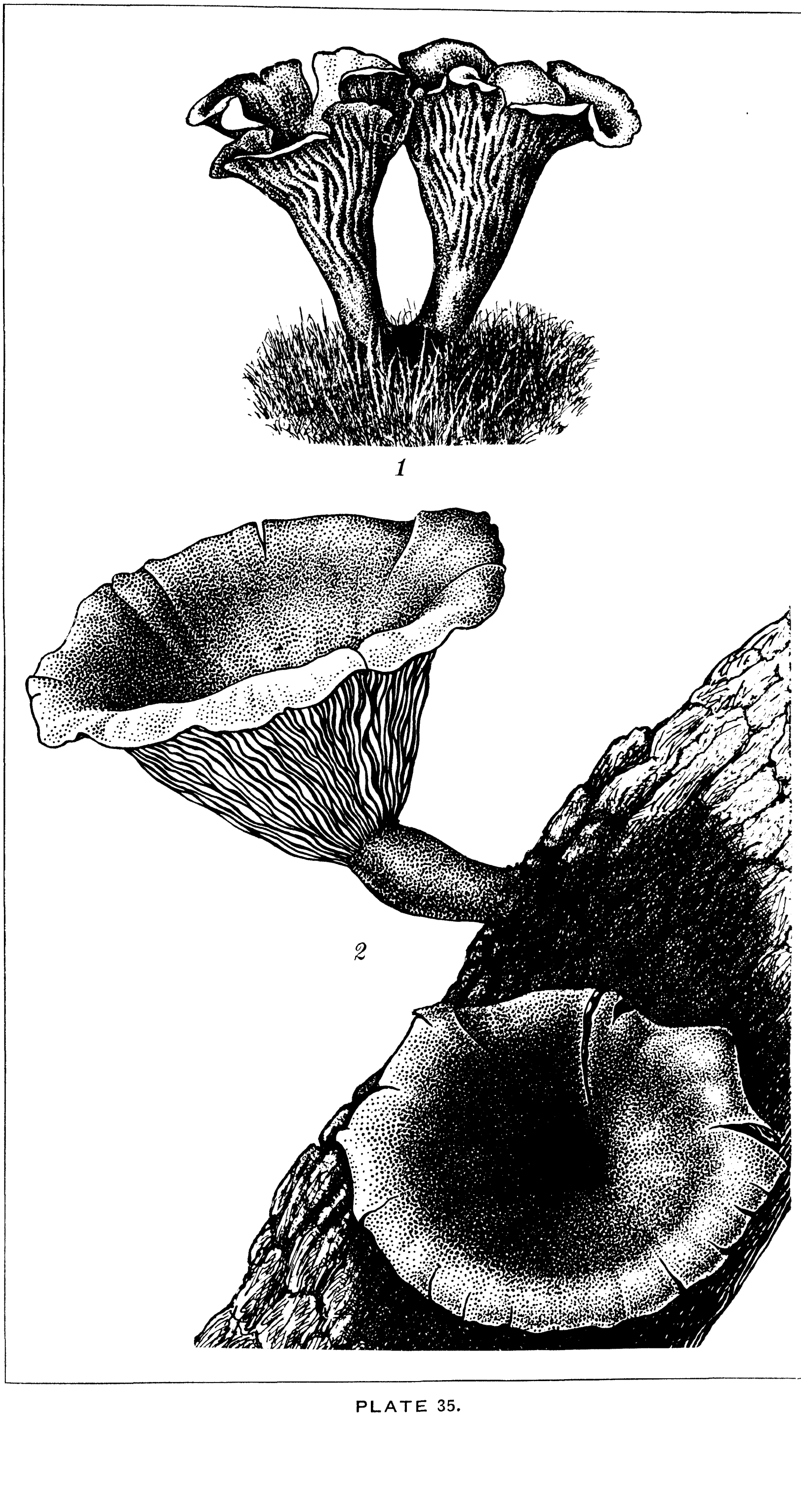

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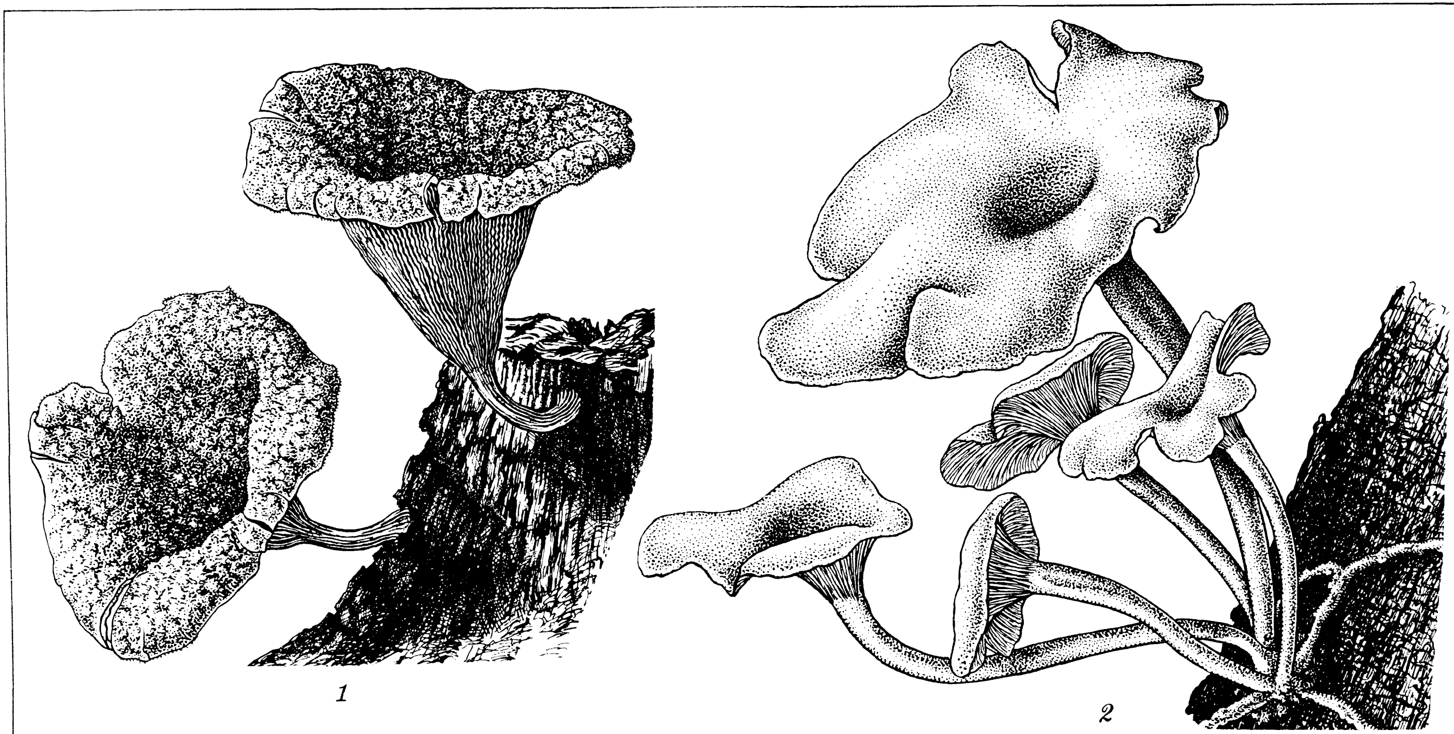

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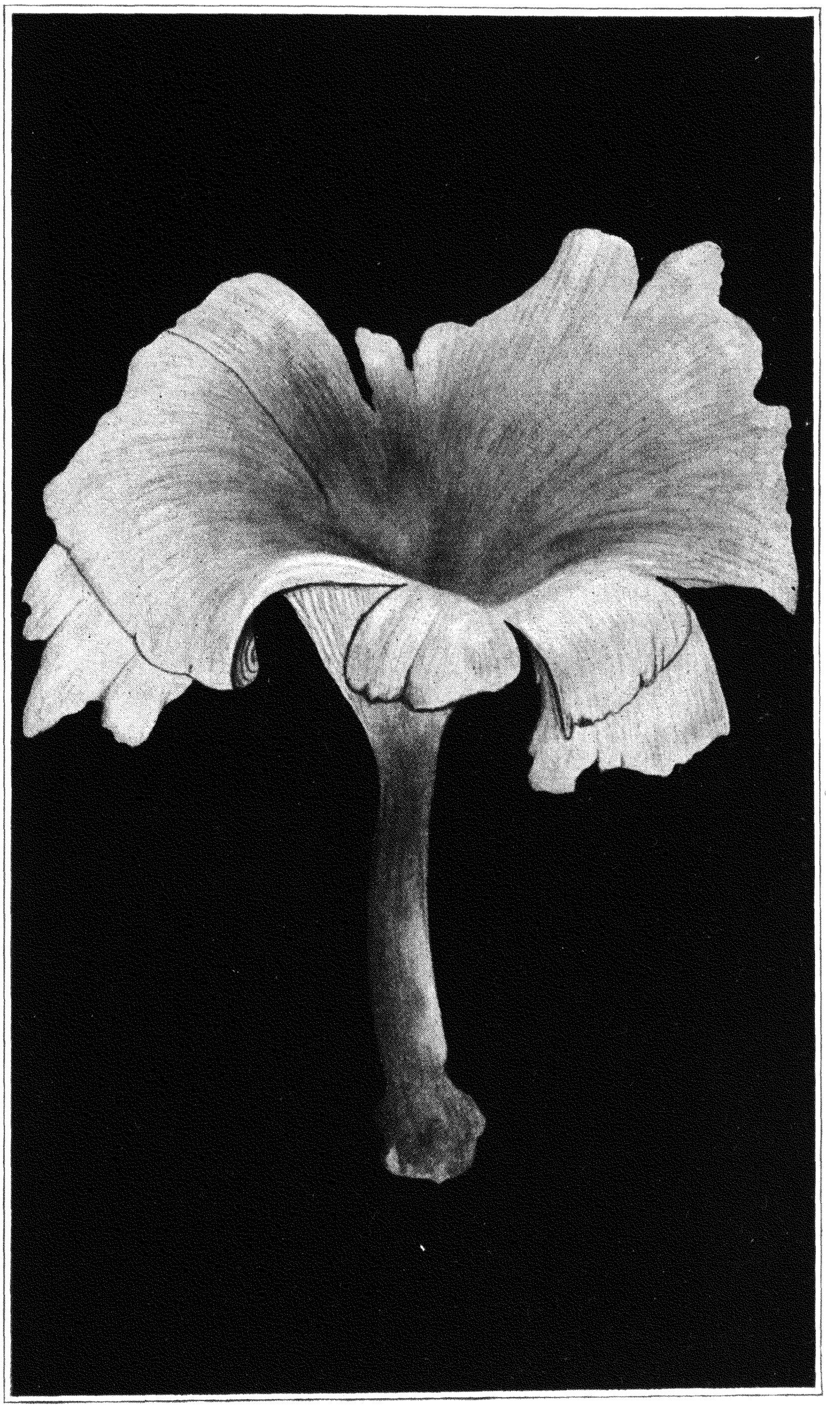

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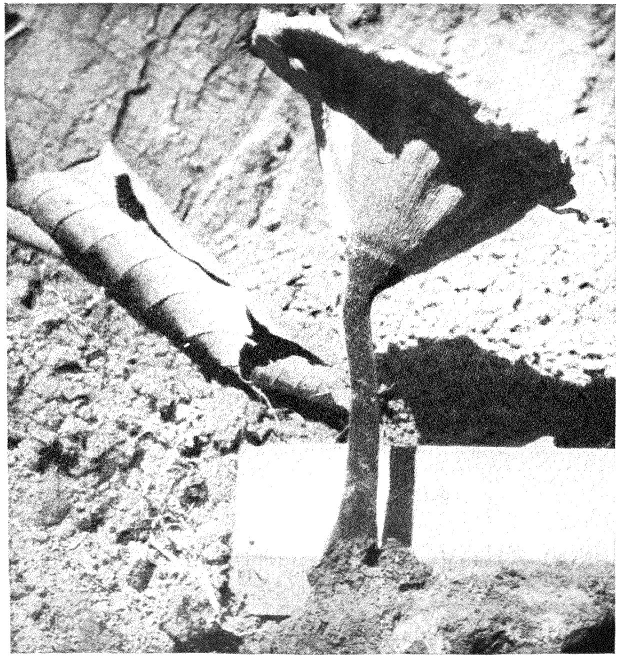

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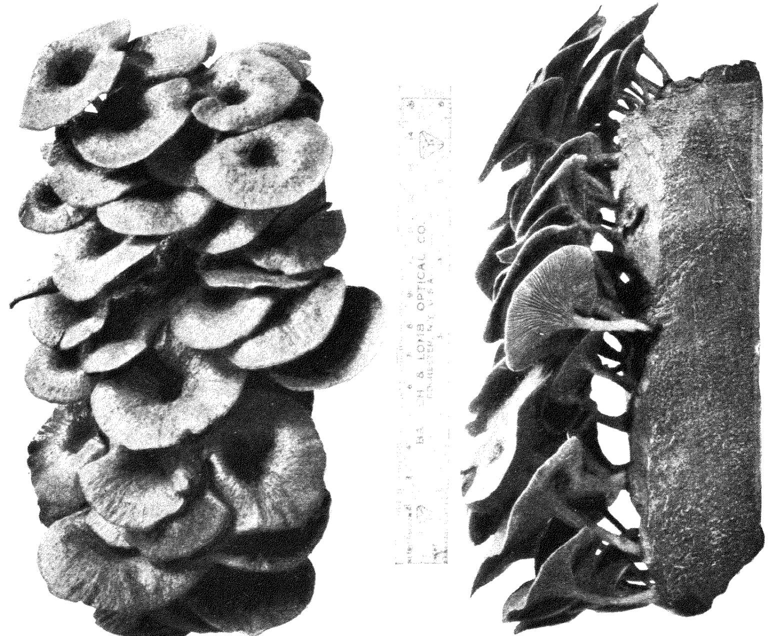

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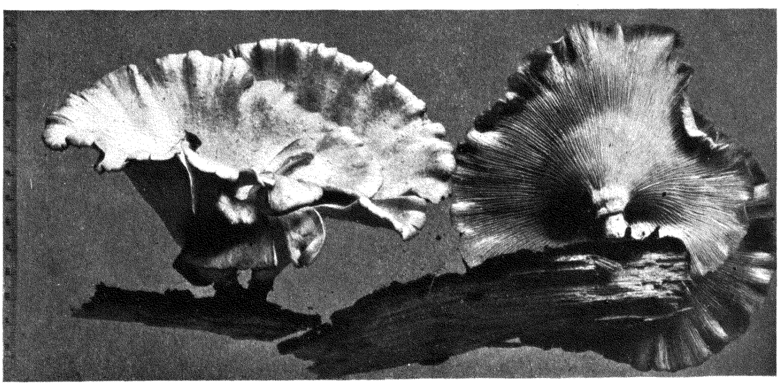

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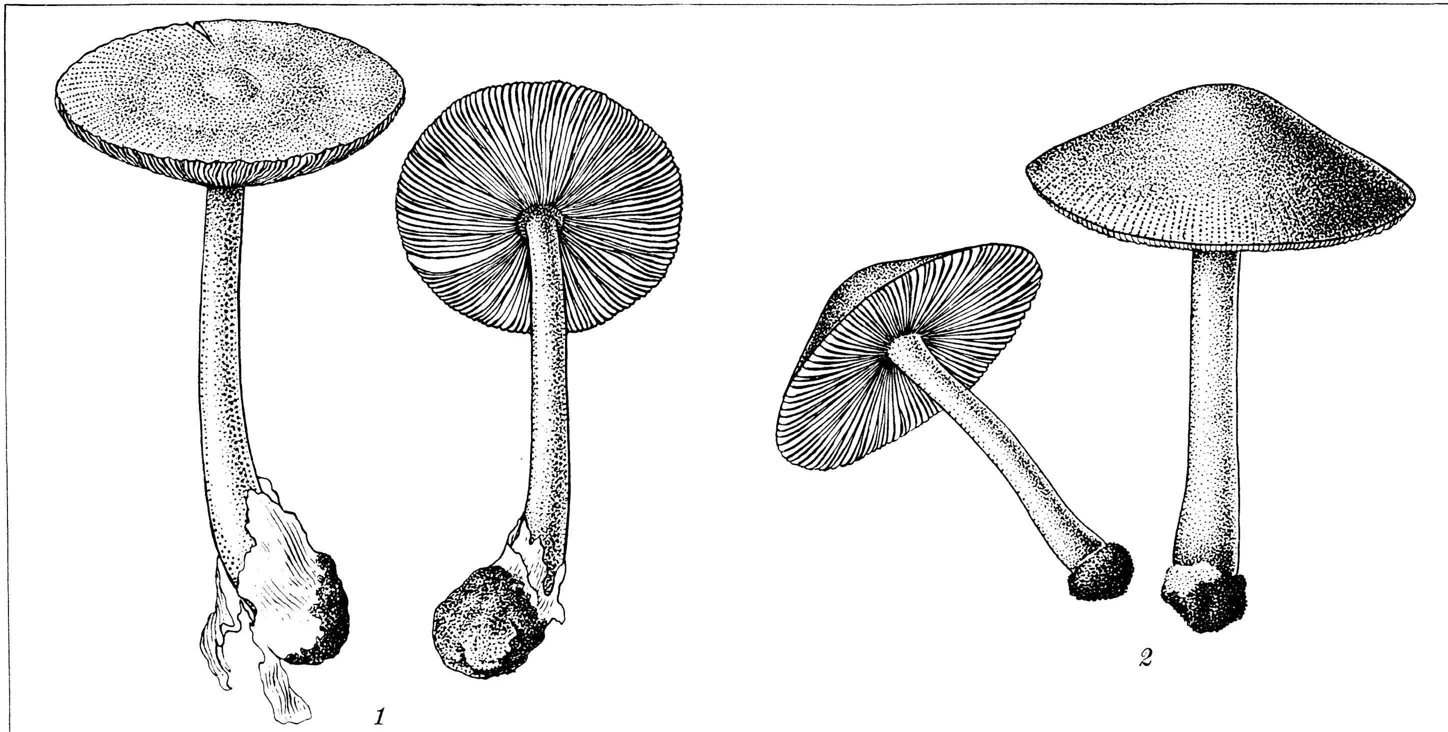

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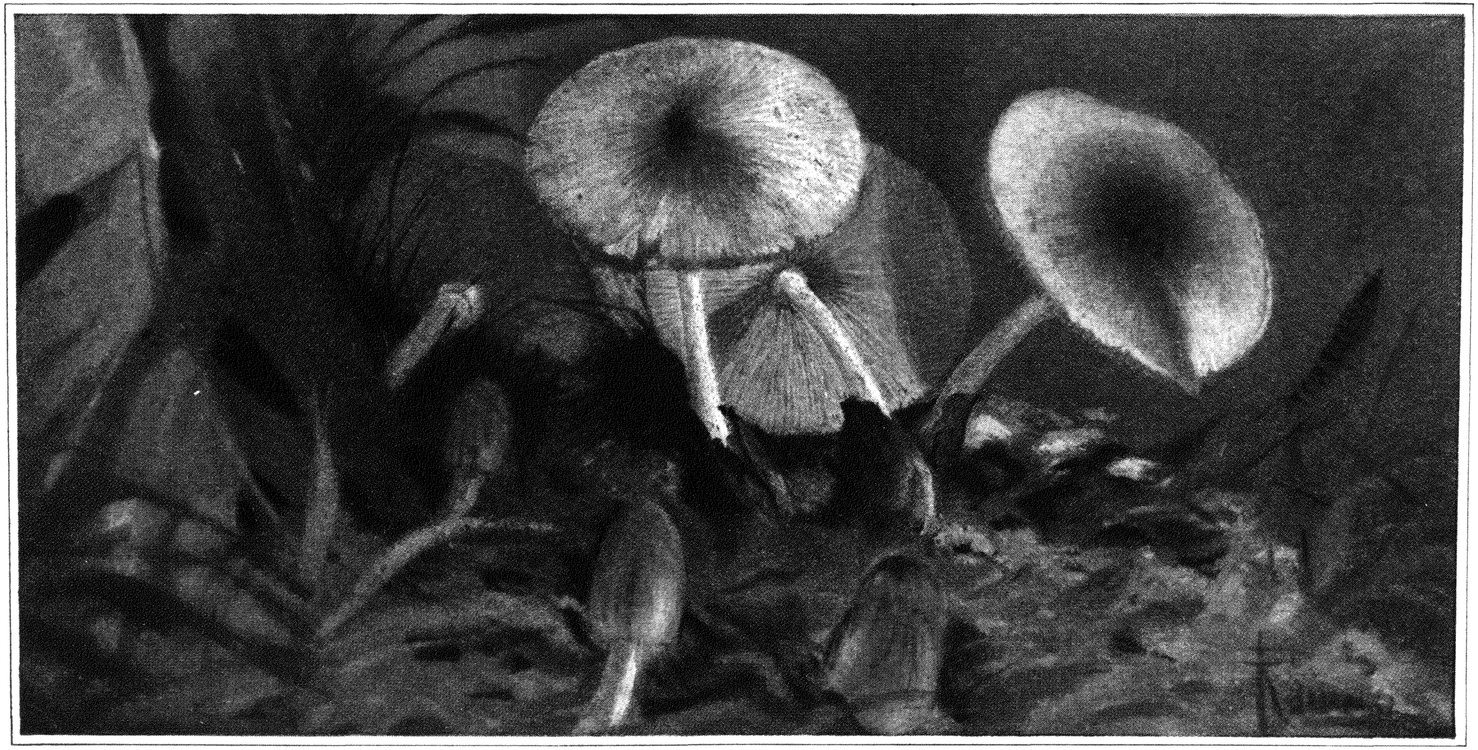

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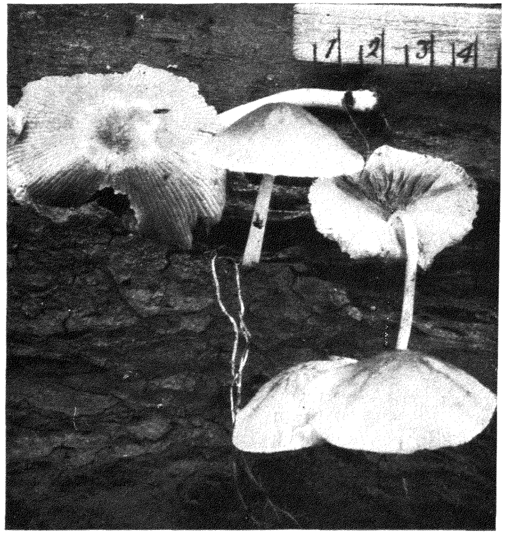

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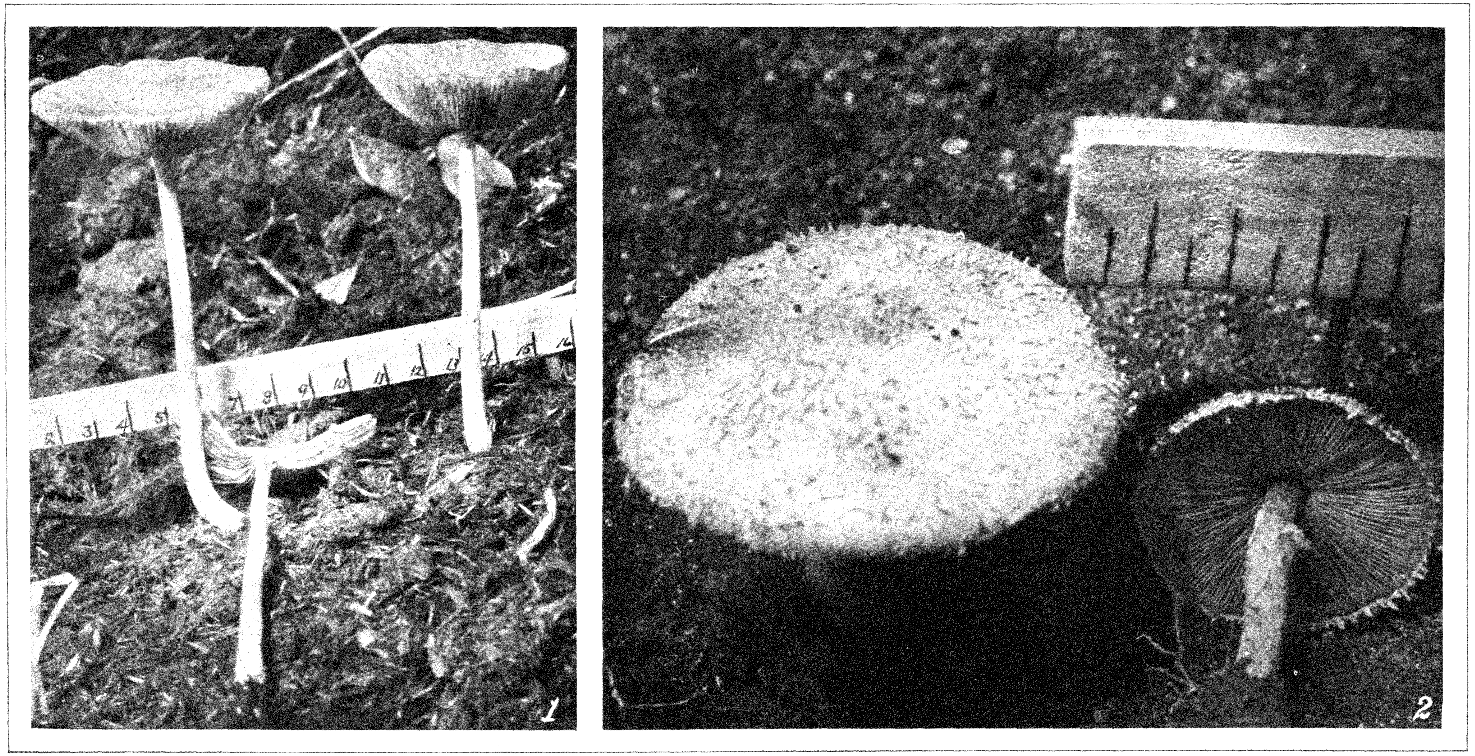

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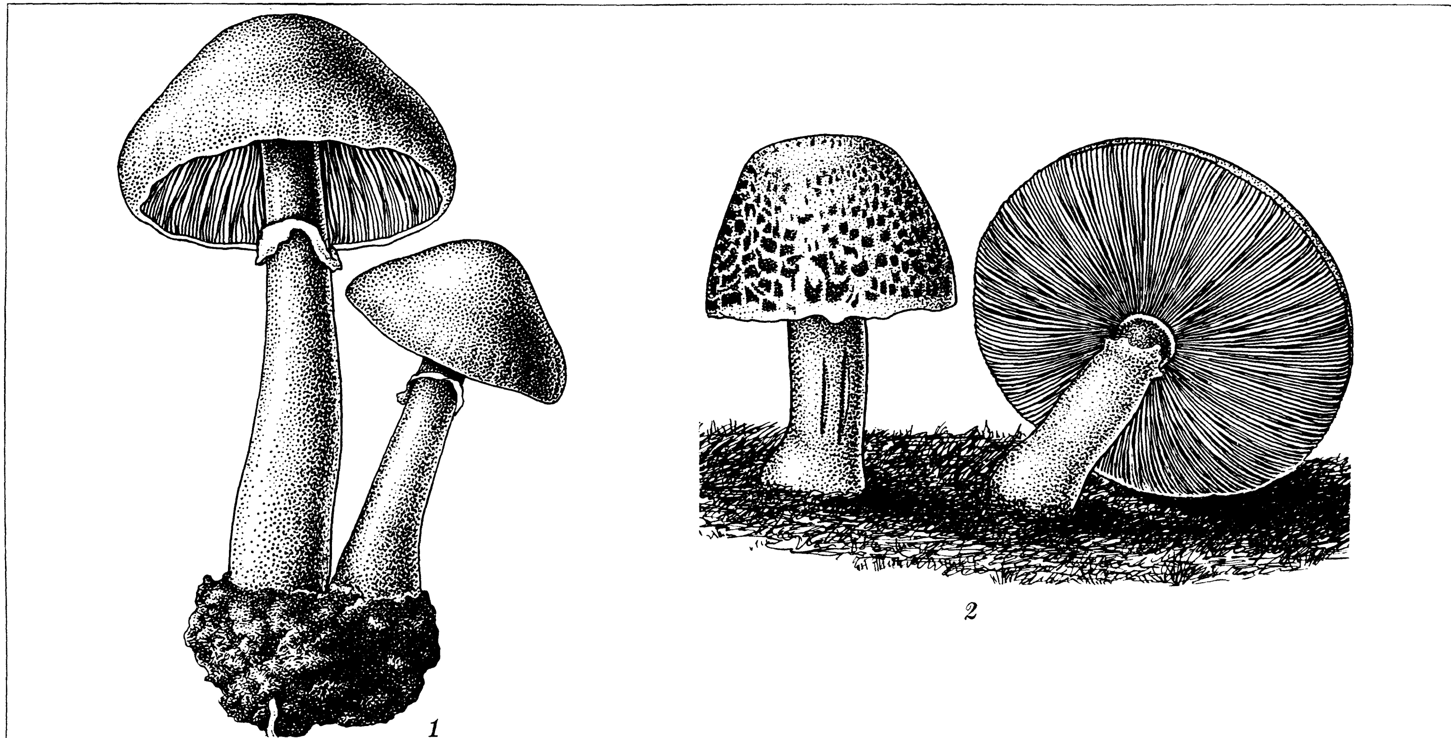

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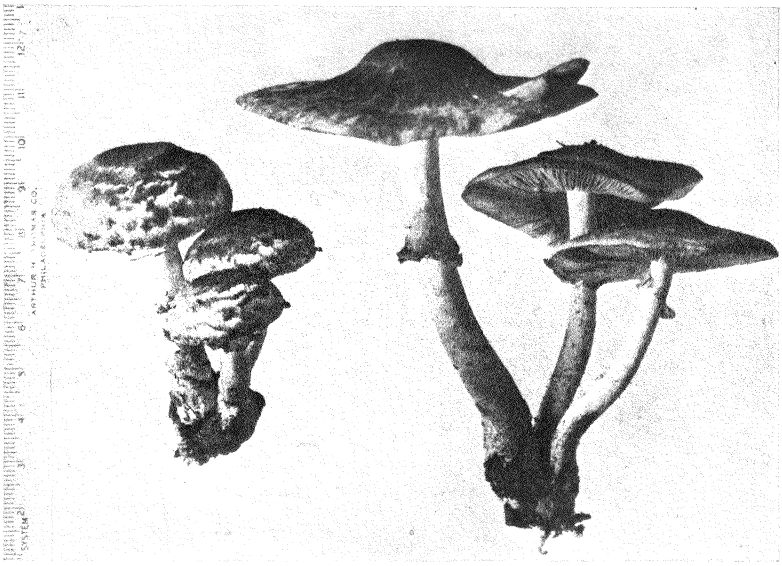

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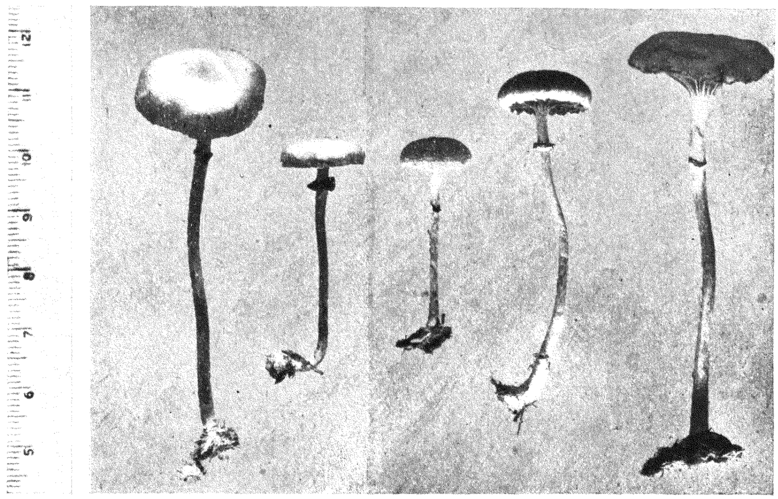

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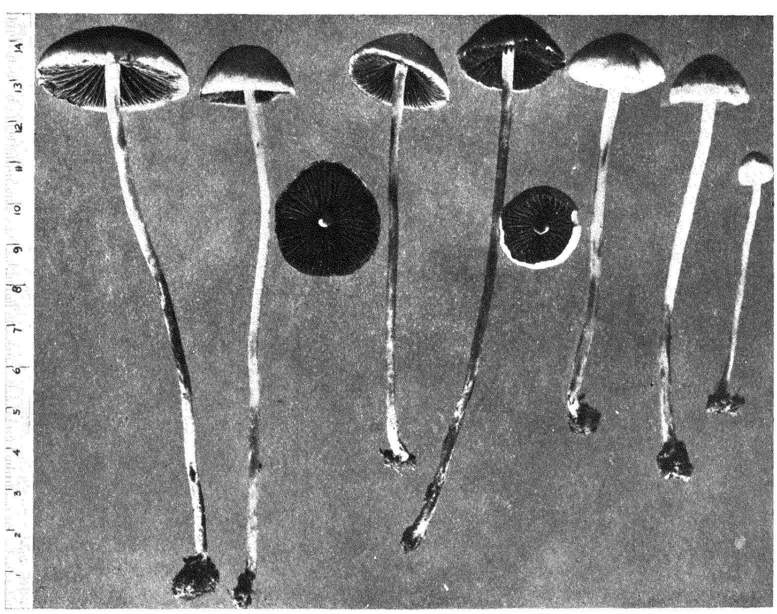

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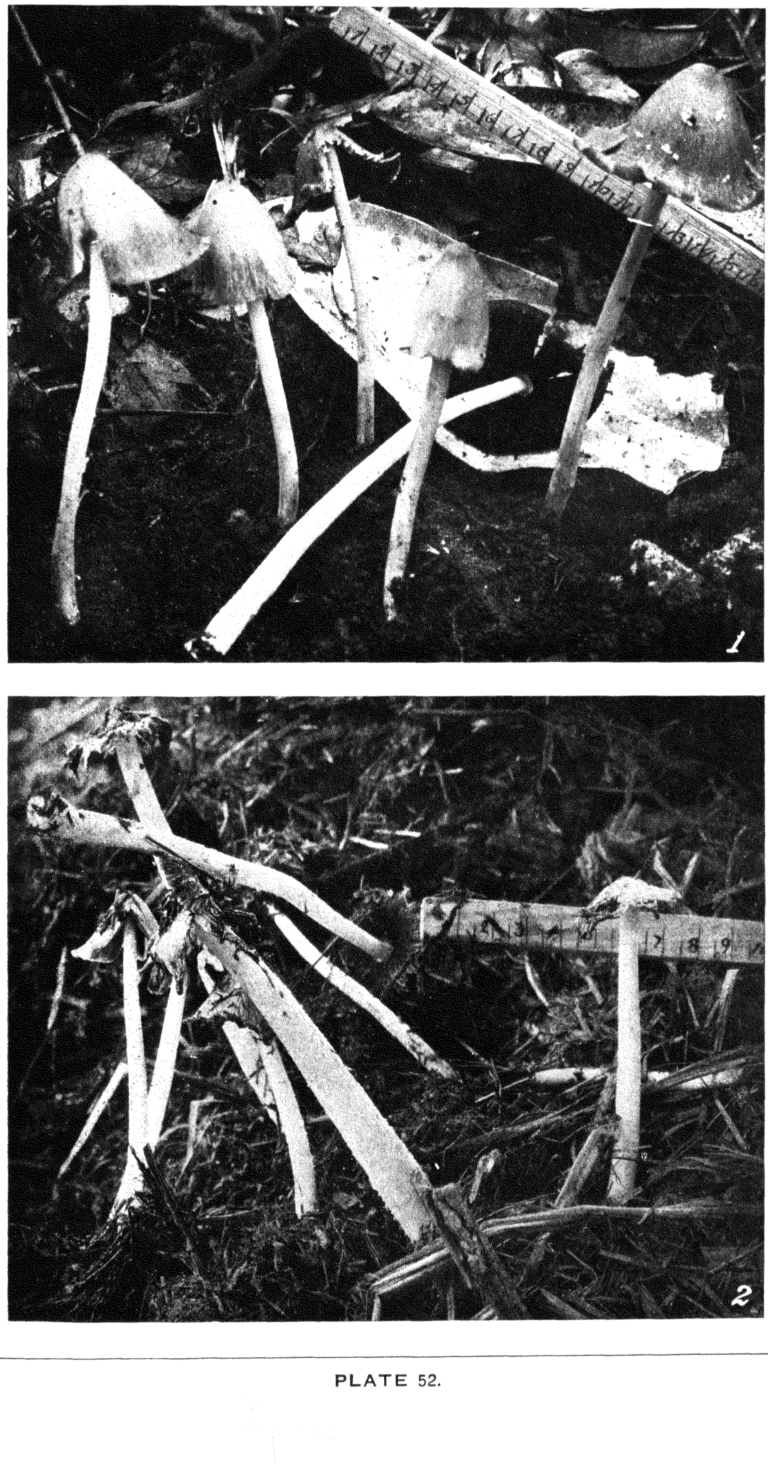

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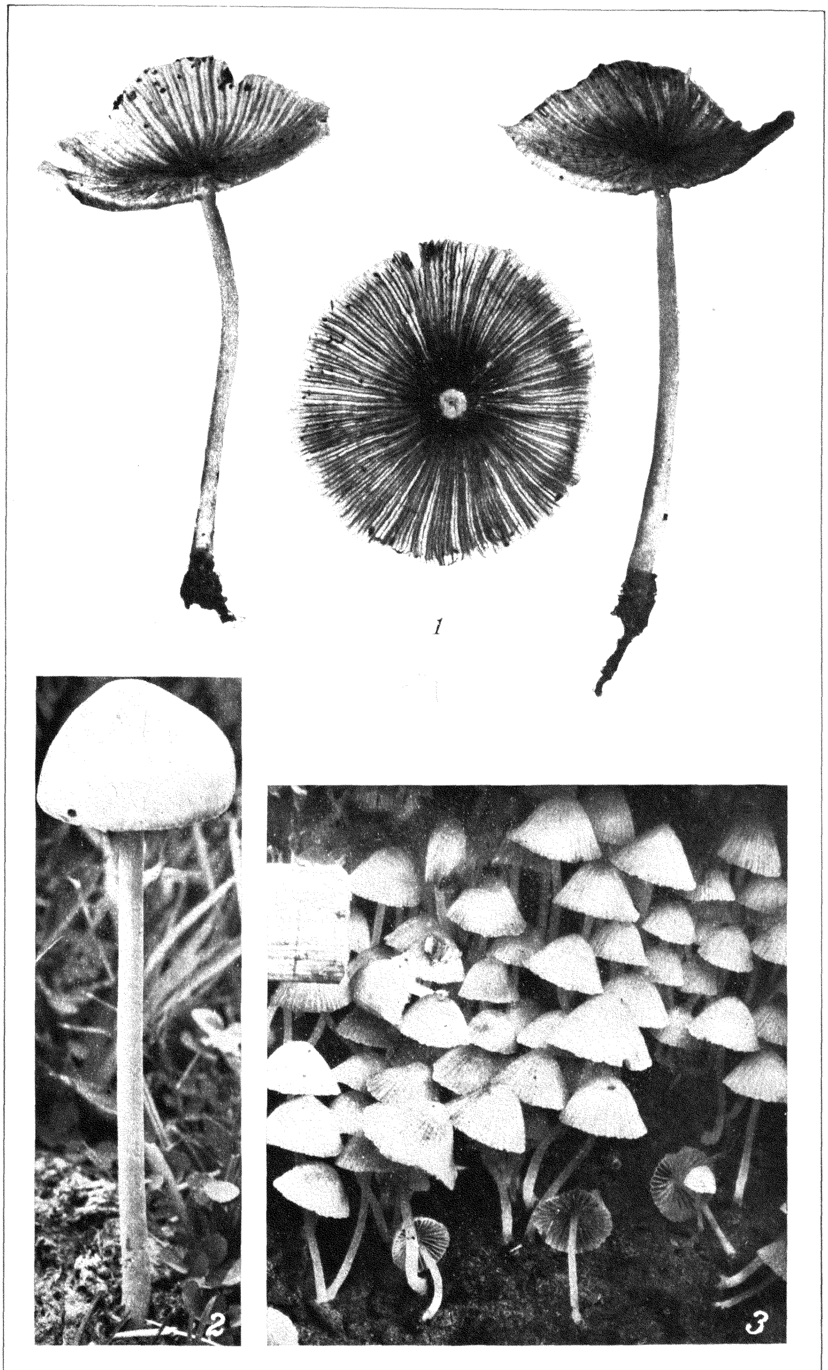

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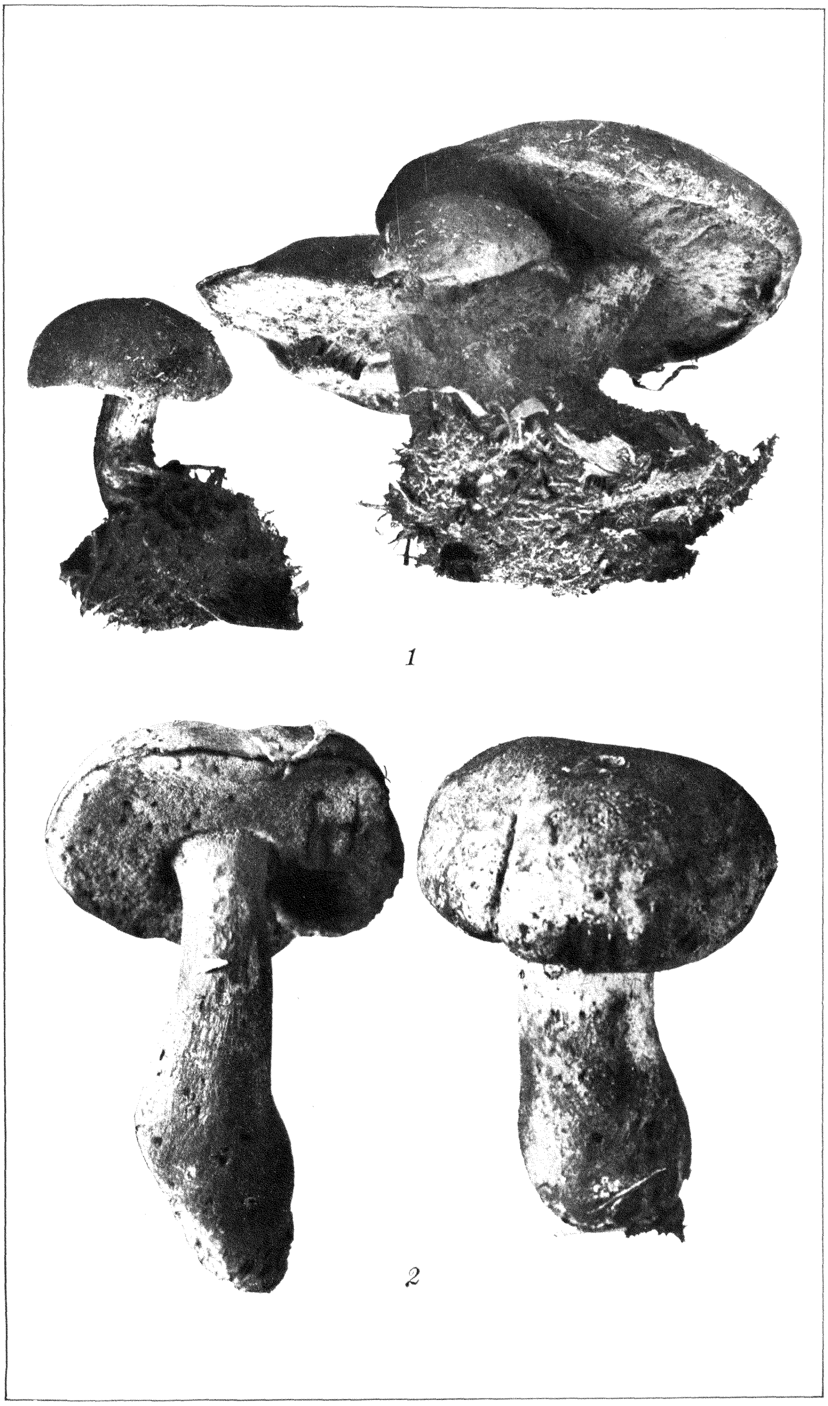

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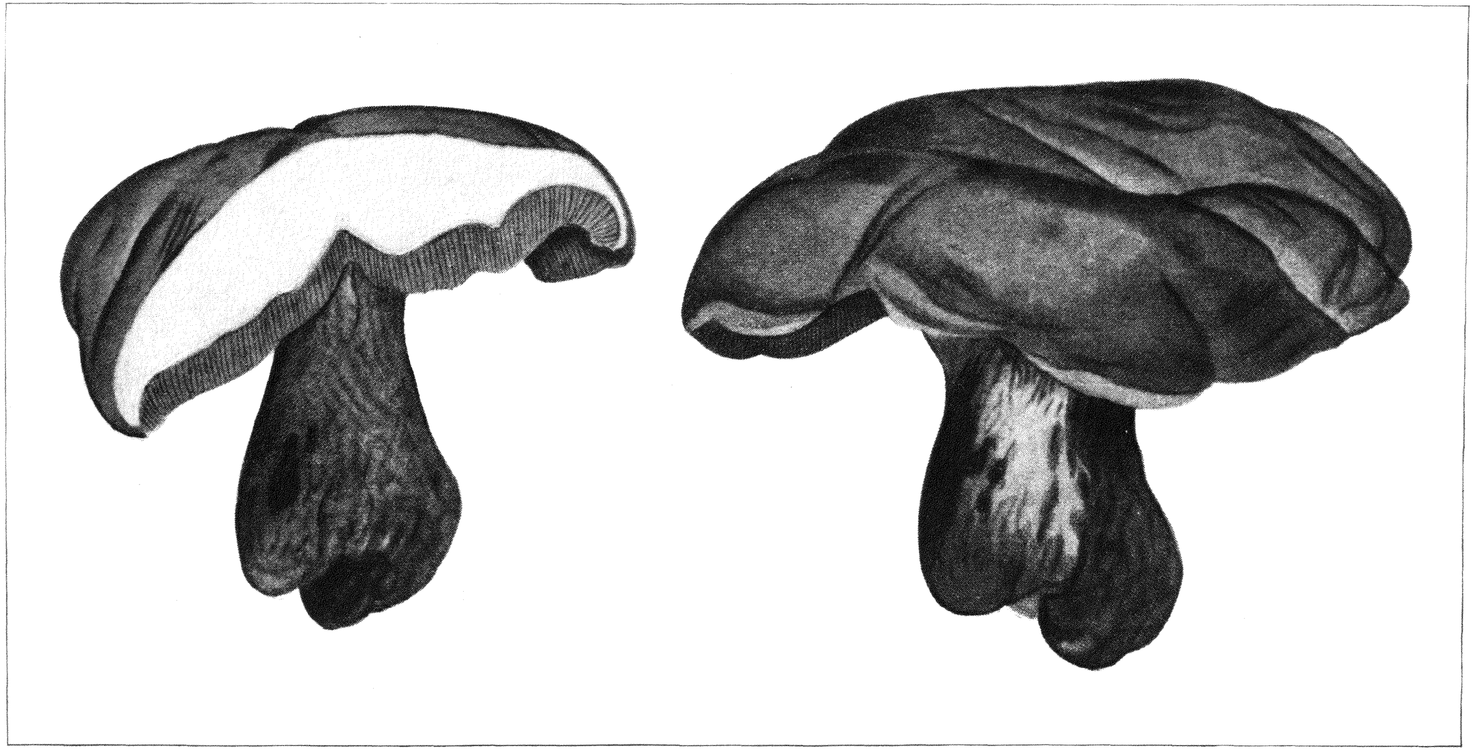

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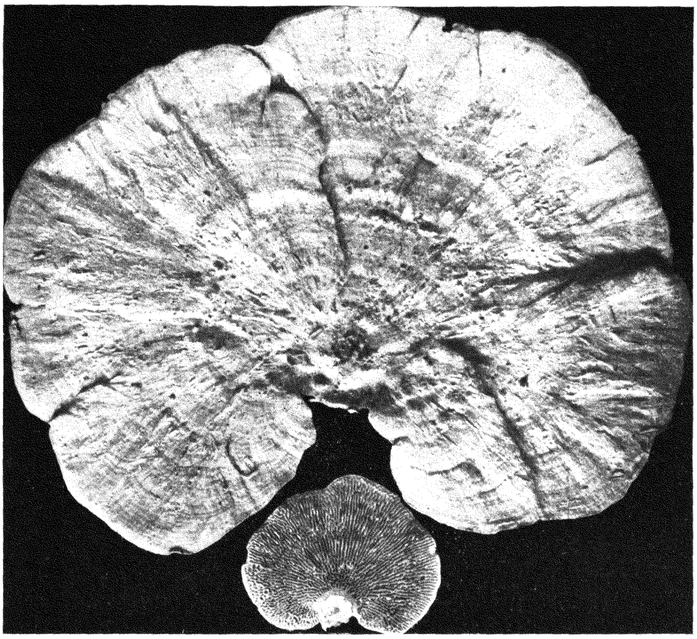

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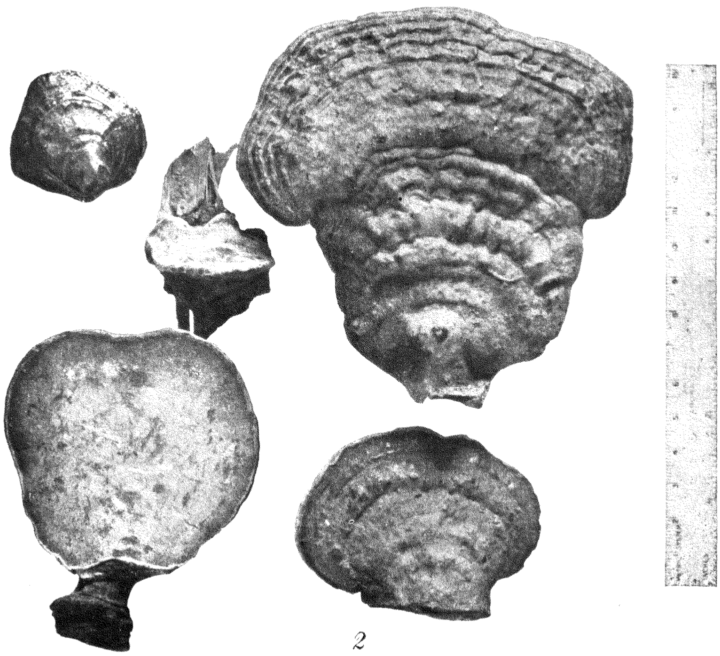

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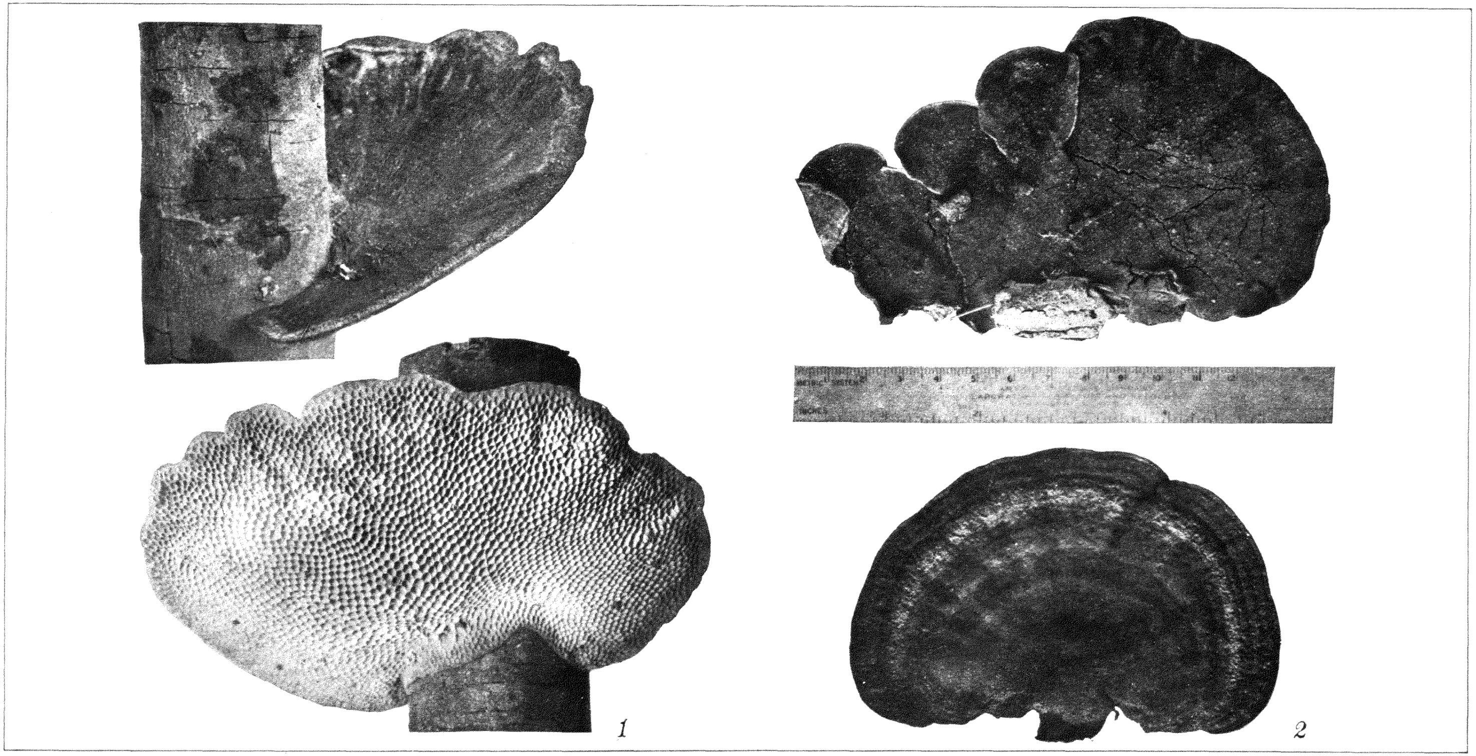

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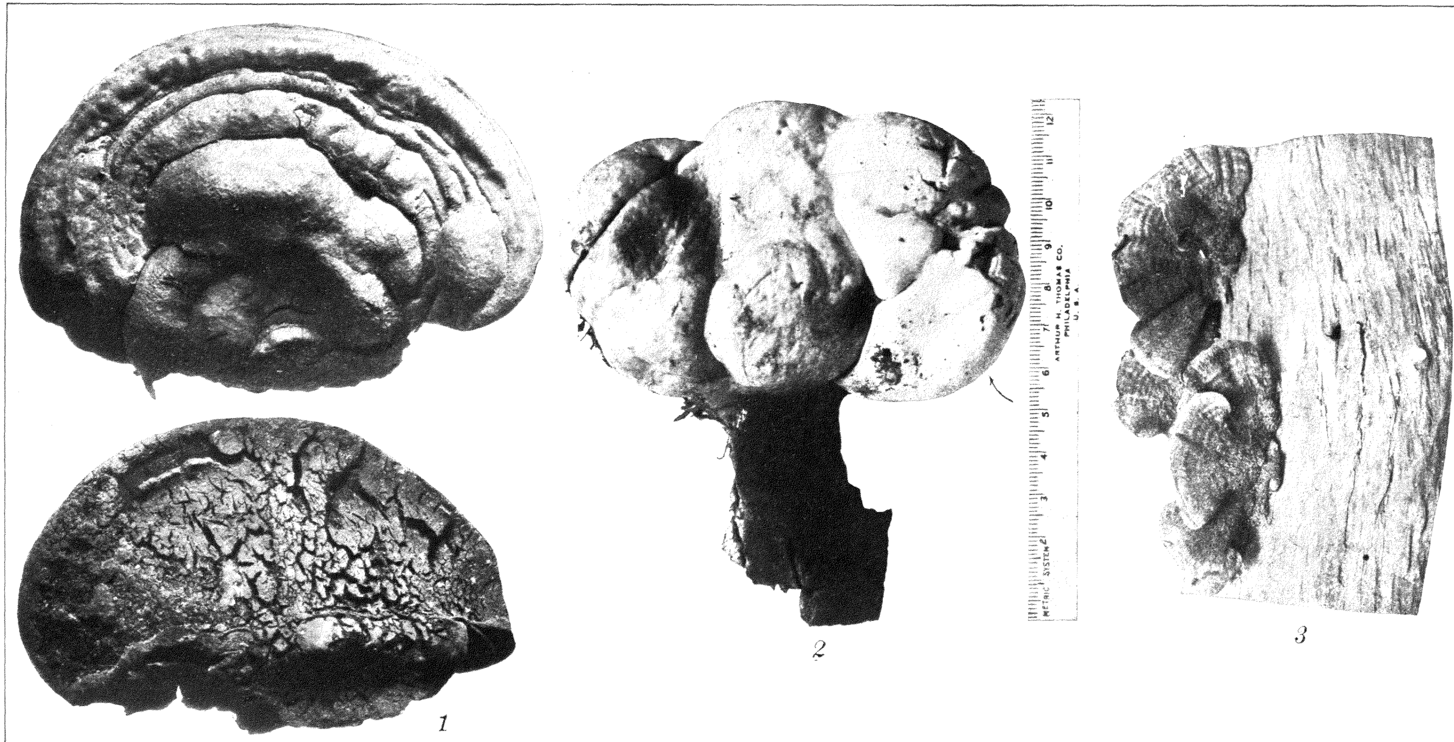

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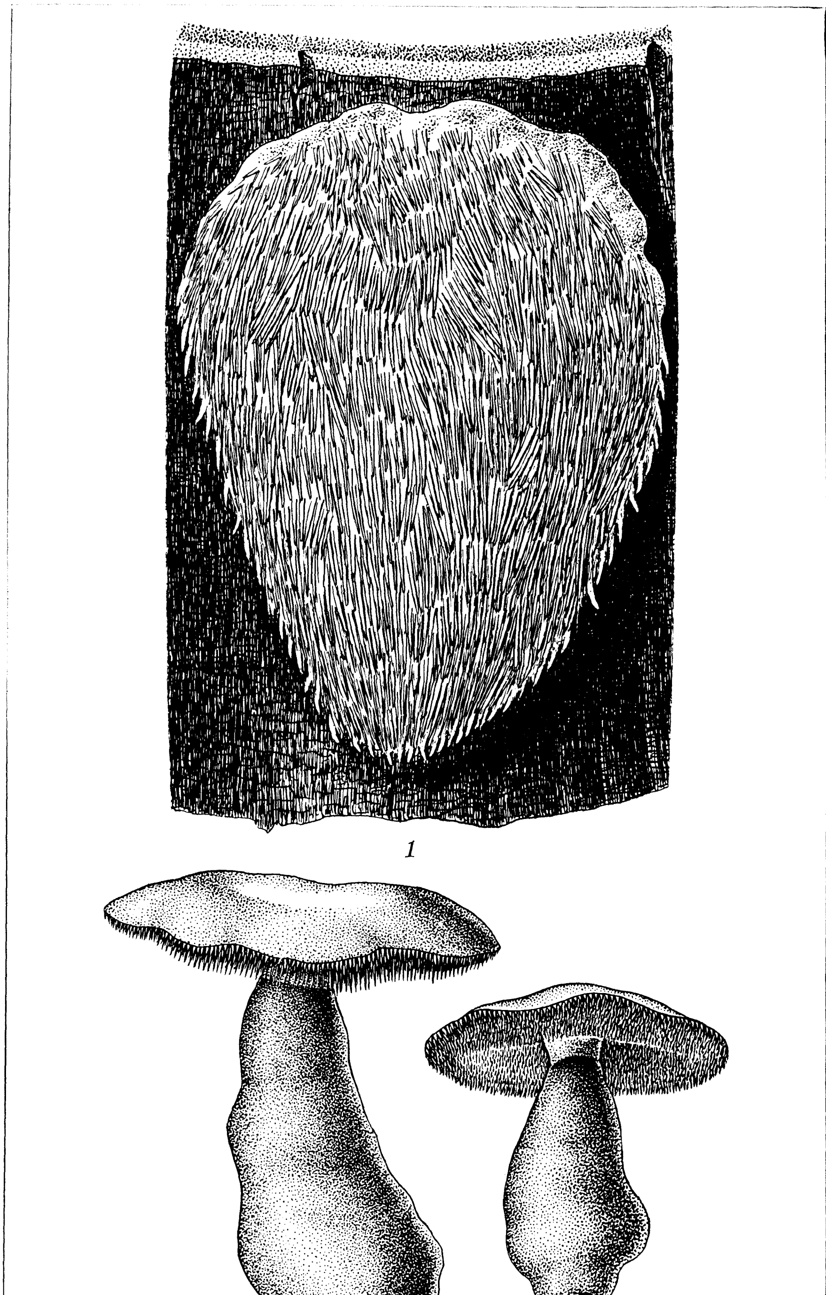

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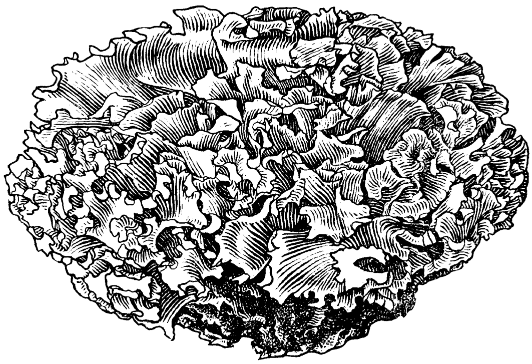

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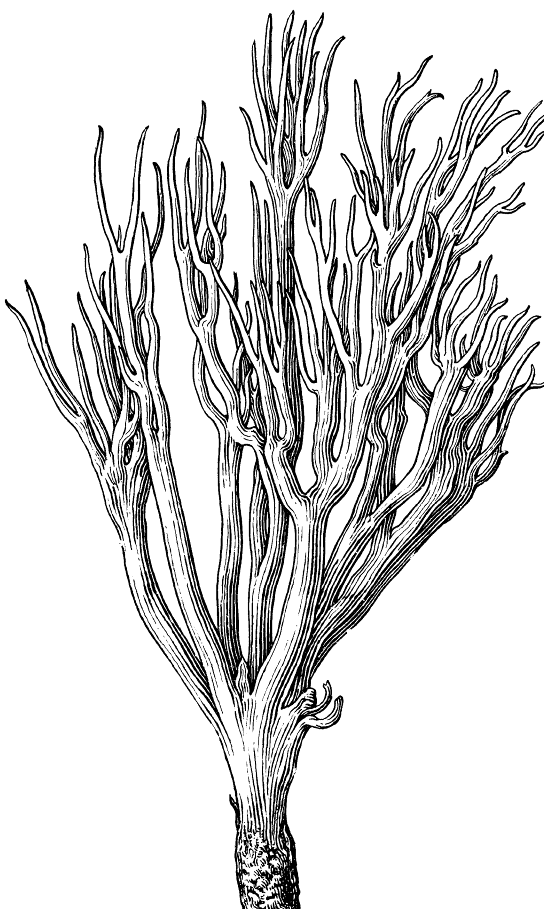

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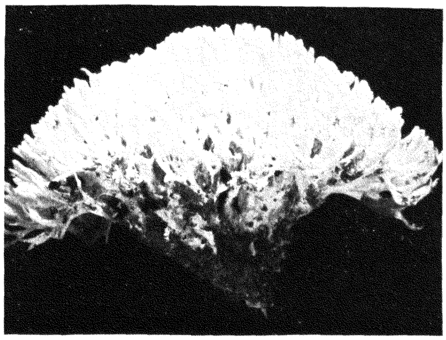

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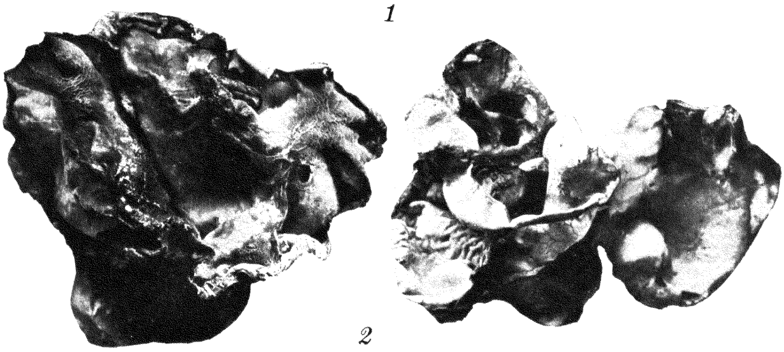

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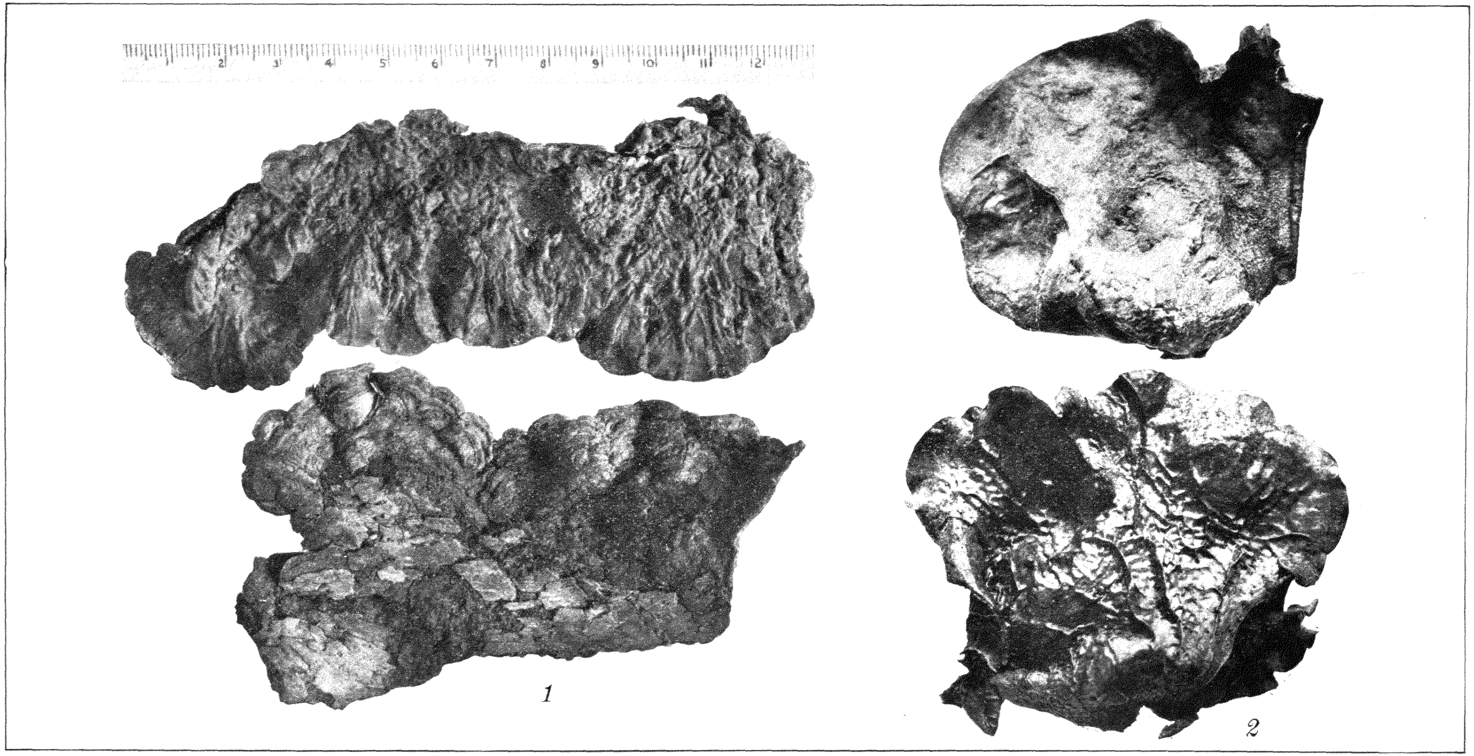

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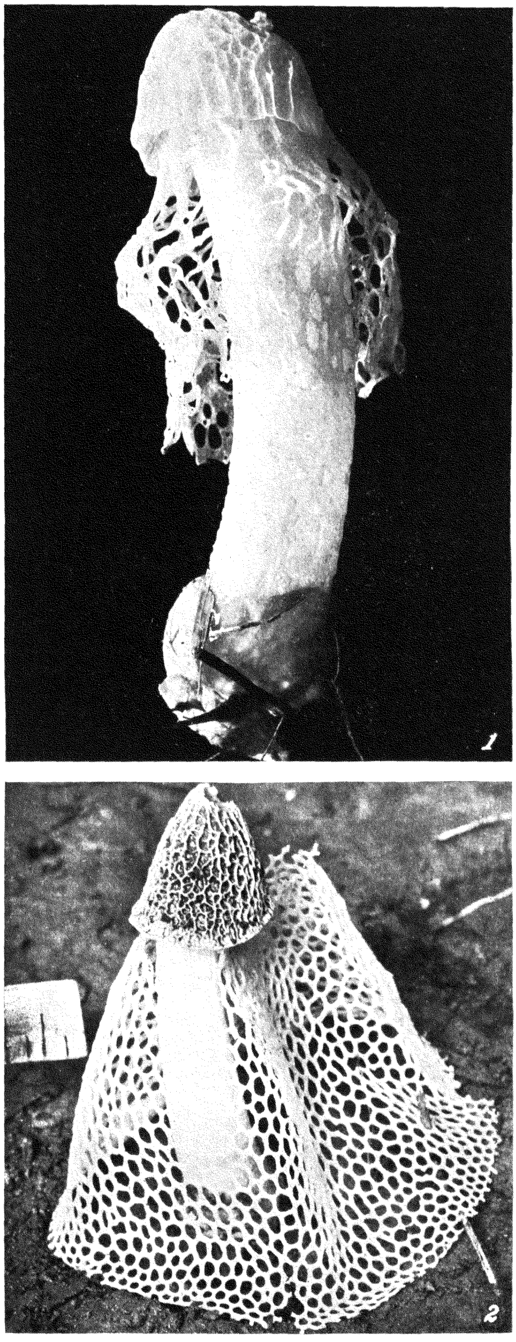

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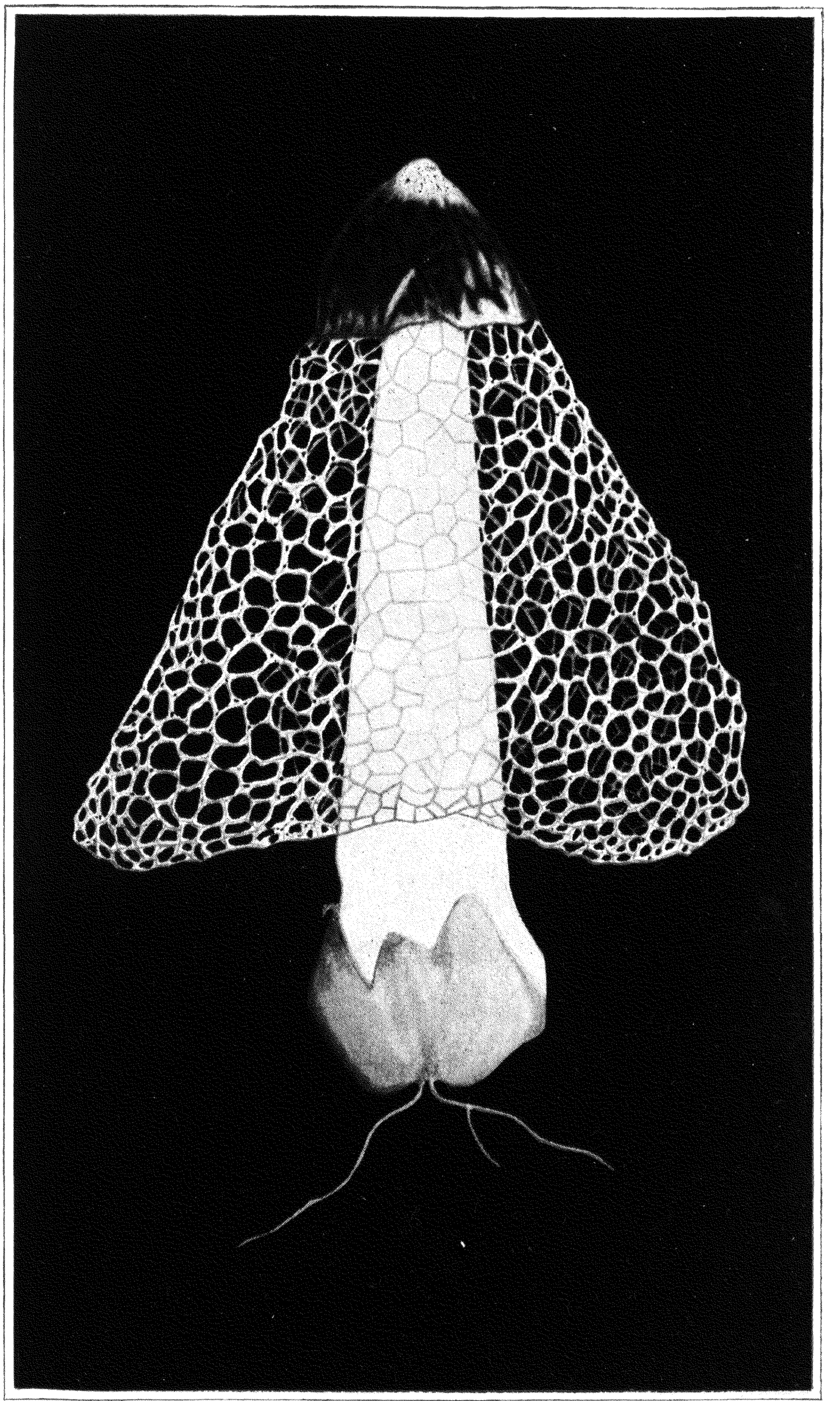

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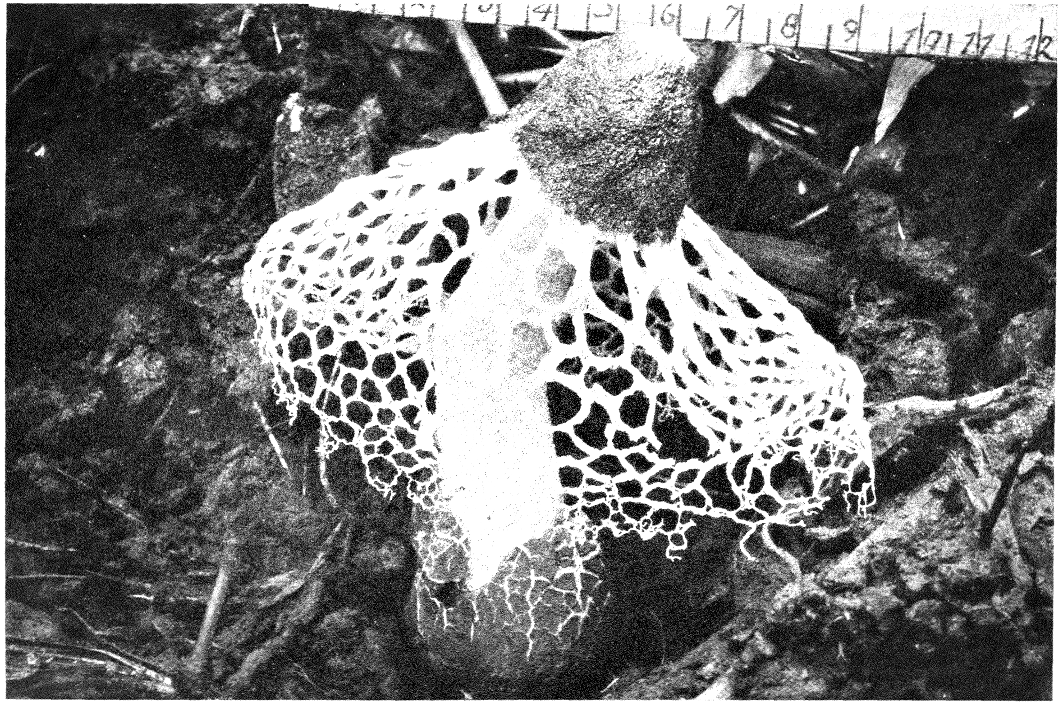

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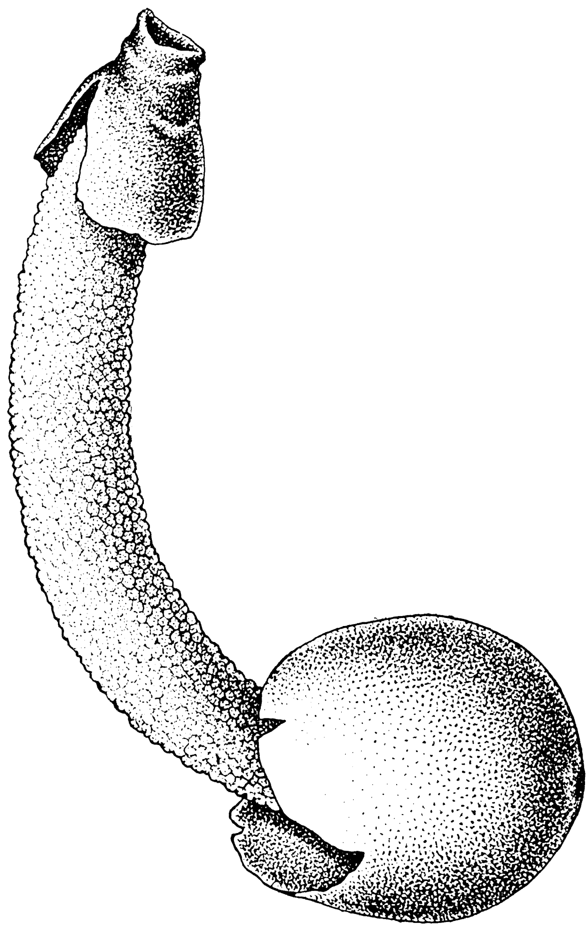

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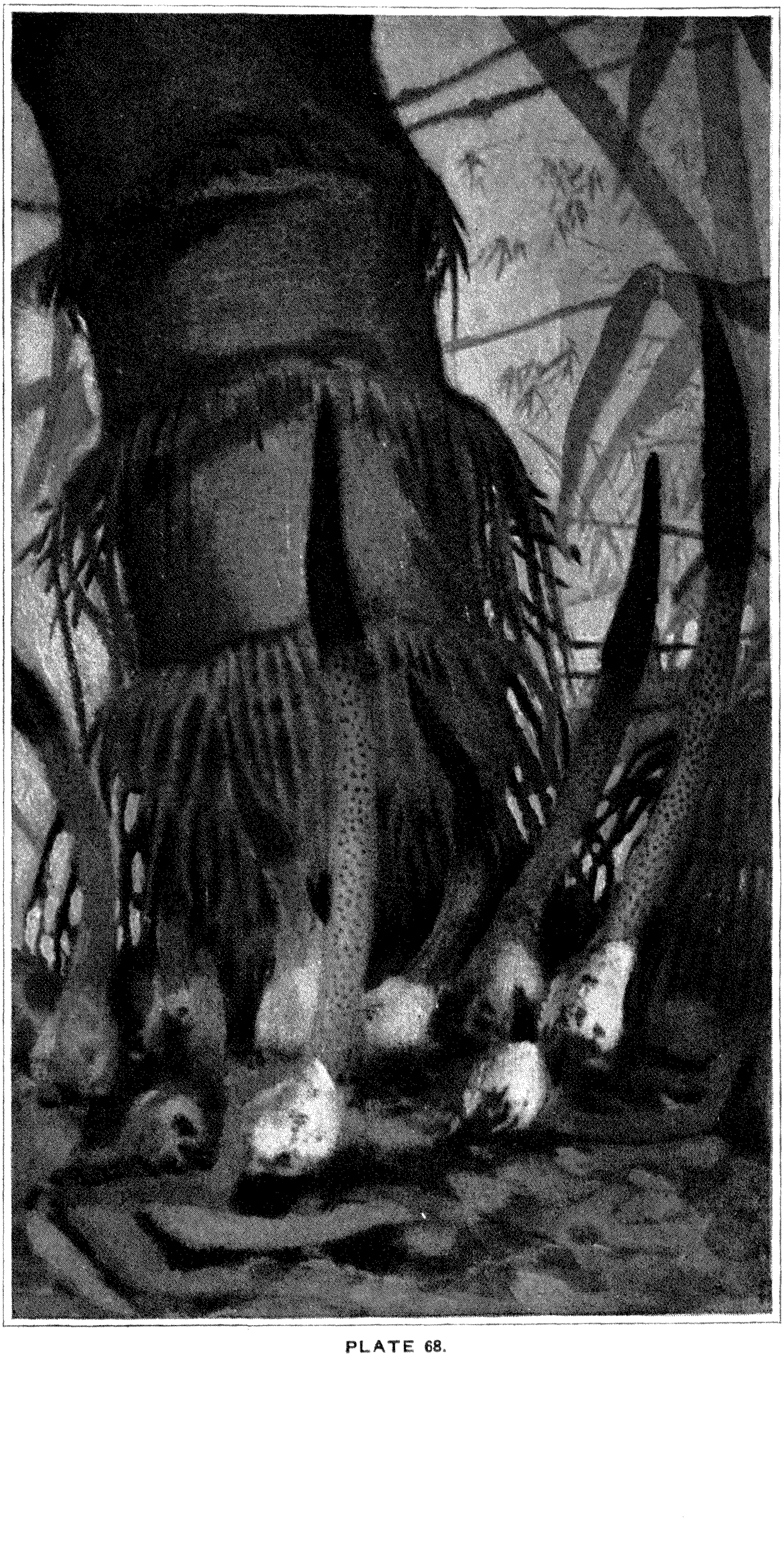

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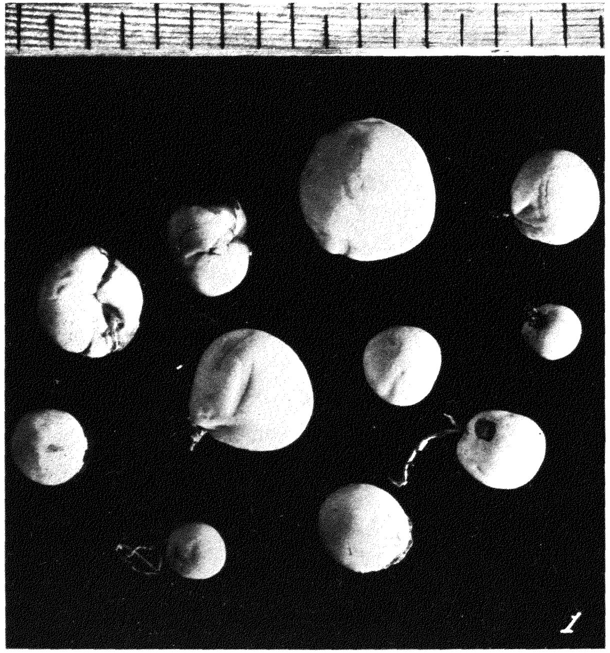


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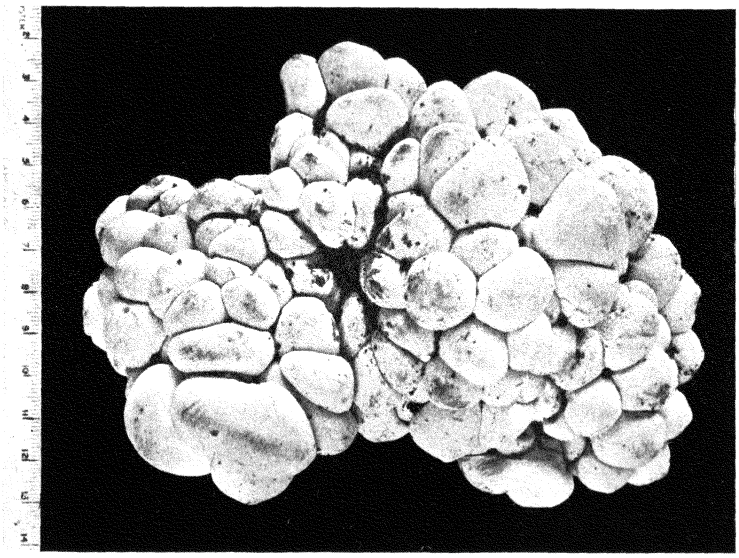

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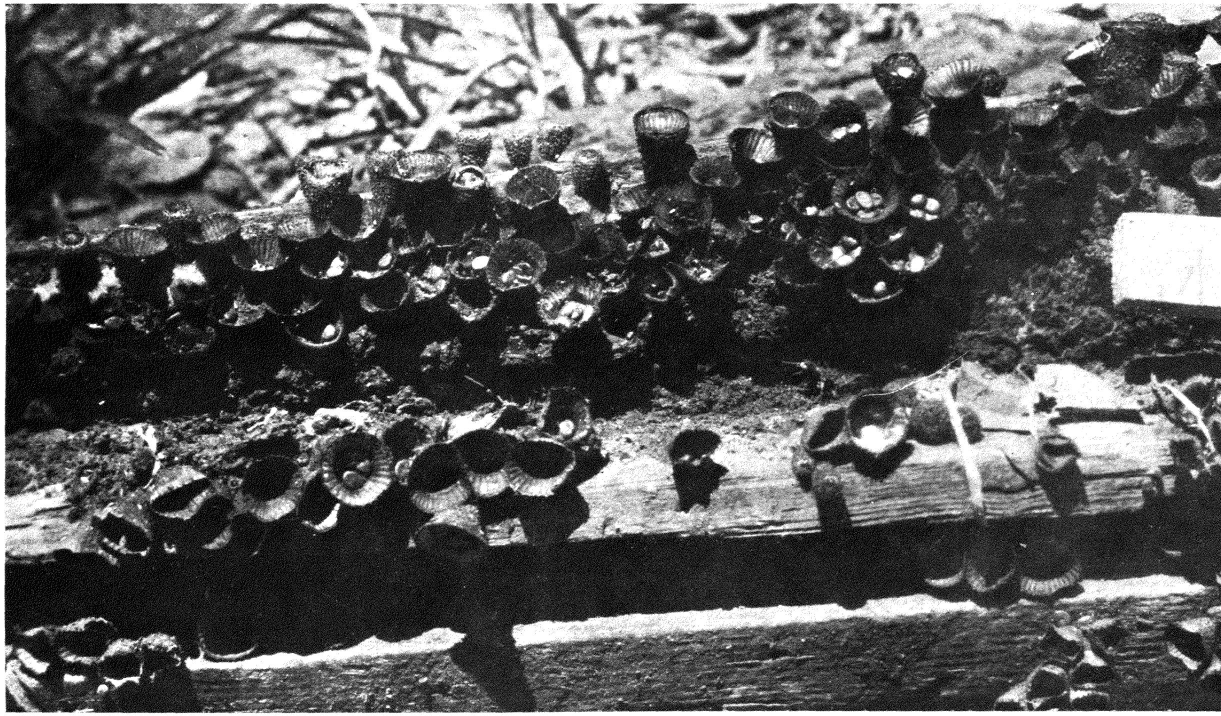

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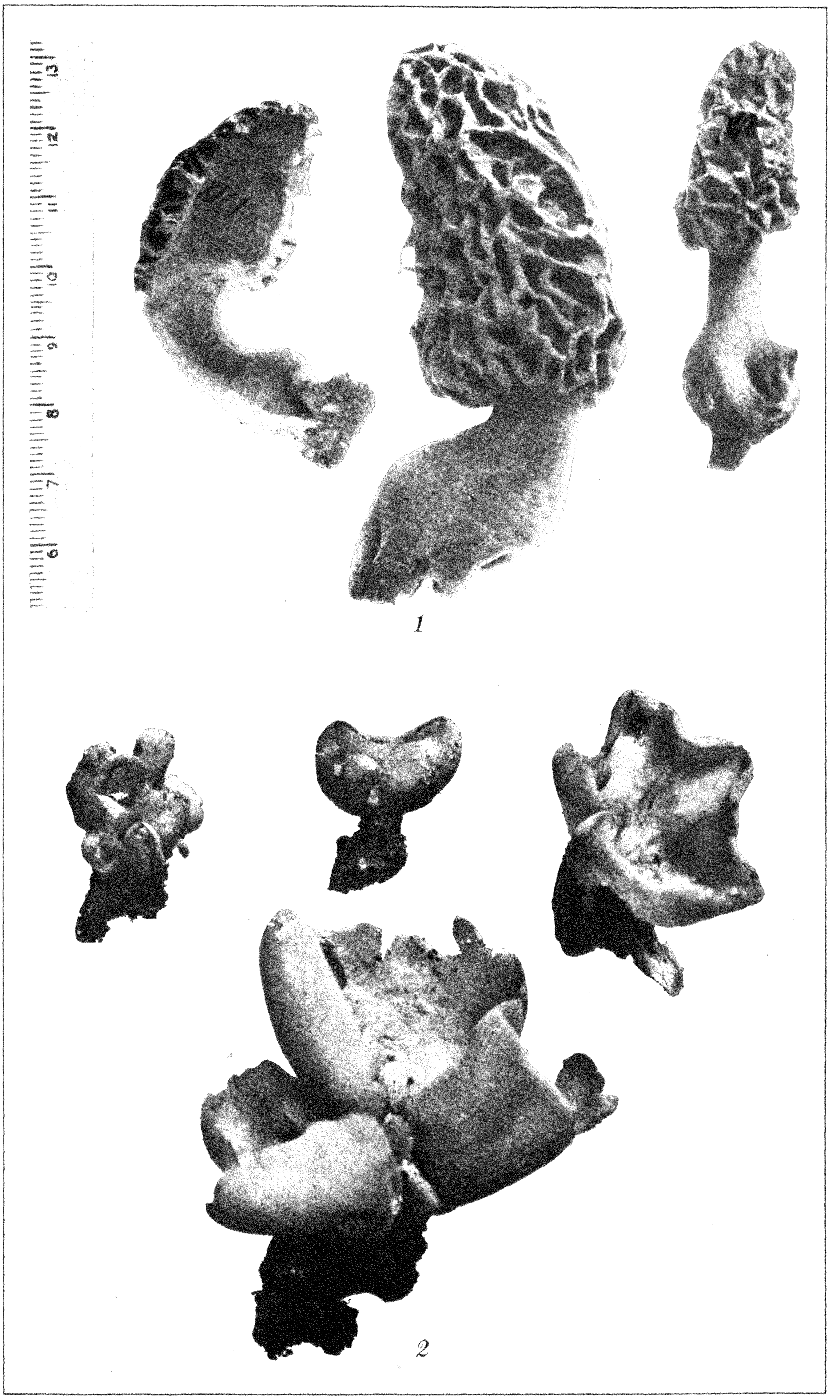

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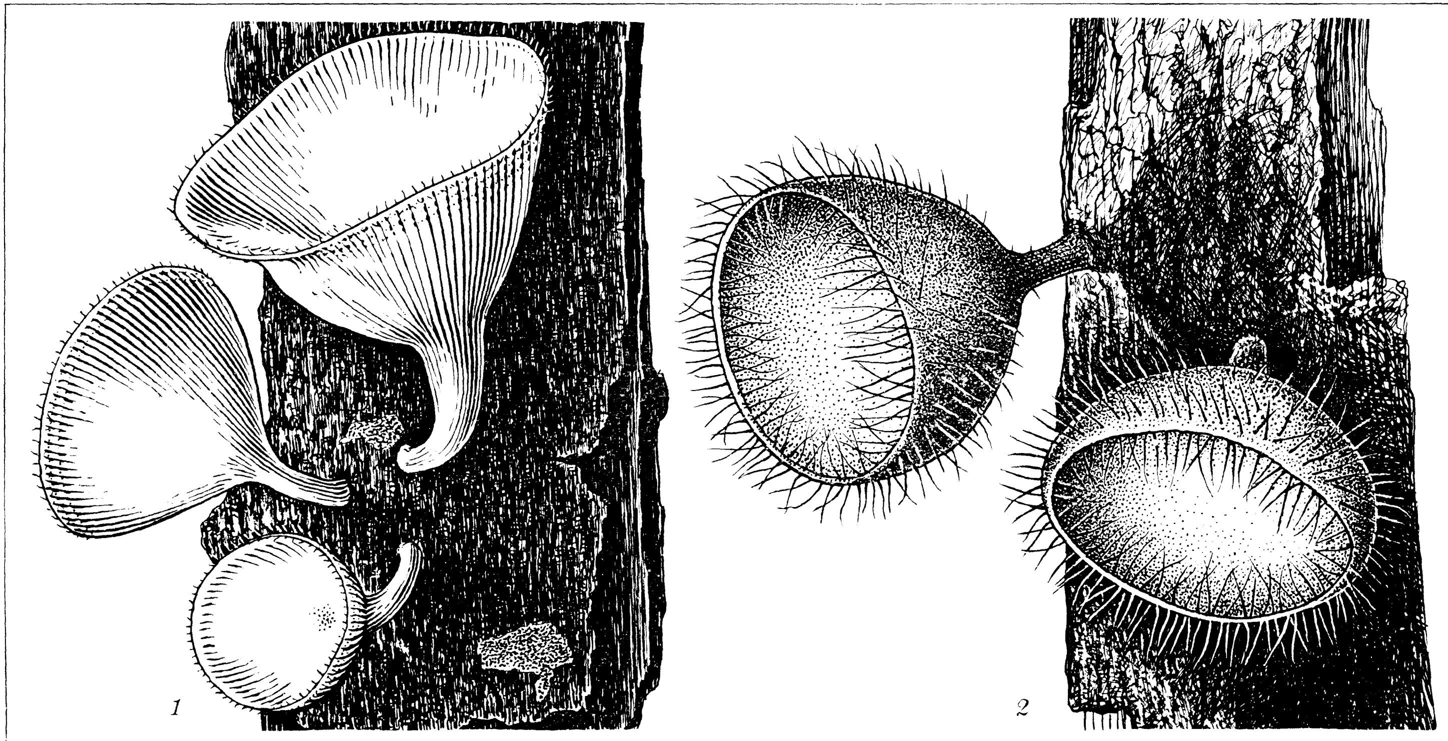

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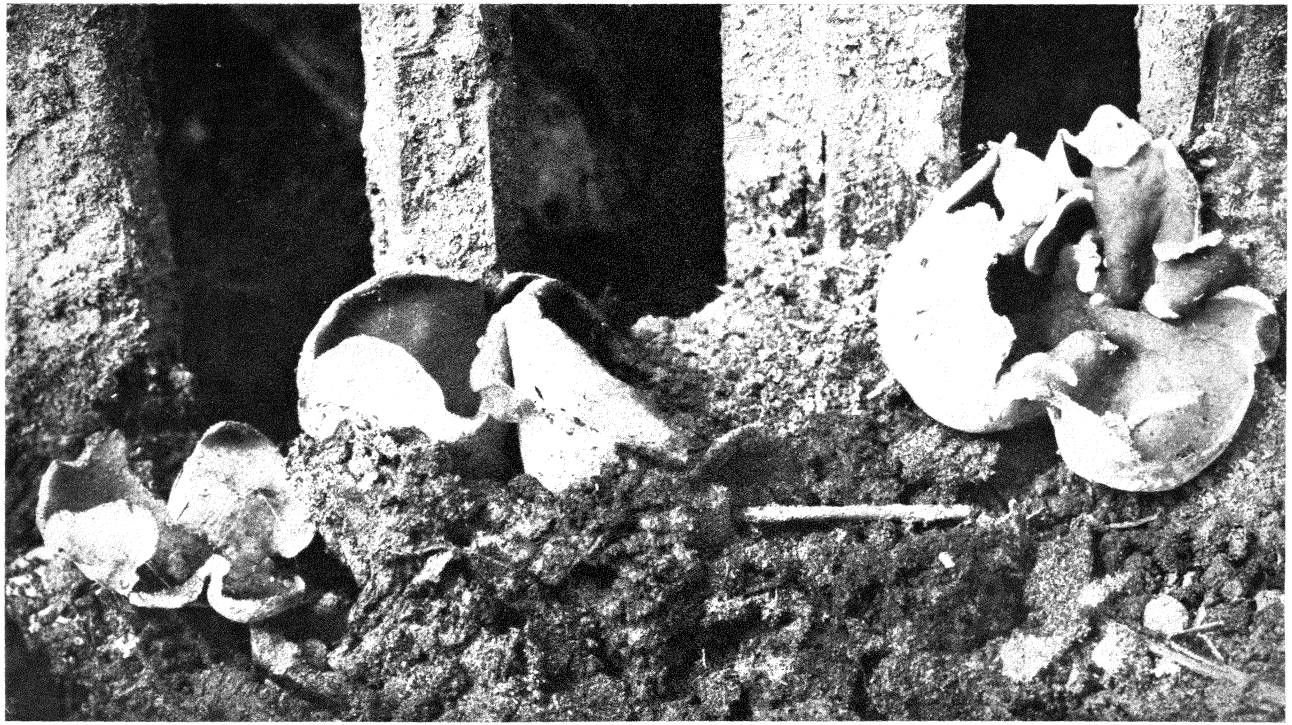

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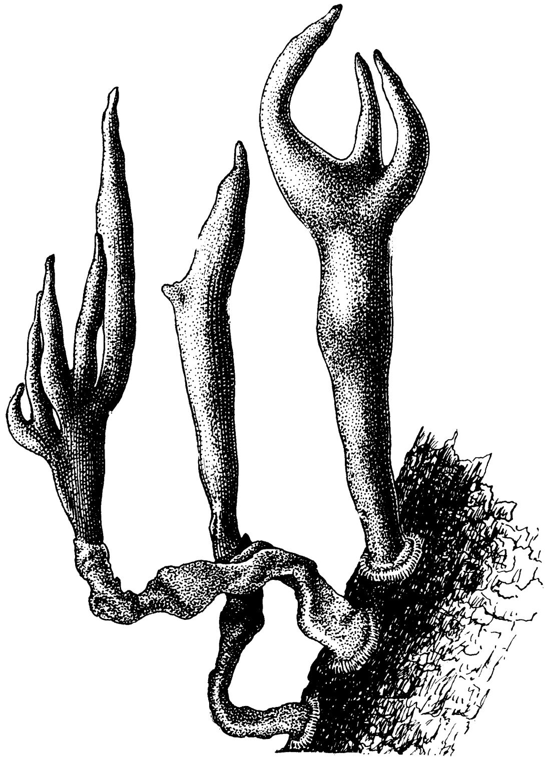

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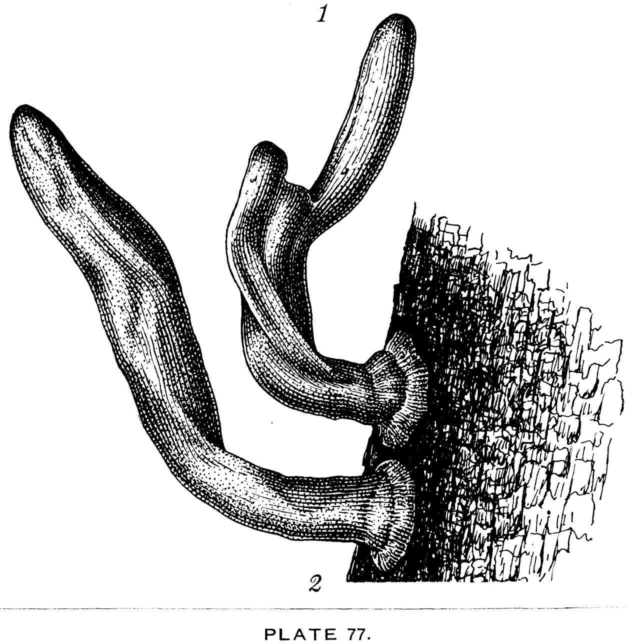

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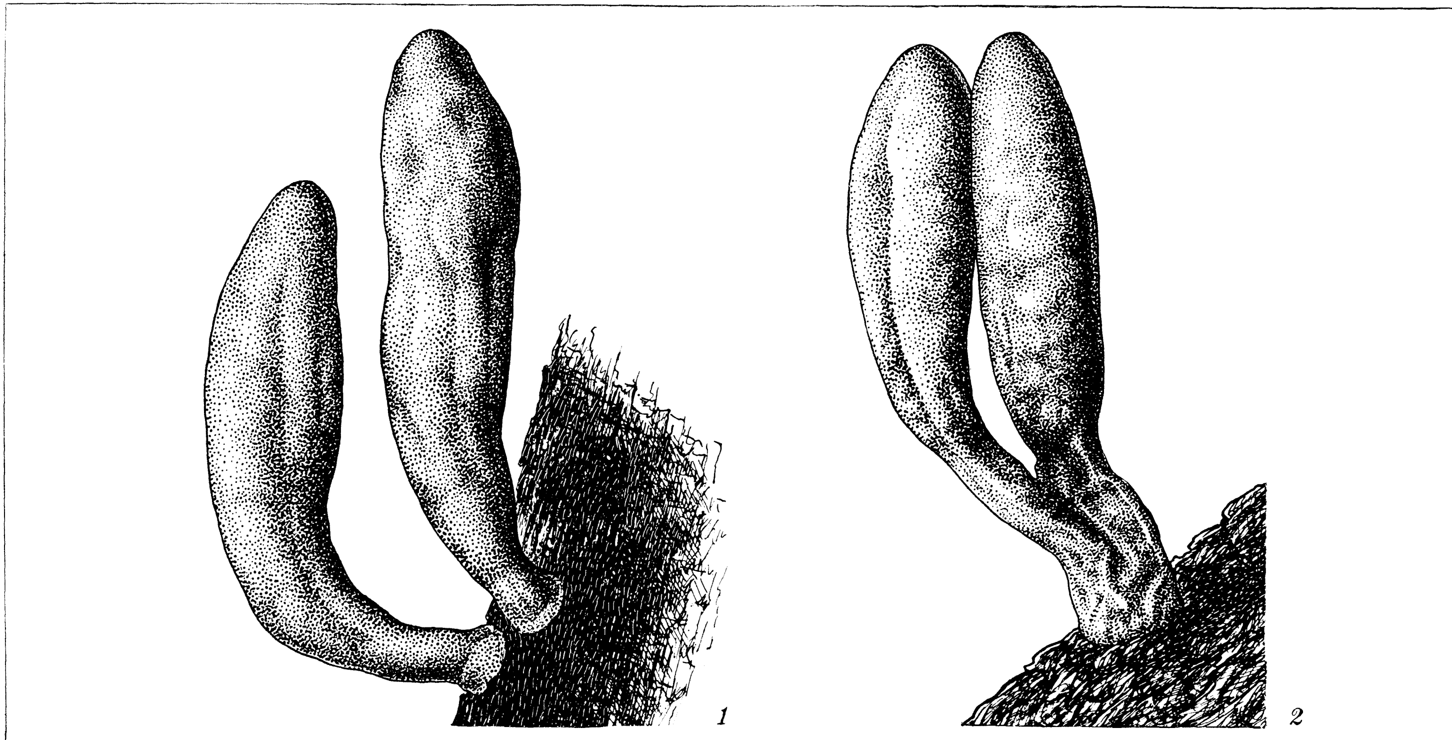

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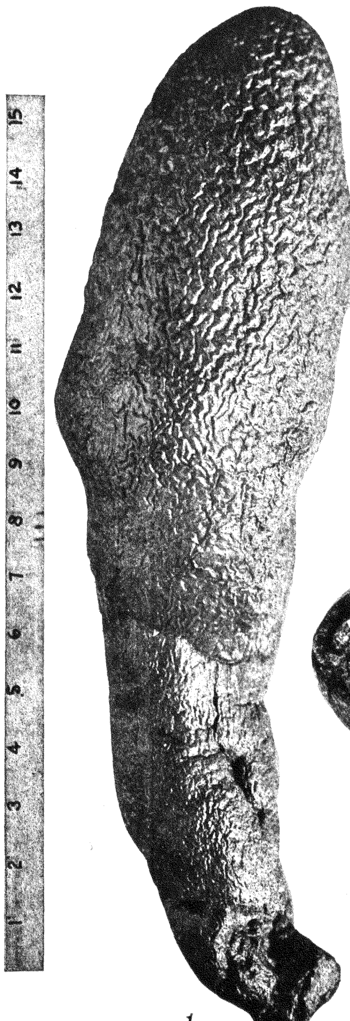

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PLATE 79.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 65 MARCH, 1938 No. 3

PRESERVATION AND PURIFICATION OF DRY RINDERPEST VACCINE

By TEODULO TOPACIO, ANACLETO B. CORONEL, and ABELARDO VALENZUELA

Of the Bureau of Animal Industry, Manila

In their reports on dry rinderpest vaccine Robles and Generoso(3, 4) observed that vaccine in the flake or unpulverized form exposed to room temperature (20° to 30°C.) for 6 days is not affected in its potency, but subjected to exposure under the same conditions for 32 days shows a definite loss of protective value. In the powdered state its potency was retained for 91 days in the ice box (0.8°C.), but tests showed loss of potency due to exposure to room temperature under shipping conditions. A marked deterioration was noted in 36 months at ice-box temperature, and in 29 days under mailing conditions (atmospheric temperature).

Jacotot(2) in the third part of his report mentions two experiments on vaccine prepared by dehydration of the virulent spleenic pulp. In one experiment he found that from the 2d to the 6th month at ordinary temperature (exact temperature not given) the protective dose of the vaccine tested varied from 0.5 or 0.75 gram to 0.75 or 1 gram. In the second experiment he found that the antigen which 2 months after preparation was active in a dose of 0.75 gram was effective after 6 months only when the dose was doubled to 1.5 grams. No literature is available on the factor or factors responsible for such deterioration; however, it is a common observation that when fresh meat is exposed to room temperature, the fat turns rancid. This process is known as fat oxidation, and leads readily to the final spoilage or decomposition. Quite successfully

Birdseye(1) and others have prevented spoilage by quick, slow, or "sharp" freezing. Birdseye was particularly successful with sharp freezing in the packing of fresh meats and fish for delivery. Since the dry rinderpest vaccine is per se a tissue derivative, the observations of Birdseye may conceivably explain its deterioration, so that its keeping quality may be enhanced by extraction of its fat content. The following experiments were conducted to investigate these possibilities.

MATERIALS AND METHODS

Materials.—The material for these experiments consisted of 11 serials of regular dried rinderpest vaccine: D–14, D–16, D–18, D–19, D–20, D–21, D–26, D–27, D–28, D–31, and D–32. Sample bottles containing 10 grams of vaccine each were obtained after the preparation of each batch. As each sample was treated differently it will be described separately. Squibb ether for anæsthesia was used as the extracting agent. Acetone, 95 per cent and absolute alcohol, and formalin were also tried.

Methods of fat extraction.—The methods of extraction used were:

1. Shaking the vaccine once, twice, or three times with Squibb ether in a bottle at room temperature (20° to 30°C.) 1 ounce of ether to every 10 grams of dry vaccine. Then the ether was decanted and the residue allowed to dry on an ordinary filter at room temperature.

2. Shaking with ether, acetone, and alcohol, respectively, one after the other. The residue was dried at 37.5°C.

3. Continuous extraction with ether in a Soxhlet extraction apparatus for 4 to 5 hours or until the ether extract remained colorless at 40°C. Upon reaching the vaccine in the thimble the temperature falls to about room temperature. Quantitative determination of the fat content of the dry vaccine by one of us by this method gave from 10 to 18.65 per cent.

Testing for potency.—Every batch of vaccine that had gone through extraction was put in amber-colored bottles and kept at room temperature. Its potency was then tested on susceptible cattle and carabaos. Some batches were tested immediately after the treatment, others sometime thereafter. A few had more than one test at varying intervals. The majority, however, had but one test several months after extraction. The vaccine was injected intramuscularly on the back muscle behind the scapula at the dosage indicated. Two weeks after, 1 to 2 cc of virulent rinderpest virus (citrated blood) was injected into the test animals, including one control. All controls developed rinderpest and were killed for vaccine. The test animals which developed clinical rinderpest after virus inoculations were killed for vaccine and were designated as "clinical rinderpest." Those that showed only thermic reaction were designated as having had "temperature reaction" while those that had no signs of disease were designated as having had "no reaction."

DESCRIPTION OF VACCINES; THEIR TREATMENT AND POTENCY TESTS

Serial D–14.—The vaccine was 2 years and 28 days in the ice chest and was still potent at a 0.5 to 1 gram dosage for cattle and carabaos, respectively. A sample of this vaccine was treated with ether once at room temperature and kept at the same temperature for 1½ years. Two grams of the dried vaccine protected carabao No. 1368 against virulent blood.

Serial D–16.—Serial D–16 was a freshly ground vaccine, potent in carabaos at a 1.5 gram dosage. Two lots were prepared. Lot 1 was treated with ether three times in 1½ hours, or 30 minutes each time. Lot 2 was treated with ether twice, 15 minutes each time, once for 10 minutes in acetone, 48 hours in 95 per cent alcohol, overnight with absolute alcohol, and then dried on filter paper at 37.0° C. Dalupiri carabaos 1318 and 1315 received 1 gram of each vaccine, respectively. Given the virus two weeks later the first animal showed a temperature reaction only, while the other developed clinical rinderpest and was killed for vaccine.

Serial D–18.—The untreated vaccine protected a carabao which developed a temperature reaction after virus inoculation. A bottle of this vaccine was treated three times with ether at room temperature during night time. It was filtered through paper and dried at room temperature. Twenty-four hours after treatment 1 gram of the vaccine was injected into Dalupiri carabao 1327. Fuga cattle 3094 and 3053 each received 0.5 gram of treated vaccine 3 months old. Tayabas bull 2423 received 0.5 gram of vaccine 5 months old. Fuga bull 3406 received 0.5 gram of vaccine 1 year 6 days old. No reaction followed the test dose of virulent blood in all these animals, except the last which showed a temperature reaction of a few days.

Serial D–19.—In the regular potency test 1.5 grams of this vaccine 20 days after preparation did not protect a carabao. A bottle of it was treated with ether three times and its potency tested on Dalupiri carabao 1320 at 1 gram dosage. The animal developed only a temperature reaction.

Serial D–20.—The untreated vaccine was potent at 0.5 gram and 1 gram doses in cattle and carabaos, respectively, but after 5 months and 24 days 0.5 gram was no longer protective to cattle. A bottle of this vaccine, 3 weeks old, was treated with ether 3 times, and Dalupiri carabao 1342 and Fuga bull 2950 were inoculated with the vaccine 24 hours after the latter was treated with ether at 0.6 and 0.3 gram doses, respectively. The first animal showed clinical rinderpest, while the other showed no reaction. Fuga bull 3258 was injected with 0.5 gram of vaccine 5 months old, with no reaction. Dalupiri carabao 1375 received 1.32 grams of vaccine 7 months and 19 days old. The animal developed clinical rinderpest upon virus inoculation but recovered completely. Fuga bull 3537 received 0.5 gram of vaccine 1 year and 1 month old. The animal showed a marked temperature reaction upon injection of virulent blood. One gram of the vaccine of this serial with the fat newly extracted was wrapped in sterile filter paper and exposed to formaldehyde gas in a desiccating chamber for 30 minutes, the formalin extracted by vacuum, and the vaccine allowed to stand overnight for further evaporation of the gas. The vaccine was found sterile in cultural tests. A potency test was made on Fuga bull 2942 at a 0.5 gram dosage, but when the virus was given, the animal developed clinical rinderpest and was killed for vaccine.

Serial D–21.—Originally this was a rather weak vaccine which did not protect a carabao at a 1 gram dosage. A bottle of this vaccine was treated with ether three times at room temperature for 1 hour, then dried in the incubator at 37°C. for 30 minutes. Its potency was tested on Dalupiri carabao 1336 at 1 gram, but upon inoculation of virulent blood the animal developed rinderpest and was killed for vaccine.

Serial D–26.—A potency test of the regular vaccine freshly prepared resulted in a temperature reaction in cattle and clinical rinderpest in carabaos after virus inoculation. A bottle of this vaccine was treated with ether twice, dried at room temperature, and its potency tested 7 months later. For comparison the original vaccine of the same batch kept in the frigidaire was also tested. Mindoro bull 3516 received 0.5 gram of the original vaccine, and Mindoro bull 3510 the same dose of the purified vaccine 7 months old. When virulent blood was given to both animals the first developed clinical rinderpest and the second showed no reaction, showing the superiority of the purified material.

Serial D–27.—The regular vaccine tested immediately after preparation was potent at 0.5 gram for cattle, but not for carabaos at 1.5 grams. Four days after preparation a bottle of this vaccine was treated with ether three times, dried, and kept at room temperature; 8 months later it was protective to Fuga bull 3584.

Serial D–28.—The untreated vaccine was potent for cattle at 0.5 gram and for carabaos at 2 grams soon after preparation. From a bottle of this vaccine 8 days old the fat was extracted with ether in a thimble for 5 hours at 40°C., and the vaccine dried in the incubator at 37°C. for a few hours. Seven and a half months after treatment its potency was tested on Fuga bull 3583, which developed a temperature reaction after virus inoculation.

Serial D–31.—This vaccine freshly prepared protected cattle at 0.5 gram but not carabaos at 2 grams. From a sample the fat was extracted with ether in a thimble for 3 hours at 40°C., and the vaccine dried for 24 hours in the incubator at 37°C. Six and one-half months later its potency was tested at 0.5 gram on Fuga bull 3582 which showed a temperature reaction after receiving the virus.

Serial D–32.—The regular vaccine soon after preparation was potent at 2 grams for carabaos and at 0.5 gram for cattle. A sample was treated with ether for 6 hours in a thimble and the vaccine dried 24 hours at room temperature. Its potency was tested on Fuga bull 3566. There was a slight temperature reaction to virus inoculation.

The details of the tests on the 11 serials of dry vaccine are summarized in Table 1.

DISCUSSION

The results of the foregoing experiments seem to show that fat extraction with Squibb ether is a promising method of preserving and purifying dry vaccine. By treating a vaccine that was originally potent with ether one to three times for 30 minutes each at room temperature, a considerable amount of fat was removed, and the process did not seem to destroy the antigenic property of the vaccine. This is shown particularly by the potency tests of D–14, D–18, D–26, and D–27. On the other hand, treating a potent vaccine with ether in any other way, such as lengthening the time of exposure, or extraction or dehydration at higher temperatures, tends to lower potency, as shown by the tests on serials D–21, D–28, D–31, and D–32. However, D–21 was not a potent vaccine to start with. Likewise, a potent ether-treated vaccine subjected to other chemical treatment lost

TABLE 1.—*Potency of dry vaccine after extraction of fat and storage at room temperature.*

Serial number.	Extraction. Agent.	Extraction. Time.	Extraction. Duration.	Extraction. Drying temperature.	Interval between extraction and test.	Test number.	Animal.	Dosage. Vaccine.	Dosage. Virulent blood.	Remarks.
								g.	cc.	
D-14	Ether	1	30 min	Room	1½ years	1	Carabao 1368	2.0	1	No reaction.
							Bull 344 (Control)		1	Killed for vaccine.
D-16	Ether	3	30 min	Room	1 day	1	Carabao 1318	1.0	2	Temperature reaction (recovered).
	Ether	2	15 min	37°C	do		Bull 2986 (Control)		2	Killed for vaccine.
	Acetone	1	10 min			1	Carabao 1315	1.0	2	Clinical rinderpest, killed for vaccine.
	Alcohol (95%)	1	48 hrs							
	Alcohol (100%)	1	overnight							
D-18	Ether	3	15 min. or less.	Room	1 day	1	Carabao 1327	1.0	2	No reaction.
					3 mos	2	Bull 3094	0.5	2	Do.
							Bull 3053	0.5	2	Do.
							Bull 3067 (Control)		2	Killed for vaccine.
					5 mos	3	Bull 2423	0.5	1	No reaction.
							Bull 3188 (Control)		1	Killed for vaccine.
					1 yr. 6 days	4	Bull 3406	0.5	2	Temperature reaction.
							Bull 3546 (Control)		2	Killed for vaccine.
D-19	Ether	3	30 min.	do	20 days	1	Carabao 1320	1.0	2	Temperature reaction.
							Bull 2978 (Control)		2	Do.
					1 day	1	Bull 2950	0.3	2	No reaction.
							Carabao 1342	0.6	2	Clinical rinderpest, killed for vaccine.

D-20	Ether	3	15 min. or less.	Room	5 mos. 24 days	2	Bull 2969 (Control)		2	Killed for vaccine.
							Bull 3258	0.5	2	No reaction.
					7 mos. 19 days	3	Bull 3602 (Control)		2	Killed for vaccine.
							Carabao 1375	1.32	1	Clinical rinderpest (recovered).
					1 yr. 1 mo	4	Bull 3408 (Control)		2	Killed for vaccine.
							Bull 3537	0.5	2	Marked temperature reaction.
	Formaldehyde	1	30 min	Room	16 days	2	Bull 3547 (Control)		2	Killed for vaccine.
							Bull 2942	0.5	2	Clinical rinderpest, killed for vaccine.
D-21	Ether	3	1 hr	37°C	None	1	Bull 3022 (Control)		2	Killed for vaccine.
							Carabao 1336	1.0	2	Clinical rinderpest, killed for vaccine.
D-26	None [a]				7 mos	1	Bull 2940 (Control)		2	Killed for vaccine.
							Bull 3516	0.5	1	Clinical rinderpest, killed for vaccine.
	Ether	2	15 min. or less.	Room	do	1	Bull 3510	0.5	1	No reaction.
D-27		3	do	Room	8 mos	1	Bull 3531 (Control)		1	Killed for vaccine.
							Bull 3584	0.5	2	No reaction.
D-28	Ether	1	5 hrs. [b]	37°C	$7\frac{1}{2}$ mos	1	Bull 3499 (Control)		2	Killed for vaccine.
							Bull 3583	0.5	2	Temperature reaction.
D-31	Ether	1	3 hrs. [b]	1 day at 37°C	$6\frac{1}{2}$ mos	1	Bull 3499 (Control)			Killed for vaccine.
							Bull 3582	0.5	2	Temperature reaction.
D-32	Ether	1	6 hrs	1 day at room temperature.	8 mos	1	Bull 3499 (Control)		2	Killed for vaccine.
							Bull 3566	0.5	2	Temperature reaction (6th day).

[a] Untreated vaccine kept in a frigidaire.

[b] At 40° C.

its potency completely, as is shown by the results of the potency test of lot 2, D–16, which was subjected to the action of acetone and two strengths of alcohol (95 and 100 per cent) successively. A portion of the ether-treated vaccine potent on cattle in 0.3 gram dosage exposed to formaldehyde gas for 30 minutes also lost its potency, even at 0.5 gram. While the gas sterilized the vaccine it also destroyed its potency.

In one instance it was noted that treating a vaccine of low-original titer with ether apparently improved its protective value, as in the test of D–19, in which the test carabao had only a temperature reaction at 1 gram dosage, while in the virus test the untreated vaccine failed to protect even at 1.5 grams. Taking the maximum amount of fat extracted to be 18 per cent, the test animal in the former case still received less vaccine than the latter.

Generally speaking, however, if one starts with a vaccine of low potency, no further treatment can improve its preserving quality, potency, and concentration, as shown in the case of D–21, in which the test animals injected with untreated and treated material did not resist the virus inoculation and had to be killed for vaccine.

Serials D–14 and D–20 are extraordinarily good vaccine as shown by the fact that 3½ years after preparation they protected the test carabao at 2 grams against the test dose of virulent blood. (Two years and 28 days in the ice chest in the untreated form and 1½ years at room temperature after fat extraction). Similarly, the first potency test of D–20 protected a susceptible bull at a reduced dose of 0.3 gram, although it failed to protect a carabao at twice that dose, 0.6 gram. This vaccine remained potent up to 5 months and 24 days at room temperature. After 7 months, however, its potency began to decline.

Serials D–14, D–26, and D–27 are the best examples of the ether-treated vaccine the keeping quality of which has been enhanced 7 to 18 times over that of ordinary untreated vaccine, under the same condition as shown by the results of the potency tests.

The fact that all of the ether-treated vaccines were kept at room temperature, and that the results of their potency tests compared favorably with those of the vaccine kept in the ice box, indicates a high degree of preservation and purification. Since ordinary dry vaccine kept only 30 days at most at room temperature, the foregoing experiments show that its keeping quality at room temperature was improved considerably by fat extraction. These experiments, moreover, show that a potent vaccine subjected to the ether treatment at ice-box temperature and stored in the refrigerator would probably maintain its potency over much longer periods than those recorded herein.

Topacio and Robles (5) in a previous paper tentatively concluded that dry vaccine does not owe its antigenic value to the presence of living virus. The various lethal operations to which the dry vaccines used in the present experiments were subjected would seem to bear out that view.

SUMMARY AND CONCLUSIONS

1. An attempt to preserve and purify the dry rinderpest vaccine by fat extraction with Squibb ether has been described.
2. The best results were obtained by treating the vaccine with ether 1 to 3 times for 30 minutes each by simple decantation at room temperature, followed by drying at the same temperature (20° to 30°C.). By this method of extraction the potency of the vaccines was not impaired, and their keeping quality was preserved for from 3 months to $1\frac{1}{2}$ years at room temperature.
3. Overtreatment or treatment at higher temperatures apparently had a deteriorating effect on the antigen.
4. Extraction with alcohol and acetone or exposure to formalin destroyed the potency of the vaccine, presumably due on the one hand to the complete removal of the antigenic lipo-proteins by the solvents, and to the destructive effect of formalin on the other.
5. Apparently the keeping quality at room temperature of a potent vaccine treated with Squibb ether by simple shaking and decantation was enhanced 7 to 18 times over that of the untreated material in the case of Serials D–14, D–26, and D–27. (Table 1).
6. The results of the foregoing experiments, in which no vaccine showed any detectable signs of living virus as shown by its reaction on the test animals, confirms the previous observation of Topacio and Robles that virulence is not involved in the immunizing property of the product.
7. There is evidence that extraction in the refrigerator would further improve the purity and keeping qualities of the product over the results already obtained.

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ELECTROLYSIS OF METHYL MAGNESIUM IODIDE IN PYRIDINE SOLUTION [1]

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and

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The electrolysis of the Grignard reagent has been carried out in ether solution by a number of workers.(3–9) Overcash and Mathers(10) studied the electrolysis of various organic magnesium complexes dissolved in organic solvents. Pyridine was unsatisfactory as a solvent for the deposition of magnesium, and dimethyl aniline gave the best results.

The mechanism of electrolysis in ether solution has been shown by Evans and co-workers(3, 4) to give magnesium plating out at the cathode, and magnesium halide, gas, and oil at the anode.

Pyridine, a tertiary base in which the Grignard reagent may be prepared, is much less volatile than ether, and has a greater dielectric constant that makes it suitable for electrodepositions. The use of this solvent for the electrolysis of akyl magnesium halides would test the generality of the mechanism of the reactions in ether solutions.

EXPERIMENTAL

Preparation of pyridine.—Chemically pure pyridine was dried over potassium hydroxide for two weeks, distilled from barium oxide, and kept over barium oxide until used, when it was again distilled.

Preparation of Grignard reagents.—Methyl magnesium iodide was prepared in ether solution, filtered, analyzed, and an aliquot used. A small amount of pyridine was added to precipitate the addition compound, and the ether removed by vacuum evaporation. The compound prepared in this way was perfectly white, whereas other methods involving filtering in air gave yellow precipitates. The addition compound was dissolved in addi-

[1] Manuscript received August 5, 1937.

tional pyridine for electrolysis. The pyridine solution prepared in this way was water white, whereas the preparation of the Grignard directly in pyridine solution gave a red solution and a precipitate of dark tar. The pyridine addition compound of methyl magnesium iodide had a solubility of about one gram per 100 cc of pyridine at room temperatures. Heating increased the solubility but caused the solution to darken.

Electrolysis of the solution.—The ether solution of the Grignard reagent was electrolysed with essentially the same results obtained by previous workers.

Electrolysis of the Grignard compound in pyridine was carried out in a graduated cylinder 6 cm in diameter and 14 cm high. Electrodes were platinum, 1.5 x 2.5 cm; potential across electrodes was 124 volts. When it was electrolysed, the solution darkened in color, no magnesium was deposited, gas bubbles were liberated at the cathode, and a gummy substance deposited on the surface of the cathode, which reduced the flow of current from initial 0.03 ampère to 0.008 ampère after 30 minutes. Various attempts were made to eliminate the deposit on the cathode. Agitation of the solution minimized but did not prevent the formation.

A divided cell was then used in which the anode was placed in an alundum thimble containing pure pyridine; the cathode was a rotating platinum spiral placed in the pyridine solution of the Grignard compound. Iodine was liberated at the anode. A number of runs were made on 100 cc of solution containing 1 gram of the pyridine addition compound of methyl magnesium iodide. Current flow fell from 0.1 ampère to 0.003 ampère after 45 minutes, when the cathode was cleaned and the electrolysis continued. The weight of deposit on the cathode was determined and the iodine in the anolyte titrated with thiosulfate. Typical results are given in Table 1.

TABLE 1.—*Results of the electrolysis of the Grignard compound in pyridine.*

Run.	Coulombs.	Cathode deposit.	Iodine at anode.	Anode eff.
		g.	*g.*	*Per cent.*
A 1	13.0	0.0053		
A 2	10.4	0.0082		
A 3	14.0	0.0083		
A 4	15.3	0.0085		
Total	52.7	0.0303		
B	38.9	0.0157	0.043	84.3
C	22.7	0.0108	0.024	82.8

Nature of the product.—The cathode deposit formed in the first experiments was a sticky brown mass. In the divided cell it formed as a brown powder with characteristic odor, soluble in water and decomposed by hydrochloric acid. It was analysed qualitatively for magnesium by the p-nitrobenzene azoresorcinol test, and magnesium found to be present. To determine whether the Grignard or pyridine was responsible for the deposit, a solution of anhydrous magnesium chloride in pyridine was electrolysed under the same conditions. The deposit was formed in the same way and gave a quantitative test for magnesium, indicating that the pyridine is responsible for the deposit.

The gas liberated at the cathode was too small in quantity to be collected and analysed.

DISCUSSION OF RESULTS

The addition compounds of the Grignard reagent with pyridine are supposed to have the structure of a substituted ammonium salt. Bergstrom and McAllister(2) by their preparation of 2-alkyl and 2-aryl pyridines have shown that this addition compound is stable up to high temperatures, at which rearrangement occurs. The mechanism of the electrolysis of methyl magnesium iodide in pyridine may be compared with ether solutions. In ether Evans and Field(3) postulate

$$\begin{array}{ccc} R_2Mg.\,MgX_2 \leftrightharpoons & [RMgX_2]^- & +\ [MgR]^+ \\ & \downarrow -e & \downarrow +e \\ & R + MgX_2 & \tfrac{1}{2}Mg + MgR_2 \\ & \text{Anode} & \text{Cathode} \end{array}$$

In pyridine solution the reaction may be represented by

$$\begin{array}{ccc} C_5H_5N{<}\genfrac{}{}{0pt}{}{CH_3}{MgI} \leftrightharpoons & I^- & +\ \left[C_5H_5N{<}\genfrac{}{}{0pt}{}{CH_3}{Mg}\right]^+ \\ & \downarrow -e & \downarrow +e \\ & \tfrac{1}{2}I_2 & [C_5H_5N{-}Mg] + CH_3 \\ & & \downarrow \\ & & \text{brown powder} \end{array}$$

It is interesting to note that a concentration of 0.1 to 1.5 mols per liter of Grignard reagent in ether would conduct but 0.2 to 0.4 ampère; the pyridine solution containing less than 0.1 mol per liter gave an initial current of 0.06 to 0.1 ampère, which decreased as the cathode deposit formed.

TABLE 2.—*Results of electrolyzing methyl magnesium iodide in pyridine solution compared with electrolysis in ether solution.*

Electrode.	Solution.	
	Ether.	Pyridine.
Anode	Gas liberated	Iodine liberated.
Cathode	Magnesium plated out	Gas liberated and brown deposit formed.

SUMMARY

The electrolysis of methyl magnesium iodide in pyridine solution has been investigated. The results are compared with those for electrolysis in ether solution.

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A NOTE ON MOSELEY'S LAW

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In view of the simple interrelationships between the physical properties of compound, such as heat of formation, electrolytic decomposition potential,(1) solubility, compressibility, melting point, and others,(2) and the simple method of calculating the value of the electronic charge, *e*,(3) as given in previous works, it was thought that possibly the atom has a structure much simpler than any of those attributed to it.

Consider a wave emanating from an electron of an atom whose radius is r. Planck found that a definite amount of energy, h, goes with each wave. It is evident that the energy per unit area on the wave front at a distance r from the center of the atom is distributed over $4\pi r^2$. Likewise a wave front at a distance mr from the center will have an energy per unit area distributed over $4\pi\ (mr)^2$, hence if E_1 and E_m are the intensities of energy on the two wave fronts the difference in intensities is

$$E_1 - E_m = \frac{h}{4\pi r^2}\left(\frac{1}{1^2} - \frac{1}{m^2}\right) \tag{1}$$

Represent now by $\Delta E'$ the energy emitted per second from every unit area of the atomic surface; if this energy is proportional to the difference in intensities, $E_1 - E_m$, then, introducing a proportionality constant, B, we obtain the equation

$$\triangle E' = B(E_1 - E_m) = \frac{hB}{4\pi r^2}\left(\frac{1}{1^2} - \frac{1}{m^2}\right) \tag{2}$$

Multiplying by $4\pi r^2$ to get the energy emitted through the whole atomic surface, we get the relation

$$\triangle E'\ 4\pi r^2 = hB\left(\frac{1}{1^2} - \frac{1}{m^2}\right) \tag{3}$$

If now we call the energy emitted by the atom in one second ΔE, it is evident that

$$\triangle E = hB\left(\frac{1}{1^2} - \frac{1}{m^2}\right) \tag{4}$$

where B is the proportionality constant, its value depending upon the units of the other factors. If $\triangle E$ is the energy per second, by the definition of h given above

$$\triangle E = h\nu \tag{5}$$

where ν is the frequency or number of waves per second. Putting now (5) in (4),

$$h\nu = hB\left(\frac{1}{1_2} - \frac{1}{m^2}\right) \tag{6}$$

On the right the only variable is m, and as m approaches infinity, $\frac{1}{m^2} = 0$, and

$$\nu = B \tag{7}$$

That is, the frequency is B if the value of the second term in the bracket becomes 1. We can identify B in equation (6) as Rydberg's fundamental frequency in the well-known Balmer's equation. The frequency of B then is the proportionality constant between the energy of the atom and the difference in intensity of energy between the first and $(\nu + 1)$th waves.

Consider now that in the atom there are n electrons that can emit waves. If $\frac{r}{n}$ is used instead of r in equation (1), equation (4) takes the form

$$\triangle E = Bhn^2\left(\frac{1}{1^2} - \frac{1}{m^2}\right) \tag{8}$$

and equation (7)

$$\nu = Bn^2 \tag{9}$$

Equation (9) is the equation for Moseley's law.

Whatever the true picture of the electrons might be at the time of the emission of waves, it seems that the foregoing considerations lead to the following attributes of the electrons when they act as centers of waves:

1. The electrons comprise the greater bulk of the atoms.
2. The n electrons of an atom are arranged as concentric shells with their centers coinciding with the center of the atom.
3. The thickness of the shells is the same or nearly so at the time of wave emission, its value being $\frac{r}{n}$, where r is the radius of the atom at the moment and n the atomic number.

4. If the waves emanate from the innermost shell, the energy quantum is distributed over its surface, so that one unit area emits energy equal to $\dfrac{h}{4\pi\left(\dfrac{r}{n}\right)^2}$; if from the second it is $\dfrac{h}{4\pi\left(2\dfrac{r}{n}\right)^2}$, from the third, $\dfrac{h}{4\pi\left(3\dfrac{r}{n}\right)^2}$ and so on.

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NEW LONGICORN BEETLES FROM FORMOSA, IV (COLEOPTERA: CERAMBYCIDÆ)

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ONE PLATE AND ONE TEXT FIGURE

This continuation of the present series, largely based on material collected by myself in Formosa in 1932 and 1934, forms my eighth contribution to the knowledge of the longicorn beetles of Formosa.[1] The localities at which the specimens were collected have also been described in a previous paper.[2] Herein are described fifteen new species or subspecies of the subfamilies Prioninæ, Cerambycinæ, and Lamiinæ. Several of the forms newly named were previously recorded from the island as continental species, but direct comparison with typical examples has proven them distinct. Besides the descriptions, some generic corrections and synonymies are presented. I am greatly indebted to Dr. K. G. Blair, of the British Museum, for kindly making comparisons and for making available to me certain material. The type specimens of the new forms are deposited in the United States National Museum in Washington, D. C., or are placed on loan deposit by myself in the type collection of the California Academy of Sciences in San Francisco.

PRIONINÆ

MACROTOMINI

Genus MACROTOMA Serville, 1832

MACROTOMA FISHERI subsp. FORMOSÆ Gressitt subsp. nov.

Macrotoma fisheri LAMEERE, Arch. Naturgesch. 79 (1913) 175; Cat. Coleopterorum 52 (1913) 29 (part); KANO, Trans. Nat. Hist. Soc.

[1] Previous papers on longicorns were published in Pan-Pacific Entomol. 9 (1933[4]) 163–170. Philip. Journ. Sci. 55 (1934[5]) 379–386; 57 (1935) 181–194; 58 (1935) 253–266; 61 (1936) 89–111, pl. 1. Insecta Matsumurana 9 (1935) 144–153. Trans. Nat. Hist. Soc. Formosa 25 (1935) 286–292.

[2] Notes on collecting in Formosa. Entomological World (Tokyo) 4 (1936) 711–727, 6 figs., 1 map.

Formosa 16 (1926) 120; MIWA, Gov. Res. Inst. Formosa, Dept. Agr. Rep. 55 (1931) 195; YOSHIDA, Trans. Nat. Hist. Soc. Formosa 21 (1931) 268; MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 162 (nec C. O. Waterhouse, 1884).

Male.—Very large, subparallel. Light reddish brown; first three antennal segments blackish; head and forelegs dull reddish to black; middle and hind legs deep red to reddish black. Dorsal surface glabrous except for tawny yellow hairs on clypeus, labrum, mandibles, mesothorax, and anterior and posterior margins of prothorax; thoracic sterna similarly clothed; abdomen glabrous except for lateral margins, apex of last, and a single row of hairs on fourth, segment.

Head, including mandibles, nearly twice as broad as long, deeply impressed on frons, narrowly and deeply concave between swollen antennal insertions, smooth and shallowly concave between the subapproximate superior eye lobes, finely sulcate medially for length of occiput, granulose-punctate behind eyes; mandibles coarsely punctured, strongly toothed before apices. Antennæ reaching to apical quarter of elytra; first three segments nearly three times as wide as following; scape rectangular and slightly concave when viewed from front, more than twice as long as broad, fairly coarsely punctured; third segment twice as long as scape and nearly as long as fourth to sixth segments united, slightly arched, concave, and broadly, though sparsely, punctured above, asperate beneath; seventh to ninth segments subreticulate above. Prothorax twice as broad as long, gradually narrowed anteriorly; lateral margins with a number of short fine teeth, some long, obliquely pointing teeth at posterior angles; disc coarsely and densely punctured, except for smooth, shiny middle and base. Scutellum practically impunctate. Elytra very slightly broader behind middle than at base, very finely vermiculate-rugulose, shiny near base, bearing four weakly raised costæ; apices broadly rounded and very weakly toothed at sutural angles. Metepisternum microscopically and closely punctulate. Abdomen practically impunctate, except for last segment. Forelegs sparsely asperate-punctate, strongly spined internally, the femora transversely grooved below; middle and hind legs glossy, nearly impunctate externally and internally, finely toothed below; first hind tarsal segment practically as long as following two segments combined, last segment nearly as long as first three together.

Female.—Antennæ finer, reaching to middle of elytra; scape twice as long as broad; third segment flat above; last two longitudinally multicarinate. Forelegs smaller, no more tuberculate than middle and hind legs.

Length, 45 to 69 millimeters; breadth, 17 to 23.

Holotype, male (No. 52191, United States National Museum), Hori (Horisha), central Formosa, altitude 550 meters, June 1935; allotopotype, female, July, 1932, author's collection; four paratopotypes, three males and one female, July, 1932, June 1934, and June and July 1935, two in the author's collection and one in Lingnan Natural History Survey Museum, Canton; two paratypes, Rokki (Rokkiri), southwestern Formosa, June 16, 1932, one in van Dyke collection, California Academy of Sciences, the other in the author's collection, taken by the author.

Differs from *M. fisheri* Waterhouse,[3] of Burma, in having the third antennal segment longer, the elytra smoother, the scutellum and abdomen impunctate, the middle and hind legs less punctate, and the elytra darker and more uniformly colored.

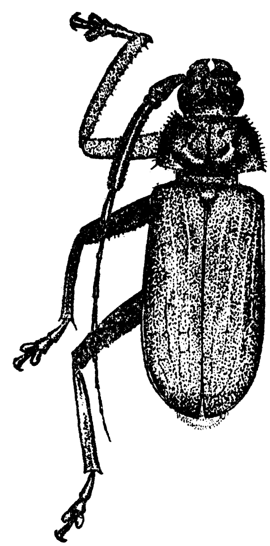

FIG. 1. *Macrotoma katoi* Gressitt sp. nov.

MACROTOMA KATOI Gressitt sp. nov. Text fig. 1.

Male.—Moderately large; length slightly more than three times breadth at shoulders, moderately dark brown; paler on elytra, with a reddish brown tinge, except for basal portions and apices; middle and hind legs and abdomen more reddish and somewhat shiny; head nearly black; first three segments of antennæ dark brown, remaining segments reddish brown and slightly shiny, like legs. Devoid of hairs except for moderately short and sparse golden-buff pubescence on labrum and anterior dorsal and ventral, and posterior dorsal, margins of prothorax; dirty golden pubescence on ventral surfaces of tarsi and at apex of last abdominal segment.

Mandibles medium-sized, black, slightly curved, basal two-thirds rough and punctate, apices smooth, pointed, with two small projecting teeth on cutting edge one-third length from apex; labrum and palpi light reddish brown; epicranial suture shallow on top of head, deeper on frons, branching at margin of

[3] Ann. & Mag. Nat. Hist. (5) 14 (1884) 382 (Burma).

frons and clypeus, forming a deep but short transverse groove; antennal supports very slightly projecting; neck short, nearly as wide as width of head across eyes; occiput slightly punctate, genæ rough. Antennæ not quite as long as body; scape rectangular when viewed from front, its sides subparallel; second segment short and ring-shaped; third stout, rough, but without true spines, three times as long as scape; fourth to last segments narrowed and subequal in length, smooth. Pronotum armed with short spines at lateral margins, moderately smooth, with four large, and two small, raised, and sparsely punctured glossy areas arranged in the form of a transverse rectangle on disc. Elytra broadest in middle, moderately smooth except at base, veins slightly raised. Forelegs rough, short spines on inner sides; middle and hind legs moderately smooth.

Length, 46 millimeters; breadth, 16.5.

Holotype, male, M. Kato collection, Tokyo; Tainan, southwestern Formosa, altitude 25 meters, May, 1922, collected by Mr. Masayo Kato, who kindly loaned the specimen to me for study and executed the accompanying brush drawing, and for whom the species is respectfully named.

This species differs from *M. crenata* (Fabricius), of India, in being shorter, in having the scape more than one-third longer than broad, the prothorax broader, the pronotum with a much wider basal callosity connected with a pair of anterior swollen shiny areas, the sides of the prothorax more rounded and bearing more numerous and finer spines, the femora a little less rough, and in other features. The illustration has the antennæ slightly exaggerated in length in comparison to the body. This species is probably the same as the form recorded from Formosa as *M. crenata* (Fabricius) by Yoshida and Matsushita.

CERAMBYCINÆ

MOLORCHINI

Genus EPANIA Pascoe, 1857

EPANIA SUBGLABRA Gressitt sp. nov. Plate 1, fig. 7.

Female.—Elongate, subparallel, robust; shiny black, apices of tarsi and bases of femora somewhat reddish brown, middle and hind tibiæ very slightly reddish, hind wings with steel-blue reflections; sides of anterior and posterior edges of swollen portions of prothorax finely clothed with silvery pubescence which is visible only at certain angles; scutellum, mesepimera, apices of metepisterna and metepimera, margins of hind coxæ, middle of lateral margin of first abdominal segment, and bases of lateral portions of second to fourth abdominal segments, clothed with silvery pubescence. Body largely clothed with fine erect pale hairs; elytra nearly glabrous; antennæ with a few short erect hairs on outer sides of first three segments and a few on inner sides of following three segments; fifth and following segments clothed with thin dull pubescence.

Head very short, plane in front, moderately coarsely punctured; frons fully as wide as high; vertex weakly concave; inferior lobes of eyes very large, rounded. Antennæ moderately thick, two-thirds as long as body; scape barely longer than third and fourth segments, slightly shorter than fifth, following diminishing in length. Prothorax longer than broad, strongly constricted basally, weakly so before apex; swollen portion coarsely reticulate-punctate. Scutellum as broad as long, concave, rounded apically. Elytra each nearly twice as long as broad, reaching to apices of metepisterna, obliquely truncated internally and rounded at apices; humeri strongly produced anteriorly; surface of each very sparsely and shallowy punctured; an arcuate depression extending from inside of humerus to truncate margin, closer to suture than to apex. Hind thorax finely and closely punctured; abdomen finely and sparsely punctured; first abdominal segment one-half again as long as second. Femora arcuate-pedunculate and abruptly clavate, hind pair reaching beyond fourth abdominal segment and clavate for slightly less than one-half their lengths; hind tibiæ nearly straight, weakly rugose; hind tarsi very slender, first segment slightly longer than following two together, shorter than last.

Length, 12 millimeters; breadth, 3.

Differs from *E. brevipennis* Pascoe in being larger, in having the antennæ black instead of brown, the elytra black instead of blue and more weakly punctured, the scutellum with silvery, instead of yellowish, pubescence, hind legs black instead of blue, ventral surface black instead of brown, and in other features. Differs from *E. subchalybeata* Miwa in having the bases of middle and hind femora dark instead of testaceous, the head and prothorax black instead of blue, and in other respects. Differs from *E. shikokensis* Ohbayashi in being longer, with the prothorax less closely punctured, the elytra longer and less distinctly punctured, the middle and hind femora dark basally and less clavate, the ventral surface less shiny, the hind tibiæ less rough and sinuous, and the hind tarsi slenderer.

Key to the Formosan species of Epania.

1. Scape shiny black .... 2.
   Scape reddish or brown... 3.
2. Elytra obliquely truncate; first four antennal segments shiny; hind femora clavate for less than one-half their length; legs entirely black. *subglabra* Gressitt.
   Elytra broadly rounded behind; first three antennal segments shiny; middle and hind femora testaceous basally; hind femora clavate for fully one-half their length .... *shikokensis* Ohbayashi.
3. Hind femora entirely chalybeate blue; head and prothorax black. *brevipennis* Pascoe.
   Middle and hind femora yellowish basally; anterior and middle tibiæ dark reddish brown; head and prothorax chalybeate blue. *subchalybeata* Miwa.

CLEOMENINI

Genus MIMISTENA Pascoe, 1866

Mimistena PASCOE, Proc. Zoöl. Soc. London (1866) 513 (Type: *femorata* PASCOE, op. cit. pl. 41, fig. 6, Penang).
Cleomenida SCHWARZER, Entom. Blätter 21 (1925) 29 (Type: *setigera* SCHWARZER, loc. cit., Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 309, 310 (=*Mimistena*).

MIMISTENA PULCHELLA (Gressitt).

Cleomenida pulchella GRESSITT, Philip. Journ. Sci. 57 (1935) 189 (Riran, Formosa).

Since *Cleomenida* is synonymous with *Mimistena,* the above substitution must be made.

This species is smaller than the others, but agrees quite well with them in structure, except that the third antennal segment is relatively a little shorter and the fourth a bit longer. It differs from *femorata* Pascoe, the type of *Mimistena,* in having the prothorax more constricted basally and the posterior femora more suddenly swollen and clavate for a smaller proportion of their respective lengths. The antennæ have the scape green, the remainder brownish, instead of blackish and white in the middle, as in *femorata.* The prothorax is largely orange instead of black, the legs and ventral surface green instead of black, and other differences.

LAMIINÆ

PHRISSOMINI

Genus DOLOPHRADES Bates, 1884

This genius is new to the Formosan fauna, having been known hitherto only from Japan proper, where the type and only previously known species, *D. terrenus* Bates, occurs.

DOLOPHRADES SUBDENUDATUS Gressitt sp. nov. Plate 1, fig. 6.

Female.—Grayish brown, blackish or pinkish in part; largely clothed with tawny brown pubescence; head blackish brown, densely clothed with pubescence; palpi reddish testaceous; antennæ dull reddish brown on scape and apices of following segments, bases of third to last segments light reddish brown, clothed with pale buffy pubescence; prothorax dull brown, densely clothed with tawny pubescence; scutellum thickly covered with golden pubescence; elytra dark brown, largely clothed with dirty tawny brown, but with irregular glabrous patches, particularly in middle portion, ventral surface dark brown, pinkish on sides of abdominal segments, entirely clothed with thin, but close, silvery buff pubescence.

Head nearly as wide as deep, moderately punctured on frons, closely and finely punctured on occiput and nearly impunctate on antennal supports; frons barely higher than wide, subrectangular; vertex concave, grooved medially; eyes with inferior lobes vertical, narrowed ventrally, occupying one-half distance between antennal insertions and bases of mandibles. Antennæ twice as long as body, slender; scape subcylindrical, two-thirds as long as third segment; third segment longer than fourth; fourth to tenth gradually diminishing in length. Prothorax as broad as long, slightly broader at apex than base, hardly swollen above, weakly constricted near base and apex, armed at each side with a short, but strong tubercle placed a little before middle; surface finely and closely punctured except below lateral tubercles. Scutellum raised, broader than long, rounded behind. Elytra broadened to just beyond middle, narrowed posteriorly, separately and narrowly rounded apically; disc convex beyond depressed base; sides fairly well deflexed; surface densely, though irregularly, punctured over entire surface, about seventeen punctures across middle of each and about thirty-five between base and apex along sutural row. Anterior portion of prosternum, and mesepisternum sparsely punctured; remainder of ventral surface impunctate; first abdominal segment as long as second and third together, last practically as long as third and fourth combined. Femora feebly swollen, hind pair reaching fourth abdominal segment; first hind tarsal segment as long as following two segments combined.

Length, 12.5 to 13.2 millimeters; breadth, 4.3 to 4.5.

Male.—Narrower than female; inferior eye lobes extending a little more than one-half way from antennal insertions to bases of mandibles; antennæ two and one-third times as long as body;

elytra parallel at basal half; narrowed posteriorly, more distinctly and sparsely punctured, denuded areas black; last abdominal segment shorter than two preceeding united; posterior femora reaching last abdominal segment.

Length, 10.2 millimeters; breadth, 2.9.

Holotype, female (No. 52192, United States National Museum), Hori (Horisha), central Formosa, altitude 650 meters, June 21, 1932; allotopotype, male, author's collection, Bukai, east of Hori, altitude 900 meters, June 14, 1934; paratype, female, Chirifu, southeast of Rokki, southwestern Formosa, altitude 750 meters, May 19, 1934, van Dyke collection, California Academy of Sciences; paratype, female, Hassenzan, north central Formosa, altitude 1,200 meters, June 24, 1934, author's collection, taken by the author.

Differs from *D. terrenus* Bates, of Japan, in being broader, more densely punctured, and in having bare patches on the elytra. One of the female paratypes has the antennæ only one-half again as long as the body.

MONOCHAMINI

Genus PSACOTHEA Gahan, 1888

PSACOTHEA HILARIS (Pascoe).

Monohammus hilaris PASCOE, Trans. Ent. Soc. London 4 (2) (1857) 103 (North China).

Diochares flavoguttatus FAIRMAIRE, Ann. Soc. Ent. Belg. 31 (1887) 133.

Psacothea hilaris GAHAN, Ann. & Mag. Nat. Hist. 2 (6) (1888) 400; MATSUMURA, Thous. Ins. Japan 3 (1908) pl. 52, fig. 3; MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 322.

Psacothea hilaris var. *machidai* SEKI, Entomological World 3 (1935) 292 (Tokyo, Japan).

Psacothea hilaris subsp. *albomaculata* KANO, Kontyu 6 (1933) 278 (type locality: Kirai, Formosa; also Loochoo Islands).

Kano's subspecies cannot hold, for I have examined over one hundred specimens from various localities in Formosa and compared them with typical examples from north central China, and find no characters to justify subspecific separation. The coloration of the pubescent spots is variable among specimens from any locality, and, moreover, among my material from Formosa the spots are more generally yellowish white or yellow and rarely pure white, and thus vary as do examples from the mainland or Japan proper. Specimens from the Loochoos and Kotosho are blacker and have paler spots, but even these are hardly worthy of separation. At any rate Kano's name cannot apply to these, as the type locality of *albomaculata* is in Formosa.

Genus MONOCHAMUS Guerin-Meneville, 1826

Xenohammus Schwarzer [4] must be placed as a synonym of *Monochamus.* I have examined specimens of both sexes of forms which agree exactly with the descriptions and figures of both of Schwarzer's species, and find no justification for their placement in the Xenoleini or their separation from *Monochamus.* Both are almost identical in structure with *Monochamus subfasciatus* of Japan and *M. bimaculatus* of India. *Monochamus filicornis* Gressitt [5] is identical with, and preoccupied by, *Xenohammus bimaculatus* Schwarzer, but as it is a true *Monochamus,* and as Gahan has already used *bimaculatus* for a *Monochamus,*[6] *bimaculatus* Schwarzer is a homonym and must be replaced by *filicornis* Gressitt. If my conclusions are correct, Schwarzer's error is a very peculiar one, as he had questionably recorded *M. bimaculatus* Gahan from Formosa previous to describing *Xenohammus bimaculatus,* and *filicornis* is exceedingly similar to *bimaculatus* Gahan, particularly in the round black spot behind the middle of each elytron. The principal differences are the slenderer build and grayish, instead of rusty, coloration of *filicornis.* I propose the following corrections:

MONOCHAMUS FILICORNIS Gressitt.

Monochammus filicornis GRESSITT, Philip. Journ. Sci. 55 (1935) 383 (type locality: Hori, Formosa).

? *Monochamus bimaculatus* SCHWARZER (nec Gahan, 1888), Entom. Blätter 21 (1925) (Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 324.

Xenohammus bimaculatus SCHWARZER, Senckenbergiana 13 (1931) 204, fig. 22 (type locality: Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 347.

I have collected specimens at Hori, Kuraru, and Chirifu (near Rokki), as well as in southeastern China.

Distribution.—Formosa (Kosempo, Hori, Kuraru, Chirifu, Fuhosho, Hozan); South China.

MONOCHAMUS NEBULOSUS (Schwarzer).

Xenohammus nebulosus SCHWARZER, Senckenbergiana 13 (1931) 205, fig. 15 (type locality: Kosempo, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 347.

[4] Senckenbergiana 13 (1931) 204.
[5] Philip. Journ. Sci. 55 (1935) 383.
[6] Ann. & Mag. Nat. Hist. 2 (6) (1888) 260.

I have collected specimens at Hori and Bukai in central Formosa. Mr. Masayo Kato, of Tokyo, has a specimen which he took at Shichito, Formosa.

Distribution.—Formosa (Kosempo, Hori, Bukai, Shichito).

MONOCHAMUS FASCIOGUTTATUS Gressitt sp. nov.

Female.—Moderately small, abbreviated; antennæ fairly thick. Jet black, irregularly clothed with white to yellowish pubescence, dense in parts, forming a median band and scattered spots on elytra; head sparsely clothed with white pubescence on genæ and lower portions of frons, glabrous on vertex and occiput; antennæ largely clothed with silvery black pubescence, annulated with white on basal halves of fourth to tenth segments and on base and apex of last; prothorax irregularly clothed with small tufts or spots of pubescence, largely tawny on disc and lower parts of sides and whitish on middle of sides and sternum, either side of middle of disc nearly glabrous, a round spot of pubescence above, and just behind, each lateral tubercle; scutellum densely clothed with pale tawny; elytra with a large spot at middle of each, forming a transverse band, broken at suture, remainder irregularly spotted, some larger spots nearly forming a narrow fascia halfway between median band and apex, most of the spots yellowish, median band largely white; ventral surface largely covered with small patches of pale pubescence, largely confluent on abdomen; mesepimeron and apex of metepisternum thickly clothed with tawny; legs thinly clothed with white hairs on femora (except apices) and at middle of each tibia, remainder black.

Head quite coarsely granulate, narrowly concave between antennal supports; frons nearly as wide as high, broader below than above, weakly swollen, inferior eye lobes nearly as wide as deep, barely occupying one-half distance between antennal insertions and bases of mandibles. Antennæ one and three-fourths length of body; scape strongly thickened apically, three-fifths as long as third segment; fourth to sixth subequal; third and following segments thickened apically. Prothorax broader than long, thickly and briefly tuberculate at each side, swollen across middle of disc, sparsely granulated. Scutellum short and rounded. Elytra less than twice as broad, not covering abdomen, separately rounded apically; surface finely granulose and irregularly punctured. Metasternum coarsely, and abdomen finely, granulose.

Length, 15 millimeters; breadth, 5.5.

Holotype, female, Hassenzan, altitude 2,100 meters, north central Formosa, June 24, 1934, loan deposit, California Academy of Sciences, taken by the author.

Differs from *M. subfasciatus* Bates, of Japan, in being shorter, less regularly, and in parts much more thickly, clothed with pubescence, with a distinct band and many rounded spots on elytra, and in having the antennal supports closer, the antennæ thicker, the prothorax more bluntly tuberculate, the elytra more sparsely, and less deeply, punctured, the ventral surface rougher, and in other features. Differs from *M. dubius* Gahan, of Burma and China, in being spotted less regularly, with paler pubescence, and in having the antennal segments unspined internally, the elytra less punctured and the legs black instead of reddish, and in other respects. Differs from *M. filicornis* Gressitt in being broader, less evenly clothed with pubescence, and in having a broad band and spots of light pubescence, instead of a round postmedian black spot on each. This species may very likely be the form recorded as *M. subfasciatus* Bates by Miwa in his Catalogue of the Coleoptera of Formosa. It is also possibly a subspecies of *M. sparsenotatus* Pic, of China.

Key to the Formosan species of Monochamus.[7]

1. Elytra granulose or asperate basally; prothorax moderately strongly tuberculate laterally .... 2.
   Elytra even and punctured basally; prothorax very weakly tuberculate. .... 3.
2. Elytra asperate and coarsely granulose basally; occiput rugulose-punctate; color rusty brown, mottled with white and black; length over twenty millimeters .... *tesserula* White.
   Elytra and occiput finely granulose; color black, banded and spotted with thick pale yellow or white pubescence; length under twenty millimeters .... *fascioguttatus* Gressitt.
3. Body largely clothed with tawny brown pubescence, a round, black spot just behind middle of each elytron; vertex forming a right angle between antennal insertions .... *filicornis* Gressitt.
   Body largely clothed with pale gray pubescence; elytra irregularly mottled with brownish black pubescence; vertex forming an obtuse angle between antennal insertions .... *nebulosus* (Schwarzer).

Genus DIHAMMUS Thomson, 1864

DIHAMMUS PERMUTANS subsp. PAUCIPUNCTATUS Gressitt subsp. nov.

Dihammus sericeomicans ? SCHWARZER, Entom. Blätter 21 (1925) 59 (Kankau, Formosa).

[7] *Monochamus flocculatus* Gressitt [Philip. Journ. Sci. 57 (1935) 188] may be more properly placed in the genus *Dihammus*.

Monochamus permutans MIWA, Gov. Res. Inst., Formosa, Dept. Agr. Rep. 55 (1931) 198 (=*sericeomicans* FAIRM.) (Horisha, Nanto, Kanshirei, Arisan).

Dihammus sericeomicans MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 329.

Male.—Large, narrowed posteriorly; black, very densely clothed with shiny golden pubescence, which, particularly on elytra, lies in different directions, giving a highly varied pattern of pale gold and velvety brown, largely marbled into small spots according to the angle of vision, and with a suggestion of two broad, incomplete dark bands, one before, and one behind, middle, the apical portions also darker when viewed from above; antennæ with scape and bases of following segments clothed with grayish pubescence, apices of third to tenth, and middle of last, black, thinly clothed with brown; frons, scape, and legs entirely clothed, lacking black spots; scutellum evenly clothed with pale buff pubescence.

Head deeper than wide, very sparsely punctured; vertex narrowly and subacutely concave between antennal insertions; frons hardly swollen. Antennæ two and one-third length of body; scape a little more than one-half length of third segment; fourth to tenth subequal, shorter than third; last twice as long as tenth; scape minutely punctured; third and following segments thickened at apices. Prothorax nearly as long as broad at base, subcylindrical, quite strongly tuberculate laterally; surface fairly deeply punctured along either side of midline of disc and more finely so behind anterior margin and between lateral tubercles and postmedian portion of disc. Scutellum narrowed and rounded apically, nearly as long as broad. Elytra distinctly narrowed posteriorly, irregularly rounded apically; surfaces asperate-punctate, subgranulate basally, moderately, and in part seriately, punctured externally, finely punctured internally and apically. Ventral surface smooth, no punctures visible through pubescence; legs very finely punctured; first hind tarsal segment hardly as long as following two combined.

Length, 22 to 29.5 millimeters; breadth, 7 to 10.

Female.—Broader than male; elytra less attenuated; antennæ clothed with paler pubescence on basal portions of third and following segments; scutellum broader.

Length, 29 to 30 millimeters; breadth, 10 to 11.

Holotype, male (No. 52193, United States National Museum), Bukai, east of Hori, central Formosa, altitude 1,000 meters, June 15, 1934, taken by the author; allotype, female, and paratype, male, Hassenzan, north central Formosa, altitude 950 meters, June 25, 1934, taken by the author; paratype, male, Giran, northeastern Formosa, altitude 50 meters, July, 1920, collected by M. Kato; paratype, female, Suisha, central Formosa, altitude 750 meters, May 28, 1932, in the author's collection; paratype, male, Hassenzan, June, 1934, van Dyke collection, California Academy of Sciences, taken by the author.

This subspecies differs from *D. permutans* (Pascoe),[8] of China, in having the pubescence less finely marbled, the frons, scape, and femora evenly clothed with pale pubescence, and lacking deep black punctures, the prothorax less densely punctured and the elytra less coarsely granulated basally.

Key to the Formosan species of Dihammus.

1. Third and fourth antennal segments of male strongly thickened and flattened; elytra less than twice as long as broad; prothorax about as long as broad at base .... 2.
   Third and fourth antennal segments of male not strongly thickened and flattened; elytra more than twice as long as broad; prothorax broader than long .... 3.
2. Largely pale tawny pubescent; elytra each with a basal brown spot. *subluscus maculihumerus* Matsushita.
   Dark brown, elytra with many spots of thick, dark pubescence surrounded by golden brown .... *flocculatus* (Gressitt).
3. Prothorax sparsely punctured; size large, over eighteen millimeters long. 4.
   Prothorax very densely punctured; size small, length under fifteen millimeters .... *contemptus* Gahan.
4. Antennal insertions strongly raised, vertex angulately concave between them .... 5.
   Antennal insertions weakly raised, vertex broadly rounded-concave between them .... 6.
5. Body golden-pubescent; elytra with pubescence lying in different directions, giving a highly variable pattern, coarsely granulose-punctate basally .... *permutans paucipunctatus* Gressitt.
   Body evenly brown pubescent; scutellum tawny; elytra finely punctured basally .... *cervinus* (Hope).
6. Prothorax strongly tuberculate laterally; elytra brown mottled with grayish, irregularly, but fairly evenly, punctured over entire surface. ? *formosanus* Breuning.
   Prothorax weakly tuberculate laterally; elytra reddish brown along suture, silvery buff laterally, subseriately punctured, the punctures hidden by thick pubescence, disappearing before apices.. *speciosus* Gahan.

[8] Trans. Ent. Soc. London 4 (2) (1857) 103 [*Monohammus*].

Genus CYRIOCRATES Thomson, 1868

CYRIOCRATES ALBOPICTUS Matsushita.

Cyriocrates albopictus MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 333, pl. 4, fig. 2 (type locality: Formosa).

Melanauster elegans KANO, Kontyu (Tokyo) 6 (1933) 279 (type locality: Horisha, Formosa).

Melanauster splendidus KATO (nomen nudum), Entomological World 1 (1933) 557, fig. 588 (type locality; Shinchiku, Formosa).

Cyriocrates elegans MATSUSHITA (nec Gahan, 1888), Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 435. (*M. elegans* Kano in *Cyriocrates*, and *C. albopictus* are synonymous with it.)

This species was first described as *Melanauster elegans* by Kano, but since it actually belongs in the genus *Cyriocrates*, Kano's *elegans* becomes a homonym, preoccupied by *Cyriocrates elegans* Gahan [9] and must be suppressed. The next available valid name is *albopictus* Matsushita, which was synonymized with *elegans* Kano by Matsushita himself, in the same work in which the former was described.[10] *Melanauster splendidus* Kato, which was listed and illustrated as *Melanauster splendidus* Gressitt, appeared before *albopictus* Matsushita, but must be considered invalid, since it was only a manuscript name and was not characterized, the illustration not being sufficient to distinguish it from certain Indian or southern Chinese forms.

Genus ARISANIA Gressitt, 1936

Arisania GRESSITT, Philip. Journ. Sci. 61 (1936) 106 (type: *submarmorata* GRESSITT, pl. 1, fig. 16).

This genus, doubtfully placed after the Hippopsini in the original designation, belongs more properly in the tribe Monochamini, though the form is very slender, the antennal scape is long and narrowly cicatricized, the third and following antennal segments are subequal in length, the prothorax is barely tuberculate, and the legs are very short. The characters placing it in the Monochamini are the subrectangular frons, the presence of a closed cicatrix on the antennal scape, the hardly ciliated undersurfaces of the antennæ, the long elytra in comparison to head and prothorax, the closed and externally angulated anterior coxal cavities, the externally open middle coxal cavities, the long metasternum, and the divaricate tarsal claws. The genus has no close relatives known to me.

[9] Ann. & Mag. Nat. Hist. 2 (6) (1888) 450.

[10] Beiträge zur Kenntnis der Cerambyciden des Japanischen Reichs.

MESOSINI

Genus FALSOMESOSELLA Pic, 1925

FALSOMESOSELLA HORISHANA Gressitt sp. nov. Plate 1, fig. 9.

Male.—Blackish brown, slightly reddish brown on antennæ and tarsal claws, largely clothed with brown, tawny, and grayish white pubescence as follows: Head clothed with dull tawny brown except for some white on middle of frons; antennæ sparsely clothed with dull tawny, basal halves of third and following segments grayish white, undersurfaces clothed with erect dark cilia; prothorax sparsely clothed with mixed tawny and gray hairs, middle of disc nearly glabrous; scutellum tawny; elytra mottled, largely dull brown mixed with tawny, a moderately broad irregular grayish white band, spotted with dark brown dots just before middle, a narrower, much less distinct, light fascia before apex; ventral surface and legs almost entirely clothed with grayish hairs, somewhat tawny on elytra.

Head strongly swollen in front, obtusely concave between antennal insertions, finely, but subasperately punctured; frons deeper than broad, wider above; eyes very deeply constricted, inferior lobes very small, oblique. Antennæ one-fourth longer than body; scape somewhat flattened, expanded ectoapically, three-fourths as long as scape, subequal in length to fourth; fifth two-thirds as long as fourth. Prothorax a little broader than long, swollen laterally, rather densely asperate-punctate, except on some small areas along middle of disc. Scutellum rounded. Elytra slightly broadened posteriorly, rounded-truncate apically, coarsely and irregularly punctured over entire surfaces, asperately so at bases. Femora very short, clavate.

Length, 7.4 millimeters; breadth, 2.5.

Holotype, male, Hori (Horisha, Polisia), central Formosa, altitude 550 meters, June 9, 1934 (loan deposit, California Academy of Sciences) taken by the author.

Differs from *F. hakka* Gressitt, of South China, in having the prothorax and elytra longer, the vertex more concave, the elytral punctures asperate and less seriate, and the elytra with a single premedian broad light band, instead of a basal and a postmedian one. Differs from *gracilior* Bates in being darker brown and less spotted with black, and in having the prothorax more swollen and the elytra less even and asperate.

FALSOMESOSELLA SUBALBA Gressitt sp. nov. Plate 1, fig. 10.

Female.—Dull reddish brown, almost entirely clothed with pubescence as follows: Head largely clothed with white, mottled with tawny above and at sides; antennæ clothed with grayish white spotted with tawny, apices of segments sparsely clothed, showing reddish derm; prothorax clothed with white, mixed with tawny, pubescence; scutellum white; elytra largely clothed with white on basal half, a brown spot on middle of each at first quarter and some tawny pubescence along costæ, posterior half mottled brown, tawny and white, an incomplete, zigzag brown band at middle; ventral surface and legs largely clothed with grayish white.

Head swollen anteriorly, grooved medially, subrounded-concave between antennal insertions; eyes deeply emarginate, inferior lobes small, deeper than wide. Antennæ one-fifth longer than body; scape flattened and produced ectoapically, nearly as long as third segment and slightly longer than fourth; fifth two-thirds as long as fourth. Prothorax broader than long, feebly rounded at each side, slightly swollen on either side of disc, fairly strongly punctured. Scutellum rounded. Elytra very slightly broadened posteriorly, rounded-truncate posteriorly; surface of each feebly tricostate and subseriately punctured, a few subasperate punctures near base. Metasternum sparsely punctured. Femora short and swollen, hind pair not reaching last abdominal segment, the latter as long as three preceding segments combined, and medially grooved.

Length, 8.3 millimeters; breadth, 3.2.

Male.—Antennæ one-half again as long as body; last abdominal segment only as long as two preceding segments combined.

Length, 10 to 12 millimeters; breadth, 4 to 4.4.

Holotype, female (No. 52194, United States National Museum), Kuraru, Koshun district, near South Cape, Formosa, altitude 160 meters, May 8, 1934, taken by the author; allotopotype, male, June 1932, Gressitt collection, taken by Y. Yano; paratopotype, female, Tsuda, May 1935, Gressitt collection; paratopotype, female, May 3, 1934, Lingnan Natural History Survey Museum, Canton, China, taken by the author.

Differs from the preceding in having the vertex more rounded-concave, the antennæ longer, the prothorax less closely punctured, the elytra more even, more finely and regularly, and less asperately, punctured, and in other respects. Easily distinguished from *hakka* Gressitt, *gracilior* Bates, or *horishana* Gressitt by its body being largely clothed with white pubescence, and spotted or streaked with tawny.

NYCTIMENINI

Genus EUSEBOIDES Gahan, 1893

EUSEBOIDES MATSUDAI Gressitt sp. nov. Plate 1, fig. 2.

? *Euseboides plagiatus* KANO, Trans. Nat. Hist. Soc. Formosa 18 (1928) 408 (Karenko and Koshun, Formosa) (nec Gahan, 1893); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. 34 (1933) 354.

Blackish brown to rusty brown; bases of antennal segments, margins of elytra, trochanters, tarsi and apical abdominal segments reddish; irregularly clothed with tawny pubescence as follows: Head sparsely clothed, prothorax with longitudinal stripes of pubescence, a very faint stripe along midline of disc, some broader, subconfluent stripes along sides of disc and upper portions of sides; scutellum densely clothed; elytra sparsely clothed, a little more densely so along middle of sides, a small spot of dense pubescence on costa just behind middle and a short oblique band one-fifth from apex, apices moderately clothed; sides of thorax moderately clothed; abdomen with five incomplete longitudinal stripes of denser pubescence; antennæ clothed with very thin pale pubescence, and a few short erect hairs.

Head feebly convex in front, rounded-concave between antennal insertions, closely and finely punctured; frons squarish; eyes deeply emarginate, coarsely facetted, inferior lobes deeper than wide. Antennæ one-third longer than body; scape cylindrical, slightly arched, one-fourth longer than third segment; third slightly shorter than fourth, subequal to fifth and following. Prothorax one-third longer than broad, as wide as head, three-fourths as wide as elytra, feebly constricted before and behind middle, finely and closely punctured. Scutellum small, rounded behind. Elytra four times as long as broad, parallel; apices slightly narrowed, obliquely truncated and strongly and subacuminately produced externally; surfaces finely punctured, most densely so on humeri, each with two obtusely raised ridges, one suboblique, from humerus to near suture at apical fifth, the other parallel to external margin, extending from humerus to apical sixth. Ventral surface quite regularly punctured; first abdominal segment nearly twice as long as each of following, which are subequal. Legs short; posterior femora fairly slender, extending to middle of second abdominal segment; first segment of hind tarsus slightly longer than second and third segments united.

Length, 10.5 millimeters; breadth, 1.6.

Holotype, male (No. 52195, United States National Museum), Hori (Horisha), central Formosa, altitude 600 meters, September, 1930; paratopotype of same sex in author's collection. Both received from Mr. Y. Matsuda, of Kyoto, for whom the species is gratefully named, and in whose collection there are additional specimens.

Differs from *Euseboides plagiatus* Gahan, of Sikkim, in being only two-thirds as long, narrower at the shoulders, with the elytra more parallel, more divaricate and acuminate apically and lighter preapically and less pale postbasally, the prothorax less cylindrical and relatively longer, and the posterior femora not reaching apex of second abdominal segment.

ACANTHOCININI

Genus CLYTOSEMIA Bates, 1884

? CLYTOSEMIA BICINCTA Gressitt sp. nov. Plate 1, fig. 3.

Slender, depressed, subparallel. Reddish brown; upper portion of head, and middle of sides of prothoracic disc brownish black; apical half of elytra chocolate brown, except along suture, partially clothed with pubescence; tibiæ dull brown; antennæ light reddish brown basally, third and following segments dull brown, their extreme bases reddish. Body clothed as follows: Head with thin silvery-white pubescence and erect dark hairs; antennæ sparsely pubescent, ciliate internally to seventh segment, cilia in a single row on fifth to seventh segments; prothorax with thin pale pubescence and erect black hairs; scutellum thinly pubescent; elytra likewise, nearly glabrous basally, two transverse glabrous dark brown bands posteriorly, first just behind middle, second between latter and apex, pubescent portions dotted with small, round, glabrous spots, entire surface with suberect setæ; ventral surface and legs thinly pubescent, latter with some erect dark setæ.

Head feebly convex, almost plane between antennal insertions, finely granulose; genal angles prominent; frons transverse; eyes coarsely facetted, inferior lobes suboblique, about as wide as deep. Antennæ slender, one-third longer than body; scape subcylindrical, slightly thickened medially, nearly as long as third segment; fourth longer than third; fifth to seventh each subequal to third. Prothorax nearly one-half again as long as broad, narrower at base than at apex, briefly and sharply spined at each side a little behind middle; surface finely granulose, moderately swollen above. Scutellum short, rounded. Elytra long, subparallel, narrowed and rounded apically, obtusely tuberculate near base, finely and closely punctured. Ventral surface finely granulose; metepisternum very narrow; first abdominal segment one-half again as long as second. Legs slender; femora compressed, clavate apically; first segment of posterior tarsus hardly longer than following two segments together.

Length, 5.4 millimeters; breadth, 1.2.

Holotype, male ? (loan deposit, California Academy of Sciences), Sakahen, near Karenko, eastern Formosa, altitude 1,200 meters, July 15, 1934, taken by the author.

Differs from *C. pulchra* Bates, of Japan proper, in having the vertex less concave, the scape less swollen, the prothorax longer and spined, instead of tuberculate, laterally, the antennæ more briefly ciliate, the scutellum smaller, the elytra more tuberculate, the anterior and middle coxæ more approximate, the body more distinctly setose, and in other features. The genus is new to Formosa.

Genus RONDIBILIS Thomson, 1857

RONDIBILIS FEMORATUS Gressitt sp. nov. Plate 1, fig. 1.

Brownish black; elytra dull reddish brown; pro- and mesosterna, coxæ, metepisterna, and deflexed portions of humeri reddish; clothed with pubescence as follows: Head thinly and evenly clothed with dull silvery; antennæ very thinly clothed with silvery pubescence; prothorax sparsely and somewhat irregularly clothed, the pale pubescence broken by indistinct brown spots, and narrowly and irregularly along suture and three or four other longitudinal stripes on disc; ventral surface thinly and evenly clothed; legs very sparsely pubescent. Body bristles very short, sparse and feebly raised, only discernible on dorsal surfaces of elytra; antennæ very sparsely bristled below.

Head very shallowly concave between antennal insertions; moderately concave anteriorly, finely granulose; eyes swollen, inferior lobes fully as wide as deep, occupying three-fourths distance from anterior tubercles to bases of mandibles. Antennæ slender, two-thirds again as long as body; scape very slightly thickened towards apex, subcylindrical, nearly as long as third segment; fourth very slightly longer than third or fifth, following gradually shorter. Prothorax one-third again as long as broad, constricted anterior to base, slightly swollen laterally, and very feebly and bluntly tuberculate behind middle of each side; disc hardly swollen, finely granulose. Scutellum triangular. Elytra narrow, very slightly attenuated posteriorly; apices narrowed and emarginate-truncate, outer angle briefly toothed; surface finely and subseriately punctured, a strong tubercle at end of basal quarter. Legs fairly long, femora swollen, hind pair nearly reaching elytral apices; tibiæ arched; first segment of hind tarsus slightly longer than remaining combined.

Length, 4.8 to 6.5 millimeters; breadth, 1.3 to 1.8.

Holotype, male (No. 52196, United States National Museum), Rokki (Rokkiri), southwestern Formosa, altitude 350 meters, May 15, 1934; allotopotype, female, May 12, and paratype, male, near Chirifu, east of Rokki, altitude 600 meters, May 19, 1934, in author's collection, all taken by the author.

Differs from *R. horiensis* Kano (*mushensis* Matsushita) in being smaller, with the vertex less concave, the eyes much larger, the prothorax less cylindrical, the elytra less oblique apically and not asperate-punctate, and the dorsal surface much less bristly, less pubescent, and lacking dark spots or bands.

Genus MIÆNIA Pascoe, 1864

MIÆNIA GRANULICOLLIS Gressitt sp. nov. Plate 1, fig. 5.

Female.—Dull reddish brown; head, except mouth parts, and prothorax, except anterior and posterior borders, brownish black; femora, except bases and apices, and tibiæ, except bases, dark brown. Body clothed with grayish white pubescence as follows: Head and prothorax largely, but thinly, clothed, the latter subglabrous on either side of scutellum, a moderately broad, suboblique band at end of first third, a slightly narrower and less complete band before apical quarter, and some irregular spots between latter and apices; ventral surface thinly and evenly clothed; apical margin of first abdominal segment with a short, but dense, fringe of hairs; antennæ with a single row of short cilia on undersides of second to seventh segments.

Head hardly concave between insertions, finely grooved medially, finely punctured; frons broader than high, slightly convex; eyes deeply emarginate, inferior lobe as broad as deep. Antennæ fine, one-half as long as body; scape subcylindrical, slightly longer than third segment; fourth nearly one-half longer than third and one-third longer than fifth; following gradually diminishing. Prothorax broader than long, slightly narrower at base than at apex; each side with a slender and slightly recurved spine a little behind middle; disc finely granulose. Scutellum rounded-truncate. Elytra subparallel, narrowed and rounded apically, finely and subseriately punctured to apices, a feeble carina along edge of lateral declivity. Posterior femora reaching to apical quarter of elytra; first segment of hind tarsus as long as following two united.

Length, 5 millimeters; breadth, 1.7.

Holotype, female (No. 52197, United States National Museum), Kuraru, Koshun district, near South Cape, Formosa, altitude 175 meters, May 9, 1934; paratopotype, female, May 8, author's collection; both taken by the author.

Differs from *M. subfasciata* Schwarzer in being broader, with the eyes larger, the scape less arched, the third antennal segment much shorter than the fourth, the prothorax broader with longer spines, its surface granulose instead of punctate, the elytra less heavily and less regularly punctured, dark with light bands instead of light with an incomplete dark fascia, and in other respects.

Genus EXOCENTRUS Mulsant, 1839

EXOCENTRUS TESTUDINEUS subsp. BREVISETOSUS Gressitt subsp. nov. Plate 1, fig. 4.

Female.—Dull chocolate brown, anterior and posterior borders of prothorax, prosternum, trochanters, bases of femora, and apices of tarsi reddish; body clothed with pale pubescence as follows: Head thinly clothed over most of surface; prothorax thinly clothed, a distinct oblique spot on either side, and a fine midlongitudinal line, on disc; scutellum fairly densely clothed; elytra each with a faint longitudinal stripe extending back from base interior to humerus and a suboblique one extending from near suture behind scutellum, both meeting a narrow transverse band that reaches external margin but does not quite touch suture, next a longitudinal stripe along middle of dorsal disc, crossing slightly over the preceding band and extending to middle where it dichotomously divides, the two branches continuing obliquely, the inner to suture, the outer an equal distance and turning and continuing transversely to external margin, and lastly a zigzag band just beyond beginning of apical quarter; ventral surface moderately clothed; antennæ with very short, slightly raised, dark hairs, and moderate, suberect internal bristles; body bristles short, strongly oblique on dorsal surface, very sparse on pronotum and legs.

Head feebly swollen, hardly concave at vertex, finely granulose; inferior lobes of eyes as broad as deep. Antennæ one-third longer than body; scape slightly thicker at middle than at apex, a little longer than third segment; third to fifth segments subequal; following slightly shorter. Prothorax about twice as broad as long, strongly produced laterally, with an obliquely backward directed spine behind middle of each side; surface finely granulose. Scutellum short, rounded. Elytra broad, parallel, rounded externally at apices; surfaces closely and irregularly punctured to apices. Last abdominal segment nearly as long as three preceding together. Femora moderately swollen.

Length, 4 millimeters; breadth, 1.5.

Holotype, female (loan deposit, California Academy of Sciences), Bukai, near Hori, central Formosa, altitude 950 meters, June 12, 1934, taken by the author.

Differs from *E. testudineus* Matsushita,[11] of Japan proper, in having the bristles much shorter, sparser, and thicker, the elytral punctures much coarser and covering entire surface, the antennæ and legs darker, and in other respects.

EXOCENTRUS VARIEPENNIS (Schwarzer).

Camptomyne? variepennis SCHWARZER, Ent. Blätter 21 (1925) 147 (type locality: Kankau, Formosa).

A specimen taken by me at Kuraru, Koshun, southern Formosa, May 8, 1934, appears to be referable to Schwarzer's species. Though Schwarzer does not state that the body is clothed with erect bristles, my specimen agrees with the original description as far as it goes, unless "Fühler einfach" means that the antennæ are unciliated beneath, rather than merely unarmed or not swollen. The species seems to be a true *Exocentrus*, so I transfer it from *Camptomyne*. This would provisionally eliminate *Camptomyne* from the fauna of Formosa. My specimen measures three and one-half millimeters in length, is reddish brown with three irregular fasciæ of spots of white pubescence on the elytra, and has the antennæ clothed with fairly long bristles internally and the elytra with long and thick bristles sparsely placed.

Key to the Formosan species of Exocentrus.

1. Legs densely clothed with bristles; elytra finely striped longitudinally.. 2.
   Legs very sparsely clothed; femora practically glabrous; elytra with transverse fasciæ or reticulate pubescent markings.............................. 3.
2. Prothorax red, less than twice as broad as long; elytra lacking a postmedian transverse fascia.. *rufithorax* Gressitt.
   Prothorax reddish brown, clothed with gray pubescence, more than twice as broad as long; elytra with a postmedian transverse fascia.
   seriatomaculatus Schwarzer.
3. Pubescent markings forming a subreticulate pattern on elytra; bristles very short, strongly oblique dorsally; elytra irregularly punctured.
   testudineus brevisetosus Gressitt.
   Pubescent markings on elytra in three transverse fasciæ; bristles long and erect; elytra distinctly seriate-punctate....*variepennis* (Schwarzer).

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[11] Trans. Sapporo Nat. Hist. Soc. 22 (1931) 47.

SAPERDINI

Genus SERIXIA Pascoe, 1856

SERIXIA GRISEIPENNE Gressitt sp. nov. Plate 1, fig. 8.

Female.—Largely black, antennæ and ventral portions of body partly testaceous; head reddish testaceous except labrum, tips of mandibles and eyes, which are black; antennæ black, becoming brownish black towards apices; prothorax reddish testaceous, slightly blackish at sides; scutellum and elytra entirely black; meso- and metapleura and sides of abdominal segments largely blackish; thoracic and abdominal sterna and posterior margins of abdominal pleura testaceous; legs largely black, tarsal claws, coxæ, and basal halves and undersurfaces of femora testaceous. Body clothed with pale gray pubescence and fine erect pale hairs, the former fairly dense on elytra, giving a gray effect; antennæ finely ciliate on undersides of first four segments.

Head slightly broader than prothorax, convex, grooved medially, moderately heavily punctured on frons and vertex; frons as high as wide; vertex feebly concave between antennal insertions; eyes with inferior lobes about as wide as deep. Antennæ slender, a little more than twice as long as body; scape subcylindrical, three-fourths as long as third segment; third and following segments subequal in length. Prothorax one-third broader than long, constricted before and behind middle, deeply and irregularly punctured. Scutellum short, subtruncate. Elytra parallel, rounded apically, subobliquely seriate-punctate along middle of dorsal surface and at edge of lateral declivity, irregularly punctured on remainder. Posterior femora reaching last abdominal segment.

Length, 8.2 millimeters; breadth, 2.3.

Holotype, female (loan deposit, California Academy of Sciences), Sakahen, near Karenko, eastern Formosa, altitude 1,050 meters, July 15, 1934, taken by the author.

Differs from *S. sinica* Gressitt, of southeastern China, in being more pubescent, much more closely punctured on prothorax and elytra, less seriately so on the latter, and in having the scutellum and pleura largely black instead of testaceous. Distinguishable from *S. atripennis* Pic by its more pubescent and more densely and less regularly punctured elytra, broader and more punctate prothorax, paler ventral surface, and in other features. Differs from *S. testaceicollis* Kano in having the prothorax pubescent, and the antennæ and legs largely black.

SERIXIA SUBSERICEA Gressitt sp. nov. Plate 1, fig. 11.

? *Serixia longicornis* SCHWARZER, Ent. Blätter 21 (1925) 149 (Kosempo and Kankau, Formosa).

Female.—Orange testaceous, elytra reddish testaceous; antennæ dull brown, first three segments and apices of following segments black; tips of mandibles, eyes, tarsi, tibiæ, and apices of femora largely black; tarsal claws reddish. Body clothed with pale silky pubescence, fairly dense on elytra; antennæ clothed with a short pile and finely ciliate on undersides of first four segments.

Head moderately convex, plane between antennal insertions, finely and not very densely punctured; frons wider than high; eyes deeply constricted, inferior lobe slightly wider than deep. Antennæ slender, twice as long as body; scape subcylindrical, feebly arched, four-fifths as long as third segment, third and following subequal in length. Prothorax one-third again as broad as long, feebly constricted near base and apex, finely and irregularly punctured. Scutellum short, rounded-truncate behind. Elytra parallel, only slightly more than twice as long as broad, deeply punctured in about five regular longitudinal rows along middle of disc, from base to apex, irregularly and more finely punctured near suture and lateral margin. Ventral surface nearly impunctate. Posterior femora barely reaching apical sixth of elytra; first segment of hind tarsus no longer than third.

Length, 8.5 millimeters; breadth, 2.8.

Holotype, female (loan deposit, California Academy of Sciences), Kuraru, Koshun district, near South Cape, Formosa, altitude 150 meters, July, 1934.

Differs from *S. longicornis* (Pascoe) in being larger, more reddish, and in having the third antennal segment entirely, and the legs largely, black. Differs from *S. signaticornis* Schwarzer in having the ventral surface of body testaceous instead of black.

Key to the Formosan species of Serixia.

1. Elytra partly, or entirely, testaceous .... 2.
   Elytra entirely black .... 4.
2. Elytra entirely yellowish or reddish testaceous; antennæ dull .... 3.
   Elytra black on apical quarter; antennæ testaceous (Botel-Tobago Island) .... *botelensis* Kano.
3. Ventral surface of body black; basal antennal segments brown. *signaticornis* Schwarzer.
   Ventral surface of body testaceous; basal antennal segments black. *subsericea* Gressitt.

4. Legs largely, or entirely, testaceous; antennæ largely brown or dull testaceous .... 5.
   Legs largely black, more or less testaceous at bases of femora; antennæ and thoracic and abdominal pleura largely black .... 6.
5. Sides of body clothed with dense silvery-white pubescence; first three antennal segments black, remainder dull testaceous basally and black apically; legs pale testaceous .... *albopleura* Gressitt.
   Sides of body lacking white pubescence; antennæ dark brown; legs dull testaceous .... *testaceicollis* Kano.
6. Elytra thinly pubescent, fairly regularly punctured; femora largely black; ventral surface entirely black, shiny .... *atripennis* Pic.
   Elytra densely pubescent, closely, and more or less irregularly, punctured; femora largely testaceous on basal halves and undersides; thoracic and abdominal sterna partly testaceous; pleura dull black. *griseipenne* Gressitt.

PHYTŒCIINI

Genus EPIGLENEA Bates, 1884

EPIGLENEA COMES subsp. FORMOSANA (Schwarzer).

Daphisia formosana SCHWARZER, Ent. Blätter 21 (1925) 153 (type locality: Taihorin, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. **34** (1933) 416.

Epiglenea comes subsp. *formosana* KANO (nec Schwarzer), Trans. Nat. Hist. Soc. Formosa **18** (1928) 127 (type locality: Musha, Formosa); MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ. **34** (1933) 426.

Daphisia formosana Schwarzer is no more than subspecifically distinct from *Epiglenea comes* Bates, and is identical with, and preoccupies, *E. comes formosana* Kano. As *comes* is the type species of *Epiglenea*, the above revision is provisionally correct, but *Epiglenea* may later prove to be an invalid genus.

Distribution.—Formosa (Taihorin, Hozan, Musha, Hori, Taito, Kosempo), Taihoku.

JAPANESE NAMES

1. *Macrotoma fisheri formosæ* subsp. nov. Togefuchi-ō-usuba-kamikiri.
2. *Macrotoma katoi* sp. nov. Sekobutogefuchi-usuba-kamikiri.
3. *Epania subglabra* sp. nov. Kurokobane-kamikiri.
4. *Mimistena pulchella* (Gressitt). Ao-kenaga-kamikiri.
5. *Dolophrades subdenudatus* sp. nov. Taiwan-beitosu-higenaga-kamikiri.
6. *Psacothea hilaris* (Pascoe). Kiboshi-higenaga-kamikiri (Taiwan-kiboshi-kamikiri).
7. *Monochamus filicornis* Gressitt. Futamon-higenaga-kamikiri.
8. *Monochamus nebulosus* (Schwarzer). Kumo-higenaga-kamikiri.
9. *Monochamus fascioguttatus* sp. nov. Hoshiobi-higenaga-kamikiri.
10. *Dihammus flocculatus* (Gressitt). Futo-higenaga-kamikiri.

11. *Dihammus permutans paucipunctatus* subsp. nov. Kinke-higenaga-kamikiri.
12. *Cyriocrates albopictus* Matsushita. Hade-ō-shirahoshi-kamikiri.
13. *Falsomesosella horishana* sp. nov. Horisha-hime-gomafu-kamikiri.
14. *Falsomesosella subalba* sp. nov. Shiro-hime-gomafu-kamikiri.
15. *Euseboides matsudai* sp. nov. Arakawa-kamikiri.
16. ? *Clytosemia bicincta* sp. nov. Futaobi-dōboso-kamikiri.
17. *Rondibilis femoratus* sp. nov. Momobuto-dōboso-kamikiri.
18. *Mixenia granulicollis* sp. nov. Sunakubi-keshi-kamikiri.
19. *Exocentrus testudineus brevisetosus* subsp. nov. Taiwan-kikkō-chibi-kamikiri.
20. *Exocentrus variepennis* (Schwarzer). Monmadara-keshi-kamikiri.
21. *Serixia griseipenne* sp. nov. Nezumiba-higeboso-kamikiri.
22. *Serixia subsericea* sp. nov. Kikiro-higeboso-kamikiri.
23. *Epiglenea comes formosana* (Schwarzer). Monki-kamikiri (Taiwan-yotsuboshi-kamikiri).

ILLUSTRATIONS

PLATE 1

[Magnified 4 times.]

FIG. 1. *Rondibilis femoratus* Gressitt sp. nov., holotype.
2. *Euseboides matsudai* Gressitt sp. nov., holotype.
3. *Clytosemia bicincta* Gressitt sp. nov., holotype.
4. *Exocentrus testudineus* subsp. *brevisetosus* Gressitt subsp. nov., holotype.
5. *Mixænia granulicollis* Gressitt sp. nov., holotype.
6. *Dolophrades subdenudatus* Gressitt sp. nov., holotype.
7. *Epania subglabra* Gressitt sp. nov., holotype.
8. *Serixia griseipenne* Gressitt sp. nov., holotype.
9. *Falsomesosella horishana* Gressitt sp. nov., holotype.
10. *Falsomesosella subalba* Gressitt sp. nov., holotype.
11. *Serixia subsericea* Gressitt sp. nov., holotype.

TEXT FIGURE

FIG. 1. *Macrotoma katoi* Gressitt sp. nov., × 1.

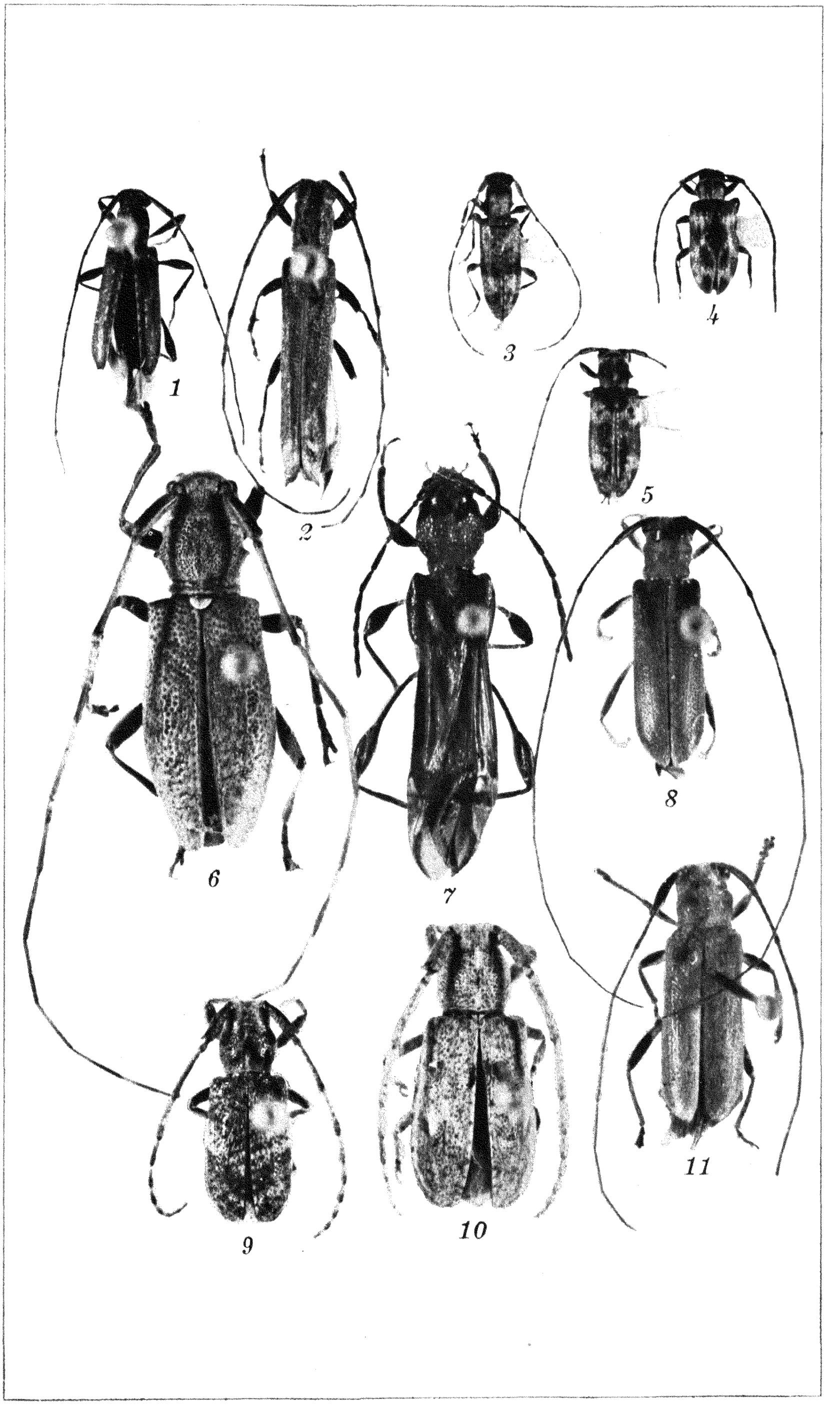

PLATE 1.

THE FISHERY INDUSTRIES OF RAGAY GULF

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THREE PLATES AND EIGHT TEXT FIGURES

Ragay Gulf, 43 miles wide at the entrance and extending 60 miles inland to the northwest, is one of the southern indentations of Luzon. With Viñas River entering its head, it almost divides Luzon at this point. Although the waters at the head of the gulf are generally muddy due to the sediment carried down by the rivers emptying there, the gulf as a whole is deep and clear, the shores being fringed with narrow coral reefs interspersed with sand and gravel beaches.

The western coast is a portion of Tayabas Province, and the eastern, of Camarines Sur Province. Burias Island, Masbate Province, and the islands and shoals north of it, divide the entrance of Ragay Gulf into two wide channels. Thus the fisheries of the gulf really fall under the jurisdiction of three provinces. Like those of the other regions of the Philippines, the activities largely depend upon the prevailing monsoon. So in this gulf, fishing is centered along the western coast (Tayabas Province) during the southwest monsoon and along the eastern coast (Camarines Sur Province) during the northeast monsoon.

Although the greater portion of the gulf is too deep and too rocky for trawling, there is a good patch of sea where the beam trawls operate; namely, towards the head of the gulf in the neighborhood and under the jurisdiction of the municipality of Guinayañgan.

Table 1 shows the income of the different municipalities from the fisheries. It readily shows that fishing activities in Ragay Gulf center around the municipalities of Guinayañgan, Tayabas Province; Pasacao, Camarines Sur Province; and San Pascual, Masbate Province. In the following paragraphs the status and importance of these fisheries are graphically presented.

San Narciso.—San Narciso is an agricultural town situated at the head of Port Pusgo, with fishing for local consumption carried on mostly inside the Port. The larger part of the Port

TABLE 1.—*Incomes from fisheries of Ragay Gulf.*

Municipality.	1935	1934	1933	1932	1931
San Narciso	----------	392.00	466.00	530.00	966.00
Guinayañgan	----------	679.00	1,227.25	2,030.00	2,405.75
Ragay	246.00	17.62	204.00	369.50	335.00
Sipocot [a]	111.25	46.76	33.75	265.00	218.75
Pamplona	90.95	76.00	99.00	----------	12.00
Pasacao	400.00	504.00	312.00	227.50	74.80
San Fernando	60.00	90.00	10.00	35.00	4.00
Bula [a]	353.57	330.00	253.00	92.00	192.75
San Pascual	973.00	970.00	1,127.00	791.00	911.00
Total	----------	3,211.22	3,921.50	4,329.50	5,206.55

[a] Incomes only partly derived from the Ragay Gulf fisheries.

is a shoal less than 2 fathoms deep, and about $\frac{1}{2}$ mile further in may be found mud bottom. The Boholano style of fish corral is the most common fishing gear. *Sakag, salap,* ordinary fish corral, and *salambao* are other gear of less importance.

Along the portion of the Port with muddy bottom is the source of raw materials for a thriving bêche-de-mer industry, consisting in the collection and curing of trepang for shipment to Manila. This industry is engaged in mostly by the Boholanos. During the southwest monsoon the open-sea fisheries are exploited by beam trawlers for bottom or ground species, and by the *largarete* fishermen for the sardines and herrings.

Guinayañgan.—Guinayañgan is the largest town in Ragay Gulf. The water within its jurisdiction is rich in both pelagic and demersal species. It may be considered the fishing center of Ragay Gulf, because the majority of the fishermen operating there are either permanently or temporarily residing in one or the other of the barrios of Manglayô and Aloneros.

Manglayô, on the northern outskirts of Guinayañgan, is the center of fishing activities. Here live the fishermen, both resident and immigrant, the latter mostly Caviteños, Rizaleños, Boholanos, and Bicolanos, who either have permanently established themselves or are mere transients in search of opportunity for good fishing. The *largarete* is the most important gear used for catching herrings, one of the most important commercial species caught in the gulf. The largerete outfits numbered to over one hundred before the typhoon of April, 1935. Many fishermen, mostly immigrant, lost their lives in that freak typhoon. At present there are only about forty such outfits left, although new ones are being equipped for fishing.

Shallow and deep-water fish corrals of the *inangcla* style, sakag and *sibid-sibid,* are other fishing gear used in this locality. The catch is sold either in the fresh-fish market of Guinayañgan or brought to Aloneros for shipment in ice to Manila.

Smoking and drying of herrings (mostly *tunsoy* and *lapad*) are done by both the natives and the Chinese. Three smoke houses and drying sheds owned by Chinese are actively operating. The natives also dry and salt fish, but their sheds are not regular establishments. The smoked and salted fish are sold locally or sent to various towns in Tayabas and to Manila. Often these herrings are simply immersed in brine and boiled and sent to Manila for final smoking.

Dynamiting and poisoning of fish by means of *bayate* have been reported rampant around Tagcauayan Bay. The apprehension of these violators of the law is emphatically demanded of the authorities by those engaged in the catching of fish by legal methods.

The barrio of Old Aloneros, or simply Aloneros, is situated eight miles up Viñas River. It is really the central landing of the major catch from the gulf for shipment in ice to Manila by rail. It is the center of the fish business, where wholesalers purchase the larger catches of the individual fishermen. Here also reside the Japanese owners of four beam trawlers—Angeles, Rosy, Koshindo Maru, and Ryojuku Maru—that operate in the municipal waters of Guinayañgan. Aside from the insular fishing license, the municipality charges each trawler a fee of 70 pesos every three months for the privilege of fishing. This the Japanese owners pay without question, just to avoid interruption and delay in their fishing activities. The Japanese trawlers fish in the open waters of the gulf to as far as Capuluan Reef and Peris Bay.

There are two smoke houses, one owned by a Filipino and the other by a Chinese. Mr. Kong Long Hai, the owner of the second smoke house, also owns a motor boat that collects the catch of the largarete and takes it to his curing shed for preservation.

Ragay.—Ragay town is in the interior, but exercises jurisdiction over a portion of the sea fisheries of Ragay Gulf in the neighborhood of Catabañgan, and Ragay Bay indentations to the northeast, all rich fishing grounds for herrings, mackerels, hardtails, and other species. The town itself is 5 to 6 kilometers from Ragay Gulf, and accessible from the gulf by Ragay River.

The fishermen of this region are concentrated in small sitios of the barrios of Catabañgan and Port Ragay.

Catabañgan is famous for its lumber mill, and is, in fact, a very progressive barrio because of the lumber industry. About three hundred largarete outfits were registered before the storm of April, 1935. Now (1936) there are only about 50. The fleet of largarete fishermen is generally towed by motor boats to rich fishing grounds for herrings to as far as the barrio of Oboyon in Peris Bay. The catches are collected by the same motor boats for marketing in the fresh, but mostly in the cured, state.

Both shallow and comparatively deep fish corrals dot the shore. Sibid-sibid (hand-line) fishermen contribute to the daily supply of fresh fish for employees of the lumber mill. It was gleaned that these hand-line fishermen are the ones employing illegal means of catching fish, using dynamite and fish poison to such an extent that they even manufacture their own explosives when the regular dynamites are not procurable.

Port Ragay, then the railroad connection of the Tayabas and Bicol lines, is a small barrio founded in 1932. Fishermen, mostly the largarete crew, live in a portion of this barrio. The largarete outfits are towed by motor boats to rich fishing areas. Fish corrals and hook and line fishing are also engaged in to some extent.

Sipocot.—Although this town is also in the interior, being located at a point almost midway between Ragay Gulf and San Miguel Bay, it exercises jurisdiction over a portion of the waters of the Gulf in Caima Bay. Fishing conditions and fishing methods here are almost identical to those obtaining and practised in Catabañgan and Port Ragay.

Pamplona.—Like Ragay, Pamplona is also in the interior, with a very limited extent of sea fisheries, covering over a small portion of the coast along the gulf. The location of the town is, however, significant, in that the catch of the large-sized species that are sent from Pasacao to Manila is shipped from this point of the Manila Railroad. The fishing gear employed are the shallow and deep-water fish corrals.

Pasacao.—The town lies at the head of the cove, in the valley leading through high land to the town of Pamplona. It used to be the connection of the Tayabas–Bicol lines. The fishing grounds under its jurisdiction are quite rocky and deep, and hence not favorable for trawling.

Inside the cove are fish corrals of the inangcla style, both shallow and deep-water. Other gear used here are the *cabiao* and the sibid-sibid.

A thriving local enterprise consists in the wholesale buying of all catch by one person, Mr. Gregorio Olivan, who stores them in ice and ships them to Manila by rail. Mr. Olivan also owns many sibid-sibid outfits that fish for him around Burias Island. The catch of the sibid-sibid fishermen are the large-sized fishes of varied species usually seen in the fresh-fish markets of Manila. In effect, these constitute one of the principal sources of fresh fish in the City. The small species are generally sent to Naga and the neighboring towns. All the large and medium-sized species caught in various gear (sibid-sibid generally) are sorted and iced, and then sent to Manila by rail. The wholesale buying prices obtaining locally and the wholesale selling prices prevailing in the markets of Manila for the different species are given in Table 2.

TABLE 2.—*Wholesale buying and wholesale selling prices of large and medium-sized species in Pasacao, and in Manila markets, respectively, in centavos.*

Species.	Buying price per kg.	Selling price per kg.
Bisugong laot	12	30
Lapu-lapu	15	40
Turiñgan	12	30
Maya-maya	12	30
Rompe	12	25
Tañgigi	20	40
Sortidos	12	25

The fishing season occurs during the northeast monsoon because the fishing ground is somewhat exposed during the southwest monsoon. There are no preservation plants locally, and the catch is temporarily stored in ice before shipment to Manila. The ice is supplied by the plant of the Camarines Sur Industry Company located at Magarao, Camarines Sur. A limited amount of the catch is either dried or salted for local consumption.

San Fernando.—San Fernando is another interior town exercising control over a portion of the coastal waters of the gulf. The barrio of Cotmô is especially significant, because of the rich fishing ground, where no less than seven fish corrals, ranging in depth from 18 to 27 meters, are located. This is a rich fishing ground for various species of tunas and bonitos, especially during the northeast monsoon and trade winds.

Bula.—Like San Fernando, but eastward of it is the municipality of Bula, also an interior town with the sea fisheries very limited, confined only to that portion of the gulf after the municipal jurisdiction of San Fernando. The fishing conditions are similar to those of San Fernando. Its major fishery consists of fresh-water resources in the lakes and rivers (Lake Baao and Bicol River).

San Pascual, Burias Island.—San Pascual is the only municipality in Burias island at the mouth of the Gulf. It is situated in the northern part of the island. The whole island is pasture land, where thousands of cattle graze the cogon hills.

Fishing is also a profitable enterprise, where the activity shifts with the monsoon—rich on the northeastern coast during the southwest monsoon and on the southwestern coast during the northeast. There is a long coast line with an abundance of fish life where coral-reef fishes of varied species abound. The gear popularly employed are the sibid-sibid and the fish corral (ordinary and *pahubas*). The sibid-sibid is the principal source of large-sized fishes that are stored at Pasacao and marketed at Manila.

COMMERCIAL SPECIES CAUGHT

Because of the extensive operation of four Japanese beam trawlers that fish almost every day of the year, the most important species composing the bulk of the catch from the gulf are the bottom or "ground" species that frequent smooth sea bottom of either sand or mud, where the trawls can be properly operated. Unlike the catch from Manila Bay, however, the hauls from this region consist of the larger fishes. Such fishes as the slipmouths (Leiognathidæ), lizard fishes (Synodontidæ), crevalles (*Caranx* spp.), nemipterids (Nemipteridæ), theraponids (Theraponidæ), goatfishes (Mullidæ), croakers (Sciænidæ), mojarras (Gerridæ), and shrimps (*Penæus* spp.) are, therefore, not infrequently seen among the fish landed at Aloneros for shipment to Manila. The fish corrals make the same hauls, with the difference that during runs of pelagic fishes the latter compose the bulk of the hauls, which, being floating or "surface" species, are never intentionally caught in the trawls.

Herrings (*Sardinella* spp.), mackerels (Scombridæ), bageyes (*Caranx crumenophthalmus*), round scads (*Decapterus* spp.), and bonitos (Thunnidæ) are the pelagic migratory species that are frequently caught in the various fish traps and fish nets at certain seasons of the year. Rock or coral-reef fishes, such as the groupers (Serranidæ), snappers and pristipomoids (Lutjanidæ), and large nemipterids, are the principal hauls of the sibid-sibid fishermen of Burias Islands.

Other species of less commercial importance, as they are caught in lesser amounts, are listed in Table 3 with their vernacular names.

TABLE 3.—*A list of species caught in Ragay Gulf.*

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Anchovy	Bolinao	Dilis	Engraulidæ.
Deep-bodied	Tegui	Tegui	*Scutengraulis* spp.
Barracudas			Sphyrænidæ.
Large	Rompe	Rompe	Do.
Small	Sega-segaro	Titso	Do.
Bonito	Tuliñgan	Turiñgan	*Euthynnus* spp.
		Rayado	*Auxis* spp.
Carangoid fishes			Carangidæ.
Cavallas	Sebo	Mamsa	Do.
		Baolo	*Caranx malabaricus* (Bloch and Schneider).
Crevalles	Salay-salay	Atoloy	*Caranx* spp.
Hardtail	Pak-an	Pakan	*Megalaspis cordyla* (Linnæus).
Leatherjacket	Lapis	Lapis	*Scomberoides* spp.
Round scad		Sibobog	*Decapterus* spp.
Runners	Salmon		*Elagatis bipinnulatus* (Quoy and Gaimard).
Threadfish		Lawihan	*Alectis* spp.
Catfishes			Nematognathi.
Sea		Tabañgoñgo	Ariidæ.
Striped sea	Patuna	I-ito	*Plotosus anguillaris* (Bloch).
Croakers		Abo	Sciænidæ.
Cutlass fish	Spada	Langkoy	*Trichiurus haumela* (Forskål).
Drepane	Kiliong	Riring	*Drepane punctata* (Linnæus).
Eel			Apodes.
Fresh-water		Kasili	Anguillidæ.
Flatfish	Palad	Palad	Heterosomata.
Flathead	Lobalob	Itang	Platycephalidæ.
Flying fish	Iliw	Iliw	Exocœtidæ.
Garfish:			
Round-bodied	Tambilauan	Balo	*Tylosurus* spp.
Compressed-bodied	Salasa	Dugso	*Ablennes hians* (Cuvier and Valenciennes).
Gizzard shad	Kabasi	Kabasi	Dorosomidæ.
Goatfish	Saging-saging	Tiao	Mullidæ.
Grouper	Segapo	Kugtong / Pogapo	Serranidæ.
Grunt, thick-lipped		Nabilan	*Plectorhinchus* spp.
Guitar fish	Sodsod	Arado / Sorodan	*Rhynchobatus djiddensis* (Forskål).

TABLE 3.—*A list of species caught in Ragay Gulf*—Continued.

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Halfbeak	Patlay	Bugiw	Hemiramphidæ.
Herring			Clupeidæ.
Indian sardine	Tamban	Turay; Tamban Tondo	*Sardinella longiceps* (Cuvier and Valenciennes).
Fimbriated	Tunsoy	Tamban laolao	*Sardinella fimbriata* (Cuvier and Valenciennes).
Deep-bodied		Alobaybay	*Sardinella perforata* (Cantor).
Fry	Malapnê		Clupeidæ.
Lactarid	Rigodon	Algodon; damos	*Lactarius lactarius* (Bloch and Schneider).
Lizard fish	Oting bondo	Tokô	*Saurida tumbil* (Bloch).
Mackerel			Scombridæ.
Spanish	Tanguingui	Tangigi	*Cybium commerson* (Lacépède).
Short-bodied	Kabalias	Kabalias	*Rastrelliger brachysomus* (Bleeker).
Striped	Lumahan	Burao	*Rastrelliger chrysozonus* (Rüppell).
Milkfish	Bañgos	Bañgos	*Chanos chanos* (Forskål).
Mojarras	Manobon	Latob	*Gerres filamentosus* (Cuvier).
Moonfish	Tabas		*Mene maculata* (Bloch and Schneider).
Mullet	Banak	Balanak	Mugilidæ.
Large-scaled	Ugapang		*Mugil vaigiensis* Quoy and Gaimard.
Nemipterid	Bisugo	Kanasi	*Nemipterus japonicus* (Bloch).
Pomadasid, spotted	Ibalay	Kiskisan	*Pomadasys hasta* (Bloch).
Pomfret, black	Pampano	Pampano	*Stomateus niger* (Bloch).
Silvery	Alumbeberas		*Stromateus cinereus* (Bloch.)
Porgy	Bakoko	Bakoko	*Sparus berda* (Forskål).
	Kanuping		*Lethrinus opercularis* (Cuvier and Valenciennes).
Ray	Pagi	Pagi	Batoidei.
Cow-nosed		Ogaog	*Rhinoptera javanica* Müller and Henle.
Remora	Kini	Kini	*Echeneis naucrates* (Linnæus).
Sailfish	Malasugui	Malasugui	Istiophoridæ.
Sea bass	Katoyot	Bolgan	*Lates calcarifer* (Bloch).
Sergeant fish	Pandaoan	Balisokan	*Rachycentron canadum* (Linnæus).
Siganid	Balewis	Toros	Teuthidæ.
Shark	Pating	Pating	Euselachii.
Hammerhead	Kroson	Krosan	
Slipmouth	Tambong	Barorog	Leiognathidæ.
Spadefish	Kikiro	Kikiro	*Scatophagus argus* (Linnæus).
Snappers			Lutjanidæ.
Flame-colored	Pargo	Agawin; Tiñgarog	*Lutjanus fulvus* (Bloch and Schneider).
Silver-spotted gray	Pargong ilog	Aliso	*Lutjanus argentimaculatus* (Forskål).
Malabar red	Polahan	Maya-maya	*Lutjanus malabaricus* (Schneider).

TABLE 3.—*A list of species caught in Ragay Gulf*—Continued.

English name.	Tayabas Tagalog.	Bicol (Ragay Gulf).	Scientific name.
Tarpon	Buan-buan	Bulan-bulan	*Megalops cyprinoides* (Broussonet).
Threadfins		Salmingan Hogao	Polynemidæ.
Theraponids	Gongong	Kanigit Korong-korong	Theraponidæ.
Tuna, large	Tambakol	Bangkolis	Thunnidæ.
Whiting	Asohos	Osohos	Sillaginidæ.
Pristipomid		Manambulao	*Pristipomoides microdon* (Steindachner).
	MISCELLANEOUS CATCHES		
	Balas (small)		*Palænetes* spp.
Shrimp	Balay-hangin Pasayan	Lokon Pasayan	*Penæus* spp.
Sea cucumber	Balatan		Holothurioidea.
Octopus, small	Etotos		Octopoda.
Crab	Kasag		*Neptunus pelagicus* (Linnæus).
Pectin	Kapis		*Pectin* sp.

FISHING METHODS

The fishing methods employed in this region range from the simple way of catching fish by the use of spears to the more or less modern commercial beam trawling. While the spear fishermen do their fishing by wading or simply diving from dugouts that are large enough to accommodate only their own bodies, motor boats with spacious holds are used in the trawling operations, enabling the outfits to fish for a much longer time and to cover a much larger territory, returning to land only when they think enough returns will be netted each of the investors in the enterprise.

Japanese beam trawl.—Of utmost commercial importance as a fishing appliance around the Gulf is the beam trawl; at the time of the survey (1936) there were four motor boats in operation, all owned by Japanese and manned by purely Japanese crew—Angeles, Rosy, Koshindo Maru, and Ryojuku Maru.

This fishing appliance and the method of its operation are described in an earlier issue of this Journal.[1]

The beam trawlers, which have Old Aloneros as their home port, weigh anchor for the fishing ground at 12 A. M., after receiving their provisions, fish boxes, trays, and ice for the catch.

[1] Philip. Journ. Sci. 48 (1932) 389–410.

Upon arrival at the fishing ground, at about 1 P. M., the net is shot and dragged until about 5 P. M., when it is hauled in. After the catch is collected and the torn portions of the net are repaired, the net is shot for the second time. The second hauling is done at about 11 P. M., after which the net is shot for the last time during that trip. The last hauling occurs at 5 A. M., after which the boats proceed homeward, reaching Old Aloneros at about 8 A. M., just in time to either sell the catch to wholesale dealers or to pack it in fish boxes with crushed ice, ready for shipment to Manila by the 11 o'clock train. This fishing routine is followed usually for seven days in the week, except for two or three Japanese holidays.

The catch is similar to that of the beam trawl in Manila, with the difference that the fishes caught are proportionately much larger and the volume of the individual hauls is greater. The catch of small slipmouths and those of other species are either thrown out or collected in bulk for the line fishermen to be used as bait. One haul nets about 100 kilograms of this miscellany, the proper utilization and conservation of which, when viewed on the basis of the aggregate amount collected by the fleet of beam trawlers, is a real problem.

The commercial catches are sorted on board the vessels during the actual fishing after each haul and on their homeward trip. The fish trays are larger than those used in Manila, measuring $26\frac{1}{2}$ by 15 by $2\frac{3}{4}$ inches, and containing 8 kilograms of fish on the average.

The following are the local wholesale prices of the major catch of the beam trawls:

Kind.	Pesos per tray of 8 kg.
Shrimp	2.80 to 3.00
Nemipterids	0.80 to 1.00
Lizard fishes	0.30 to 0.40
Slipmouths	0.30 to 0.40
Miscellaneous	1.00

Largarete.—The largarete is really a set gill net made to hang from a stationary banca anchored right in the fishing ground, the herrings entangling themselves in the meshes from both sides as they approach the light or lights used to dazzle and perhaps also to attract them. Text fig. 1 shows the fishing device in operation.

The banca used in this method of fishing is an ordinary dugout from 10 to 11 meters long, 1.10 meters wide, and 0.60 meter deep, or approximately 1.2 gross tons. One side is provided with an outrigger, while the other is free, to permit unobstructed manipulation of the net in the actual fishing operation.

Towards the stern is a detachable bamboo mast to which a canvas sail is hoisted when the wind is favorable in order to

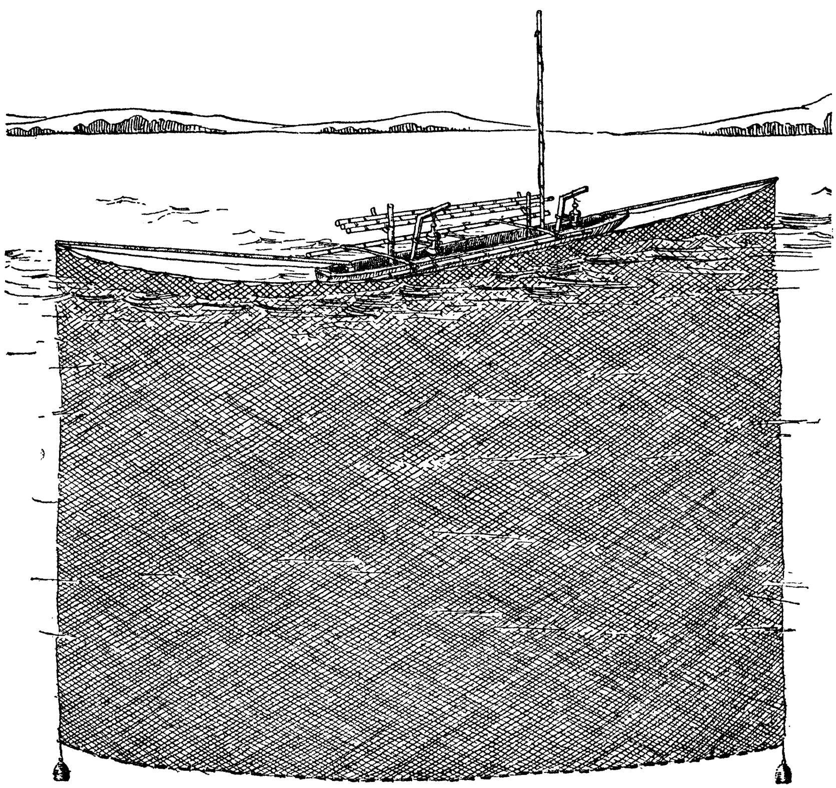

FIG. 1. Largarete in operation.

speed up the trip to and from the fishing ground. For shelter, most of the bancas are provided with a detachable canvas awning. Towards one side, usually the outriggered side, is an improvised open-air stove.

In the actual fishing operation two bamboo poles from 10 to 15 meters long and with a small pulley at the tip are attached to both the bow and the stern of the boat; these poles are, however, removed when the fishing is over. One to three incandescent petroleum lamps (Continental, Petromax, Standard, or Coleman) from 300 to 2,000 candle power, are hung from wooden stands on the side of the banca.

A largarete outfit is generally manned by four or five men, one being the *piloto,* or the steersman, and the rest the members of the fishing crew.

The net, which is of No. 40[2] cotton twine, is a curtainlike affair, 1,000 meshes wide and 20 meters deep. The sizes of the webs, which differ with the size of the fish sought, are as follows:

Serial number.	Size of web.	Fishes caught.
1	No. 27	Tunsoy.
2	Nos. 26, 27	Lapad or alobaybay and alañgan.
3	No. 25	Siliniasì or malapnê.

The bottom and cork lines are selvaged with 6 meshes of No. 14 web, while the sides are provided with a 12-mesh strip of No. 14 web selvage. The cork line, instead of carrying corks, is equipped with brass rings 2.5 centimeters inside diameter, attached at intervals of 50 centimeters. To the two ends of this line are attached two sets of 0.5-centimeter cotton cords—the "stretching cords" passed through the pulley and used in stretching the net, and the "retrieving cord," passed through the rings so that, upon being pulled in opposite directions, they cause the net to collapse after the catch is made (text fig. 2). The lead line is provided with 100-gram lead weights strung at intervals of 25 centimeters. At the two extreme ends of the lead line are attached heavy lead weights to serve as anchors for the net.

The approximate cost of a fishing outfit is as follows:

	Pesos.
Nets (at least 3 at 50 pesos each)	150
Banca	100
Lamps (from 1 to 3 at 30 pesos each)	90
Total	340

The monthly maintenance, which includes food, drinks, and cigarettes for the crew and petroleum and matches for the lamp, amounts to 100 pesos. Largarete fishermen operate only during moonless nights. They leave port at about 4 P. M., reaching the

[2] The standards adopted are those of L. R. Aguinaldo as specified in his catalog for 1935.

fishing ground exactly at dusk. The boat is anchored at some rich ground around the Gulf. The lamps are lighted and the two bamboo poles set in place at the bow and stern of the boat. The stretching and the retrieving cords are then attached to the net. The stretching cord is pulled through the pulley at the end of the bamboo pole, and the net spread like a curtain from the side of the boat.

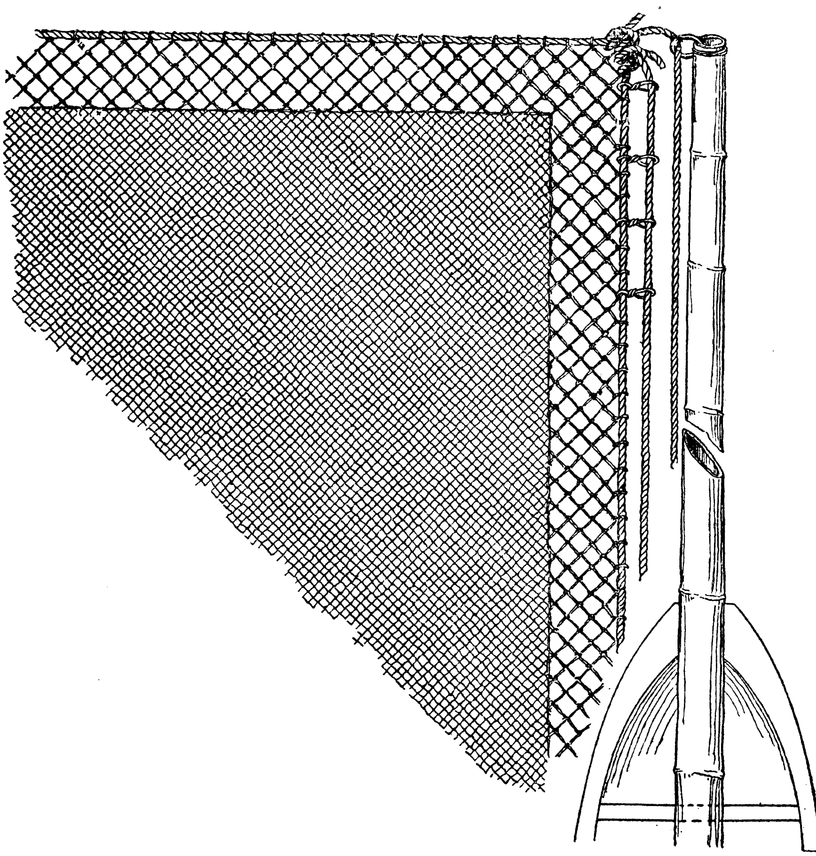

FIG. 2. Detail of stretching and retrieving device of largarete.

After some hours of fishing and as soon as the cork line sags, indicating a quantity of herring entwined in the meshes, the net is hauled in by letting go the stretching cord and pulling on the retrieving cord from opposite directions, that is, the line attached at the bow is pulled towards the stern and vice versa. This action collapses the net which, as a whole, with its load of fish, is hauled into the boat, where it is hung and the entwined fishes picked one by one from its meshes. Once free of fishes, the net is again spread, and this operation repeated; the same routine is followed from dusk to dawn of the next day, the number of hauls made depending upon the abundance of fish.

Often one or more outfits are towed to rich fishing grounds by a hired motor boat, and the catch collected from each of them the following morning by the same motor boat, so that these largarete outfits need not return to their home until the ground no longer offers good returns. The catch, consisting mostly of herrings, and small amounts of squids, remoras, halfbeaks, mackerels, and barracudas, is sold to the owners of motor boats who are also owners of smoke houses and fish-preservation sheds. In fact, the bulk of the catch of the largarete is cured, only a very negligible portion of it being consumed in the fresh condition.

The division of the income from this method of fishing is as follows: After all the expenses incidental to fishing operations are deducted, the remainder is divided into three parts—one part for the lamp, one part for the net, and the third for the members of the crew, including the piloto who, however, gets an additional bonus from the owner of the outfit.

Fish corrals.—Of third commercial importance as a fishing gear in this region is the age-old fish corral, wherein enormous sums of money are invested annually. These corrals vary in size from the small and shallow-water fish trap along wading depths in beaches and rivers to the large deep-water fish weirs wherein nets (siguin) are employed in the collection of the catch. In the shallow or small corrals bamboo stakes are used as supports, while in the deep-water ones *palma brava* are employed as posts. All the fish corrals are planted or constructed with the leaders perpendicular to either of the two coasts—the eastern or western, the pound or collecting portion of the arrangement being in the deeper portion of the gulf.

Although the catch are of varied species, the most common are the anchovies, herrings, mackerels, hardtails, bag eyes, bonitos, and tuna.

As in other fishing grounds of the Philippines, various styles of both the shallow and the deep-water fish corrals are in vogue in Ragay Gulf, foremost among which are the *quinavite* or *inangla,* the *boholano,* the *pangalato,* the *natural,* and the *pahubas.*

The inangla or the quinavite (text fig. 3) is usually planted in water from 10 to 22 meters deep, although shallow weirs from 2.5 to 4 meters deep are also constructed in this style; in the latter case a pound or crib is provided for, whence the catch is collected by means of a dip net.

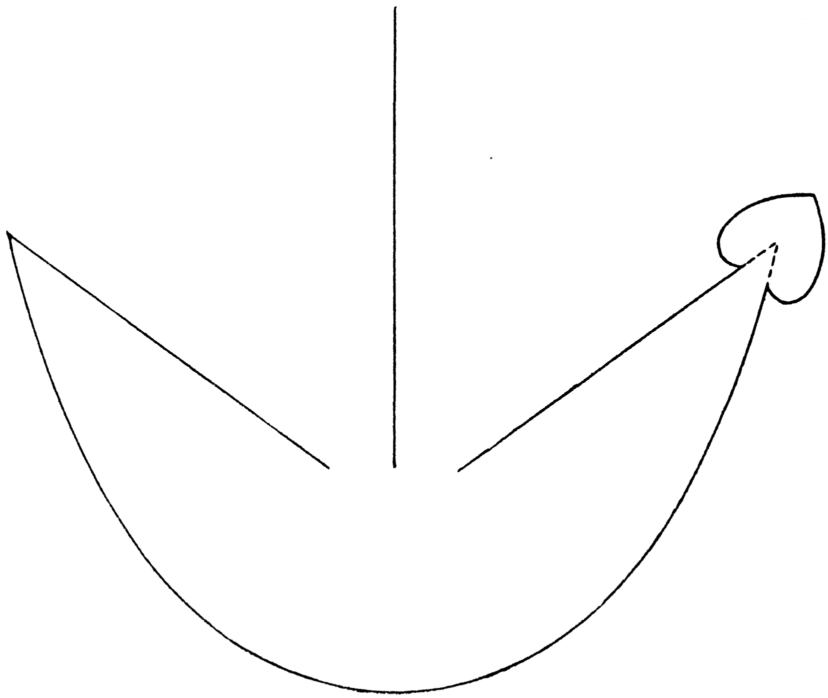

FIG. 3. Quinavite fish corral.

The following expenses are incurred in the construction of a deep-water corral of the inangcla style, as given by Mr. Vicente Torres of Guinayañgan.

	Pesos.
Materials and equipment:	
500 Palma brava (bahê) at 60 centavos each	300
2,000 Bamboos (bolô or bohô) at 20 pesos per 1,000	40
20,000 Rattan at 3 pesos per 1,000	60
200 Bamboos for raft (balsa) and bridge (vela) of the tawanik variety at 12 pesos per 100	24
1 Cotton net (siguin)	300
1 Banca	250
Construction:	
Cost of splitting 2,000 bolô at 20 pesos per 1,000	40
Cost of weaving the mattings:	
Body of 14 pieces (bantasan)[a] at 5.80 pesos each	81
Leader of 20 pieces (bantasan) at 5.80 pesos each	116
Labor (by contract):	
First maestro	60
Second maestro	50
Seven men at 15 pesos each	105
Grand total	1,426

[a] 1 bantasan=21 meters.

The monthly maintenance includes the payment of one *encargado* at 25 pesos and five men as laborers with food at 15 pesos each per month.

The expenses incurred in the construction of a shallow-water fish corral of this style are as follows:

	Pesos.
800 Bamboo poles at 6 pesos per 100	48
2,000 Rattan at 30 centavos per 100	6
200 Banata of the spiny variety of bamboo at 40 pesos per 100	80
1 Net	40
Labor	200
Grand total	374

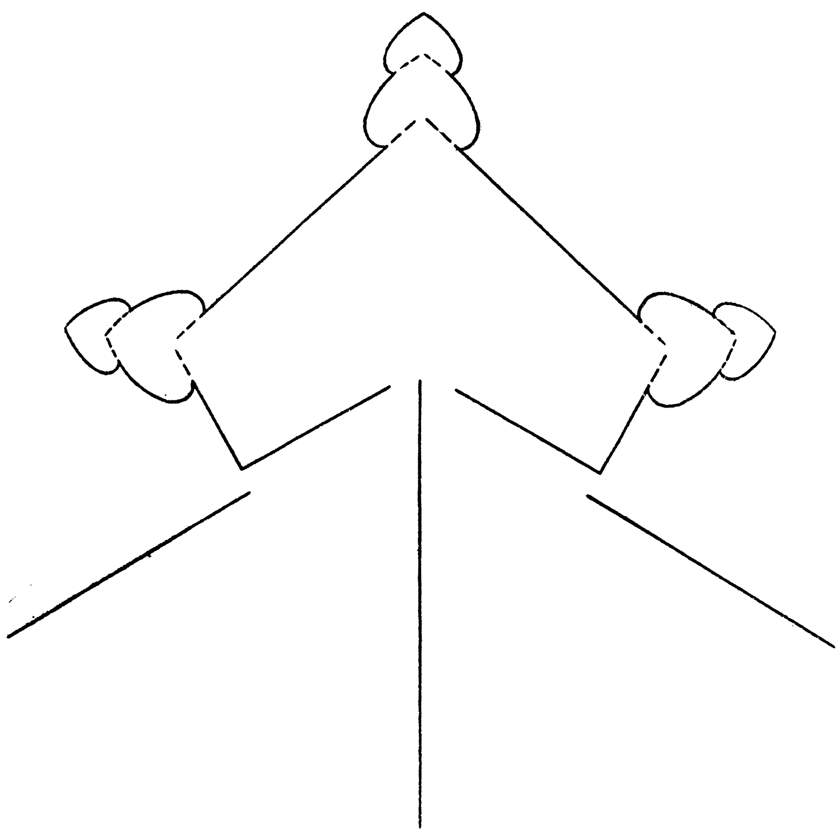

FIG. 4. Boholano fish corral.

The ground plan of the Boholano style is shown in text fig. 4. This shallow-water corral is built at a depth of from 2 to 4 meters, employing *bolô*, *tinikan*, or wire netting as mattings.

This trap necessitates the investment of from 100 to 200 pesos. The net or siguin is used in the pound only.

Text fig. 5 shows the pangalato style, another shallow-water corral, which requires the investment of from 150 to 300 pesos.

Text figs. 6 and 7 are the ground plans of the natural or ordinary corral and the pahubas, respectively, both shallow-water corrals. In the latter style the mattings or a portion of the mattings of the wings are generally lowered during high tide in order to permit the entrance of fish, and again made fast to the stakes in upright position at the slack of the tide to prevent the escape of the impounded fishes.

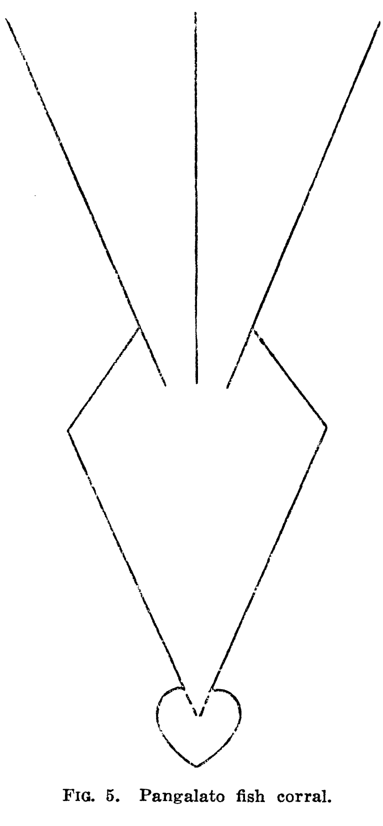

FIG. 5. Pangalato fish corral.

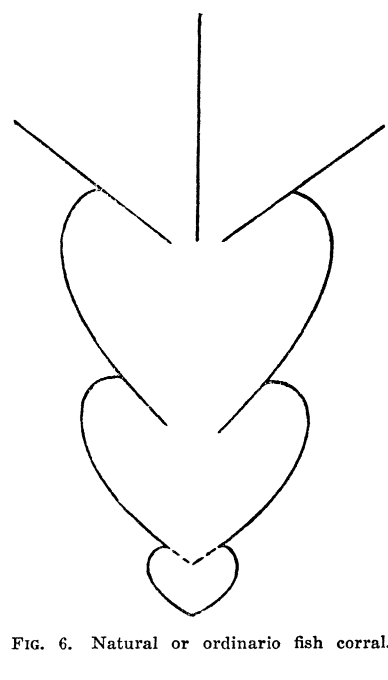

FIG. 6. Natural or ordinario fish corral.

Sibid-sibid.—The sibid-sibid is a troll line consisting of a stout line provided with a hook at one end baited with fresh sardines, shrimps, squids, or white chicken feathers tied around a small bamboo ring. Fishing is done in a fast sailing banca or dugout of the outrigger type. As the line is dragged along the water from the stern of the boat, the feathers revolve continuously and are supposed to attract the fish. Often these sibid-sibid fishermen are just ordinary hand-line fishermen with the lines no longer dragged but simply baited and allowed to hang from the banca, which drifts with the current and the tide. Light is usually employed in this mode of fishing.

The catch consists of the large game fishes, such as Spanish mackerel, tuna, snapper, grunts, barracudas, whitings, nemipterids, pristipomoids, and sergeant fishes.

Kubkub.—The *kubkub* is a purse seine popularly used in the catching of pelagic species that run in schools; such as the herrings and the mackerels. An outfit is composed of a banca or dugout and a purse seine or net. The banca is similar in

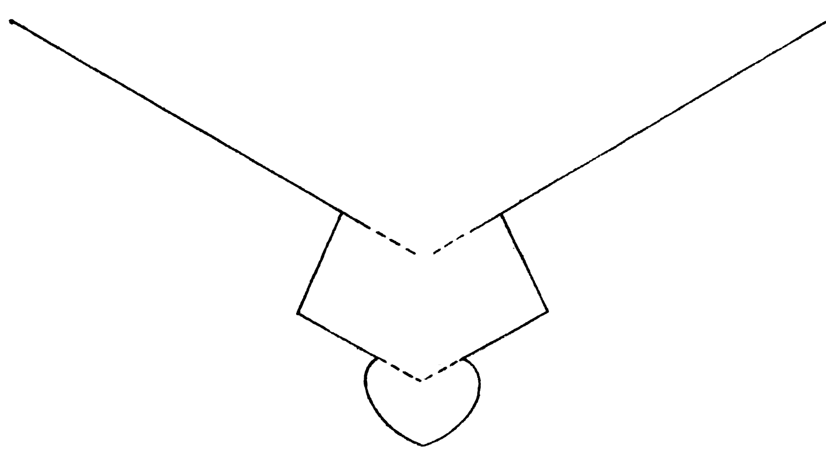

FIG. 7. Pahubas.

construction to that used in largarete fishing, with the difference that in the former it is large, and both the bow and the stern are provided with a groove for the pursing of the line during the pursing operation. This outfit requires from eight to eleven men to operate.

The net is composed of from five to seven pieces, one piece being 2,000 meshes wide and from 15 to 30 meters deep when hung. This seine is built like a shallow curtain without any bag at the middle. Its upper portion is buoyed up with numerous wooden floats (No. 1A) strung 30 centimeters apart on a strong rope, the float line, to keep the seine floating on the surface of the water. The lower edge is weighted with No. 2 lead weights strung along a light rope at intervals of 30 centimeters. The lead line must be ten per cent shorter than the float line to allow the net to be pursed quickly and the bottom strips of the net to bag. Uniformly distributed along the entire length of the lead line and attached by short ropes are a great number of No. 4 brass rings. Through these rings runs the purse line of abaca, about 1 centimeter in diameter, by means of which the net is pursed from the bottom.

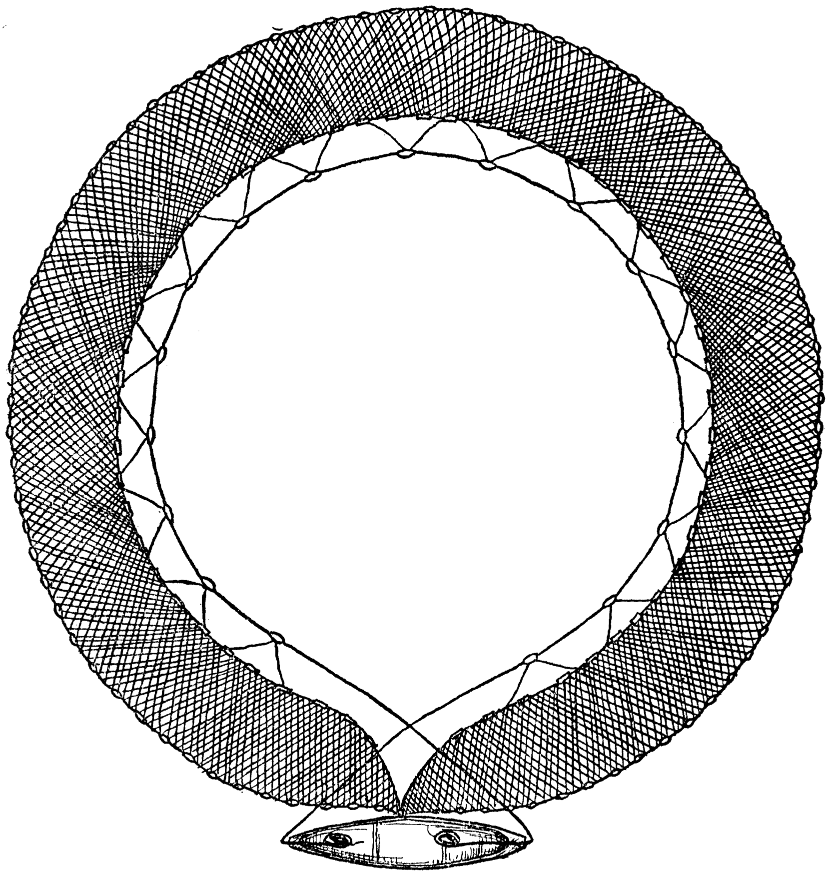

FIG. 8. Kubkub in operation.

The main body of the net is of No. 14 (herring) and No. 10 (mackerel) cotton netting. The bunt or landing bag is of No. 8 (herring) and No. 23 (mackerel) web. The net is selvaged with a 50-centimeter strip of No. 23 (herring) and No. 30 (mackerel) web towards both the float and the lead lines.

Fishing with this gear (text fig. 8) is also done at night, and the catch delivered in the morning. When a school of fish is sighted, the net is paid out by setting a lighted buoy and entirely encircling the school with the net. The banca is then brought alongside and the pursing lines pulled by hand in opposite directions from both the stern and the bow. The catch is then concentrated in the bunt, whence the fish are brailed out by means of dip nets.

The kubkub catches herrings, mackerels, hardtails, and bonitos, all pelagic species that run in schools at certain times of the year.

The banca and the net require an investment of from 1,000 to 3,000 pesos.

Sapiao or cabiao.—This round haul seine is made of cotton twine, and is used also in pelagic fishing with the aid of light. The schools of such species as the anchovies, herrings, and mackerels are first attracted by powerful lights and then surrounded by the net concentrating the catch in the landing bag, whence they are brailed out by means of dip nets. This method of fishing is described in detail in an earlier paper published in this Journal.[3]

Other gear of less commercial importance and popularly used in other parts of the Philippines in the same manner as they are employed in Ragay Gulf, and which require no further illucidation, are the *bobo* (fish trap); *quitang* (trawl line); *sakag, kolokotok, salambao* (huge dip nets); *pante* (gill net), and *pukot* or *chinchorro* and *salap* (drag seines).

FISH PRESERVATION

Rapid and adequate transportation coupled with ready facilities for icing tend to make possible the marketing of the bulk of the catch in a fresh condition in big centers, such as Naga, Lucena, and Manila, and consequently a very limited part of the hauls is converted into the preserved product for sale. Only the pelagic fishes caught seasonally in great quantities, such as the herrings, sardines, and mackerels, pass through the salting and smoking sheds. A limited quantity of the beam-trawl catches is also salted and dried. Thus three methods of preservation are commonly observed here—refrigeration, dry salting, and smoking.

Refrigeration.—Refrigeration is only a temporary method of preservation, serving to check the process of putrefaction by

[3] Philip. Journ. Sci. 54 (1934) 372–377.

lowering the temperature by means of ice, and thus to prevent the action of bacteria on the flesh of the fishes. This method is never resorted to by the fishermen that use small bancas, but is rather confined to those employing motor boats in their business.

Ice is supplied by the San Miguel Brewery of Manila in special cars of the Mania Railroad Company, by The Calauag Ice Plant, and by the Camarines Sur Industry Company at Magarao, Camarines Sur Province.

The beam trawls take ice blocks to the fishing ground, and the catch is iced on board the vessel in fish trays after every haul. Upon arrival at the home port the catch is transferred to fish boxes preparatory for shipment to Manila. In these boxes a layer of crushed ice alternates with a layer of fish. This method is what is known as direct icing.

In Pasacao the catch of the sibid-sibid fishermen of Burias Island is collected by a motor boat. It consists of the large-sized species commonly seen in the fresh-fish markets of Manila. Upon arrival at the landing proper, these are temporarily placed in a big wooden ice box, whence they are transferred or packed in regular fish boxes in which they are shipped to Manila by rail at the Pamplona Station of the Bicol line. In Pasacao direct icing is also employed, a layer of ice alternating with a layer of fish.

Dry salting.—The procedure of dry salting followed is the same as that practiced in Manila and other fishing centers in the Philippines. The catch is washed first in sea water, then in fresh water, then immersed in brining tanks (with saturated salt solution) for about 4 hours, again washed in fresh water to remove excess salt, and dried thoroughly in the sun. The product is finally packed in bamboo fish baskets and shipped to Manila by rail.

The following is the cost of producing one *canastro* containing about 3,000 individual dry-salted herrings.

	Pesos.
Raw fish	8.00
Salt	0.30
Arranging in fish trays for drying	0.30
Cargador	0.20
Total	8.80

Smoking.—Because of the fact that those engaged in the preservation of the catch are mostly immigrants from Manila, the preservation methods, including the making of tinapa or smoked products, are identical with those used in Manila.

The herrings, which are the fishes generally smoked, are first washed in sea water. They are then rinsed in fresh water and immersed in brining tanks or vats containing a very concentrated solution of salt, the strength of which is determined by touch. Simultaneously one liter of salt is added to one *kawa* of water and brought to a boil; the fish in the brining tanks are arranged in fish trays and thus immersed in the boiling salt solution until the eyes bulge out and a portion of the tail breaks. The accumulation of fish eyes at the bottom of this basin denotes a well-salted product. The fish are then allowed to drain, and when cooled are placed in the ovens where they are smoked until they turn brown. This operation generally requires two refuelings.

Often the brined herrings are simply cooked and shipped to smoke houses in Manila where they undergo final smoking.

The following items enter into the conversion of 3,000 herrings into the smoked product (tinapa):

	Pesos.
Raw fish	8.00
Salt	0.30
Arranging in trays	0.30
Sawdust	0.20
Firewood	0.50
Cargador	0.20
Total	9.50

CONCLUSIONS AND RECOMMENDATIONS

1. The center of the fishing industry in Ragay Gulf for Tayabas Province is Barrio Aloneros, Guinayañgan, and Pasacao for Camarines Sur Province.

2. The fishing season in the gulf occurs throughout the year, the eastern coast being rich and favorable during the northeast monsoon and trade winds and the western during the southwest monsoon.

3. While the coasts around Pasacao and Burias Island are rich fishing grounds for coral-reef species, the eastern coast and the head of the gulf are hiding places of pelagic species, such as the herrings and mackerels. Trawling is carried on only in the neighborhood of the head of the gulf around the municipal jurisdiction of Guinayañgan.

4. From the point of view of proper utilization and conservation of the fishery of this region, fishing with light and the catching of enormous quantities of small fishes are problems that need immediate attention.

5. Dynamite fishing and the catching of fish by the employment of poison (bayate) must be strictly dealt with.

6. A more sanitary supervision over the preparation of *tuyô* and *tinapa* is essential. The use of a more refined salt that will not greatly increase the cost of production is needed.

7. Aside from the ground species that compose the bulk of the beam-trawl catch, herrings (tamban, tunsoy, and laolao), mackerels (hasa-hasâ and lumahan), anchovies, hardtails, bag-eyes, and bonitos and tunas are the most important species caught in the gulf.

8. More attention and care must be exercised in the handling of the catch before they are refrigerated, dried, or smoked, so as to maintain as much as possible the original flavor of the fresh fish.

ILLUSTRATIONS

PLATE 1

PLATE 2

PLATE 3

TEXT FIGURES

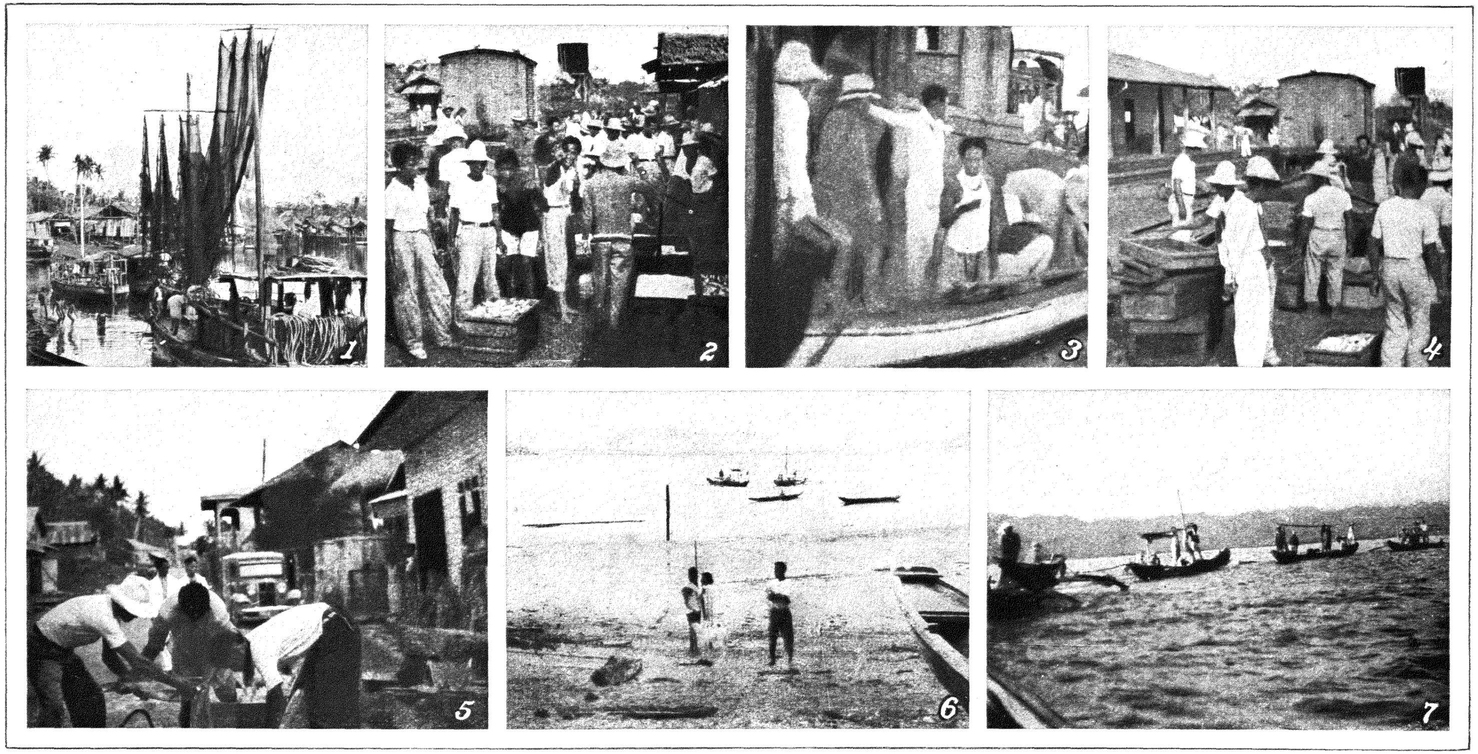

PLATE 1.

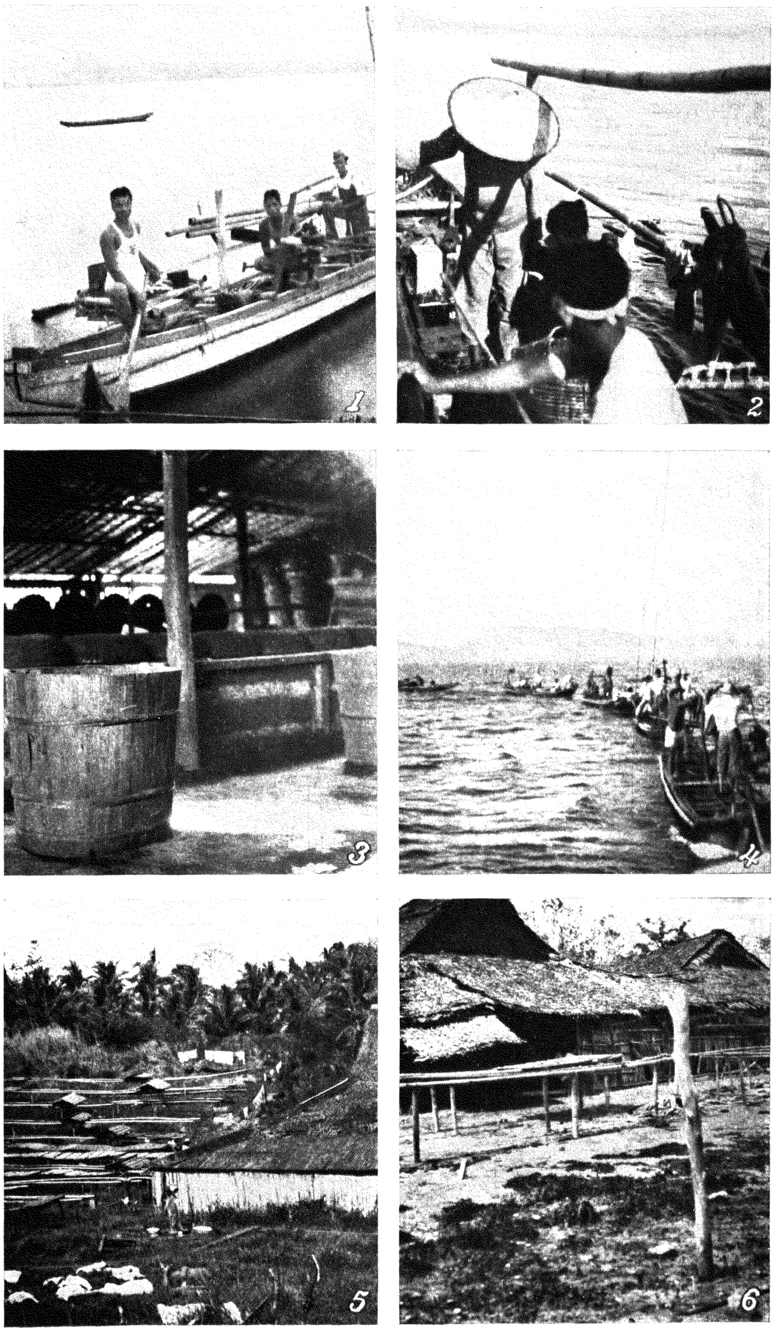

PLATE 2.

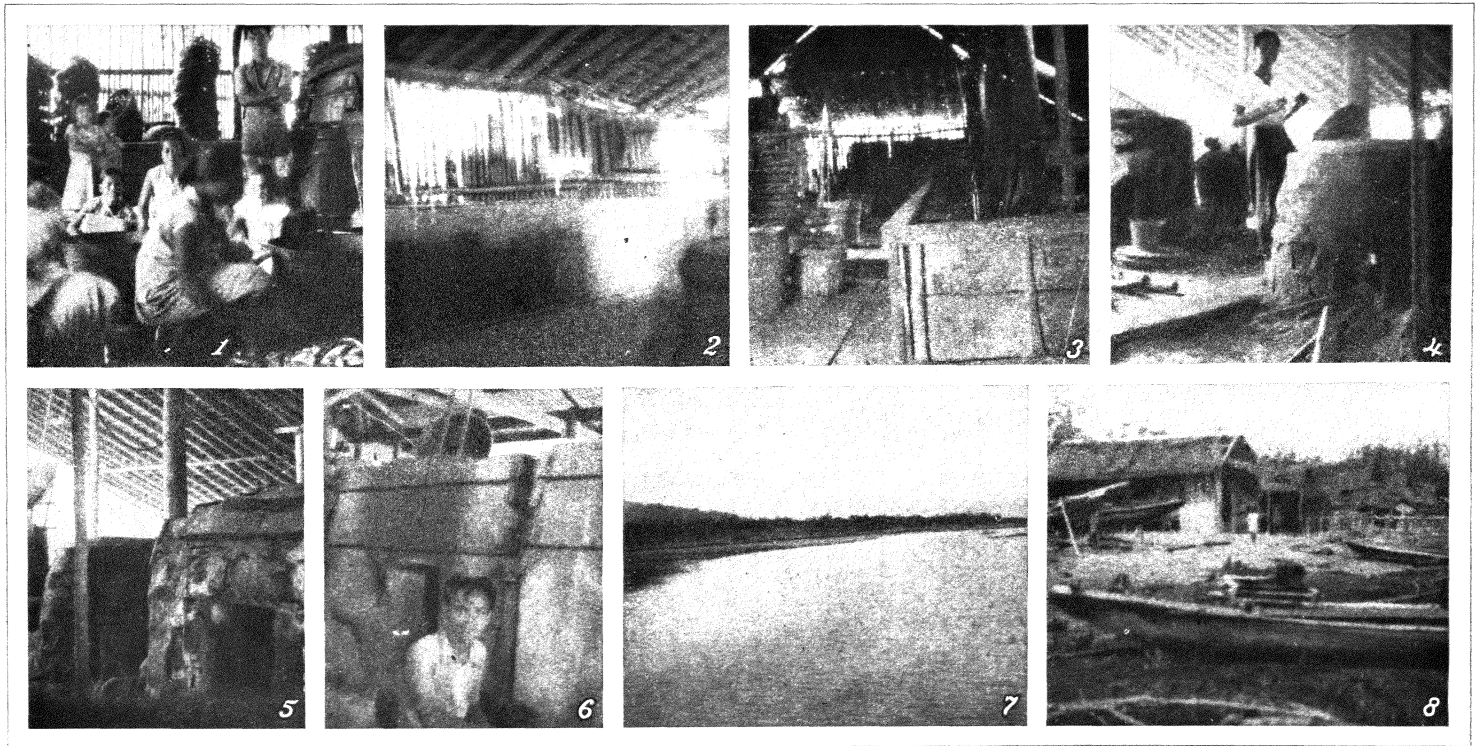

PLATE 3.

NOTE ON THE INVERTEBRATE FAUNA OF SAKUL ISLAND LAGOON, ZAMBOANGA

By José S. Domantay

Of the Fish and Game Administration, Bureau of Science, Manila

Sakul is a small island located southeast of the peninsula of Zamboanga, longitude 122° 15′ and latitude 6° 55′. The southwestern two-thirds of the Island is covered with mangrove swamps. The northeastern third is hilly, with a plain along the coast planted with coconuts. Across the mangrove swamps is a narrow canal which is navigable by small motor boats during high tide, and thus serves as a short cut from the eastern side of the island to the mainland of Zamboanga. At the southern end of the northeastern third of the island is a small lagoon, known among the residents of the place as Moro Inlet, with an area of less than two hectares. The lagoon is well protected from the open sea by a high sandy coral bar with a narrow passage extending into the inward end of the lagoon, which is navigable during high tide. The lagoon serves as anchorage and shelter for Moro vintas during bad weather, although the Moros living in vintas are usually found in this place even during calm days. It is said that at times as many as one hundred of these vintas are found in the lagoon.

The lagoon is almost rectangular, with a slight irregularity in its coastline. The coastline is generally sandy, with a small portion covered by rock boulders. The bottom of the lagoon is sandy, with eel grasses, and the banks of the passage are rocky. A small very shallow creek empties into this lagoon. On the end opposite to that of the narrow passage is a mangrove swamp usually exposed at low tide. The deepest part of the gulf at low water is only a meter.

Few fishes, mostly anchovies and fry of other fishes, are found in this lagoon. Among the eel grasses and along the sandy shore are numerous jellyfishes of the genus *Cassiopea,* synaptids of the species *Opheodesoma spectabilis* Fisher var. *puertogaleræ* Domantay, a few echinoids of the species *Diadema setosum* (Leske), and asteroids of the species *Oreaster nodosus*

(Linnæus). Among the rock boulders are synaptids of the species *Synapta maculata* (Chamisso and Eysenhardt), echinoids (*Diadema setosum*), ophiuroids of the species *Ophiocoma scolopendrina* (Lamarck), and *O. erinaceus* Müller and Troschel, holothurians of the species *Holothuria pulla* (Selenka), and a few sponges of the genera *Euspongia* and *Siphonochalina*. The crustaceans are represented by hermit crabs of the genus *Pagurus* and a few ordinary crabs of the genus *Neptunus*. Along the shores are numerous empty shells of razor clams of the species *Pedalion isognomum* Linnæus which may have been collected from the sea outside the lagoon. Several species of *Cyprea* and other shells are occasionally found along the shores. The predominant forms in the lagoon are *Diadema setosum*, *Synapta maculata*, *Opheodesoma spectabilis* var. *puerto-galeræ*, and *Cassiopea*. A more thorough survey of this lagoon may reveal more forms of marine life. Along the eastern shoal of Sakul Island are numerous starfishes (*Oreaster nodosus*) which can be collected by the thousands.

THE LITTORAL ASTEROIDEA OF PORT GALERA BAY AND ADJACENT WATERS [1]

By JOSÉ S. DOMANTAY and HILARIO A. ROXAS

Of the Fish and Game Administration, Bureau of Science, Manila

SEVENTEEN PLATES

The starfishes collected by the 1912 joint expedition of the University of the Philippines and the Bureau of Science from Port Galera Bay, Mindoro, and adjacent waters, and deposited in the Department of Zoölogy, University of the Philippines, formed the nucleus of a starfish collection which was left untouched till 1924. Every summer since 1924 the writers have had occasion to collect additional specimens from the same region. In the absence of facilities for collecting them, deep-sea forms are not available and therefore not included in this work. Since new specimens are added to the collection almost every year, it is believed that later examples of additional forms may be encountered in this region, especially when collecting is done throughout the year.

Not a single specimen from Port Galera Bay was included in the collection described by Fisher in 1919. A few from this locality were reported, however, by H. L. Clark in 1921. The present manuscript, which embodies the result of asteroid studies started in 1924, gives an idea of the extent of the littoral starfish fauna of Port Galera Bay. Fifty species, belonging to nineteen genera and ten families, are briefly described here and illustrated with photographs. Keys to species are provided in the case of genera represented by several species.

LITTORAL ASTEROIDEA OF PORT GALERA BAY AND ADJACENT WATERS

Order Phanerozonia Sladen.

Family Astropectinidæ Gray.

1. *Astropecten polyacanthus* Müller and Troschel.
2. *Astropecten phragmorus* Döderlein.

Family Luidiidæ Verrill.

3. *Luidia maculata* Müller and Troschel.

[1] This work was started while the writers were with the Department of Zoölogy, University of the Philippines.

Family Archasteridæ Viguier.

4. *Archaster typicus* Müller and Troschel.
5. *Archaster angulatus* Müller and Troschel.

Family Goniasteridæ Forbes.

6. *Hippasteria philippinensis* sp. nov.
7. *Stellaster incei* Gray.

Family Oreasteridæ Fisher.

8. *Oreaster nodosus* (Linnæus).
9. *Oreaster nodosus* var. *honduræ* var. nov.
10. *Oreaster alveolatus* (Perrier).
11. *Oreaster doederleini* Goto.

Family Pentacerotidæ Gray.

12. *Pentaceropsis tyloderma* Fisher.
13. *Pentaceropsis tyloderma* var. *mindorensis* var. nov.
14. *Pentaceropsis obtusatus* (Bory de Saint Vincent).
15. *Culcita novæ-guineæ* Müller and Troschel.
16. *Culcita novæ-guineæ* var. *grex* Goto.
17. *Culcita novæ-guineæ* var. *plana* Goto.
18. *Culcita novæ-guineæ* var. *typica* Goto.
19. *Culcita novæ-guineæ* var. *acutispinosa* Goto.
20. *Halityle regularis* Fisher.
21. *Choriaster granulatus* Lutken.

Family Gymnasteriidæ Perrier.

22. *Gymnasteria carinifera* (Lamarck).

Family Linckiidæ Perrier.

23. *Fromia indica* Perrier.
24. *Fromia pacifica* Clark.
25. *Fromia elegans* Clark.
26. *Fromia eusticha* Fisher.
27. *Fromia japonica* Perrier.
28. *Leiaster speciosus* von Martens.
29. *Linckia lævigata* (Linnæus).
30. *Linckia lævigata* var. *honduræ* var. nov.
31. *Linckia multifora* (Lamarck).
32. *Linckia guildingii* Gray.
33. *Ophidiaster granifer* Lutken.
34. *Ophidiaster squameus* Fisher.
35. *Nardoa variolatus* (Lamarck).
36. *Nardoa squamulosa* Koehler.
37. *Nardoa novæ-caledoniæ* (Perrier).
38. *Nardoa mollis* de Loriol.
39. *Nardoa lemonnieri* Koehler.
40. *Nardoa pauciforis* (von Martens).
41. *Nardoa tuberculata* (Müller and Troschel).
42. *Nardoa frianti* Koehler.

Order Spinulosa Perrier.

Family Asteriinidæ Gray.

43. *Asterina* (*Patiriella*) *exigua* (Lamarck).
44. *Asterina coronata euerces* Fisher.
45. *Asterina coronata puerto-galeræ* subsp. nov.

Family Echinasteridæ Verrill.

Subfamily Acanthasterinæ Sladen.

46. *Acanthaster planci* (Linnæus).
47. *Acanthaster mauritiensis* de Loriol.

Subfamily Echinasterinæ Viguier.

48. *Echinaster callosus* von Marenzeller.
49. *Echinaster luzonicus* (Gray).
50. *Echinaster purpureus* Savigny.

Key to the families of littoral Asteroidea of Port Galera Bay.

a^1. Marginal plates usually large and conspicuous; abactinal skeleton of paxilliform plates, or flat, tessellate plates which are smooth or with granules or spines, and either naked or covered with a thick membrane. Pedicellariæ never pedunculate forcipiform, but spiniform, pectinate, valvate, or excavate. Papulæ restricted to abactinal area (except in some Linckiidæ and Asteropidæ) circumscribed by the marginal plates .... (Order PHANEROZONIA).

b^1. Tube feet pointed, without a well-developed flat sucking disc, sometimes with a small pointed knob at tip.

c^1. Superomarginal plates never obsolete, though at times small; not replaced by paxillæ; papulæ simple.... ASTROPECTINIDÆ.

c^2. Superomarginal plates aborted and replaced by paxillæ; inferomarginals broad; papulæ compound................ LUIDIIDÆ.

b^2. Tube feet with well-developed and prominent sucking discs.

c^1. Abactinal plates paxilliform or tabulate; marginal plates opposite, not conspicuously spiny; papulæ not confined to base of ray and adjacent portion of disc and never localized in special papular organs.

d^1. Abactinal plates arranged in oblique rows on either side of a conspicuous medioradial series and with special internal imbricating ridges; actinal intermediate plates obsolete or very few, gonads extending far along rays. ARCHASTERIDÆ.

d^2. Abactinal plates not arranged in definite oblique series, no internal imbricating ridges; actinal interradial areas large, with numerous plates; gonads interradial. GONIASTERIDÆ.

c^2. Abactinal plates neither tabulate nor paxilliform, but flat, convex, spinous, tubercular, granular or smooth; sometimes overlaid by a thin or thick, smooth or granulous skin; marginal plates with or without robust spines or tubercles.

d^1. Disc large; actinal interradial areas extensive; no papulæ on actinal surface.

e^1. Marginal plates large, but as a rule inconspicuous, being more or less hidden by granulous skin; abactinal skeleton stellate-reticulate plates, always granulous; papulæ numerous, and in definite areas.

f^1. Abactinal plates usually with large conical tubercles or spines; disc usually high..OREASTERIDÆ.

f^2. Resembling Oreasteridæ but without conical tubercles or spines; disc usually not high.
PENTACEROTIDÆ.

e^2. Marginal plates small, more or less imbricated. Abactinal skeleton tessellate; plates often irregular and only partially contingent, the whole covered with a thick, leathery skin; abactinal skeleton tessellate or reticulate............ GYMNASTERIIDÆ.

d^2. Disc small, usually with very small actinal interradial areas, if large, with papulæ on actinal surface. Marginals small; abactinal skeleton tessellate, arranged irregularly or more or less in regular longitudinal series. Superambulacral plates usually present. Pedicellariæ, when present, excavate. Rays usually slender, long, and subcylindrical.................................... LINCKIIDÆ.

a^2. Marginal plates not usually conspicuously large; abactinal skeleton not composed of true paxilliform plates, nor in the form of a tessellated pavement, but usually more or less reticulate or imbricate. Papulæ frequently but not invariably also intermarginal and actinal. Some form of abactinal spinulation always present.
(Order SPINULOSA).

b^1. Abactinal skeleton formed of closely imbricating plates bearing a tuft or fan of spinelets. Marginal plates minute. Pedicellariæ very rare and never pedunculate or excavate. Papulæ distributed throughout the abactinal area. Abactinal plates thick, crescentiform, devoid of internal processes............ ASTERINIDÆ.

b^2. Abactinal skeleton formed of plates disposed in longitudinal and transverse series, or in an irregular network, bearing spinelets; spinelets not disposed in a tuft or fan. Spinelets small, pointed, naked, or covered with a thin skin containing calcareous granulations .... ECHINASTERIDÆ.

Order PHANEROZONIA Sladen

Marginal plates large and highly developed in the adult. Superomarginals and inferomarginals contingent, with their axes usually in parallel planes. Papulæ restricted to abactinal area, circumscribed by superomarginals. Ambulacral plates well spaced, usually broad. Actinostomial ring with adambulacral plates prominent. Pedicellariæ valvate, foraminate, or excavate.

Family ASTROPECTINIDÆ Gray

With large marginal plates bearing spines or spiniform papulæ. Abactinal skeleton with true columnar paxillæ. Actinal interradial areas small, intermediate plates when present spinous. Adambulacral plates present. Pedicellariæ rarely present.

Genus ASTROPECTEN Gray (1840)

ASTROPECTEN POLYACANTHUS Müller and Troschel. Plate 1, figs. 1 to 4; Plate 2, figs. 7 and 8.

Astropecten polyacanthus MÜLLER and TROSCHEL (1842); PERRIER (1876); SLADEN (1879, 1889); BELL (1884*b*); DE LORIOL (1885); DÖDERLEIN (1888, 1917); FARQUHAR (1898); FISHER (1906, 1919); GOTO (1914); CLARK (1923); MORTENSEN (1933, 1934).
Astropecten hystrix MÜLLER and TROSCHEL (1842).
Astropecten armatus MÜLLER and TROSCHEL (1842).
Astropecten vappa MÜLLER and TROSCHEL (1842).
Astropecten edwardsi VERRILL (1867).

Rather rare and found on sandy-rocky bottom along Gabino and Boaya points. A beautiful starfish, greenish gray on aboral and pinkish red on oral side, especially along ambulacral grooves.

Superomarginal spines upright and prominent, proximally equalling height of plate; second superomarginal without spine; inferomarginals with 3 to 4 large bristling spines, with 28 to 30 superomarginal plates. R, 100 millimeters, r, 18; R = 5.5r. University of the Philippines, E-684, E-700, E-754, E-801.

ASTROPECTEN PHRAGMORUS Döderlein. Plate 1, figs. 5 and 6; Plate 3, fig. 13.

Astropecten phragmorus DÖDERLEIN (1917); FISHER (1919).
Astropecten acanthifer phragmorus FISHER (1913).

Color pattern varying slightly. Anal region pinkish orange, surrounded by a circular area (pentagonal in some specimens) of purple, speckled with purplish violet; blotches of similar color on proximal third of ray, homogeneous yellowish brown on middle third, more or less homogeneous purple on distal third of ray. Oral side, except proximal two-thirds of tube feet and distal tip, reddish orange.

Superomarginal plates 25, bearing pinkish brown spines, about $1\frac{1}{2}$ as high as plates. Second and third plates devoid of spines. Inferomarginals same in number as superomarginals, with 3 lateral spines of different sizes, the uppermost largest. Furrow spines 3 or 4. R, 60 millimeters; r, 12; R = 5r. Three specimens collected from sandy-grassy region of Hondura shoal. University of the Philippines E-1005, E-1028, E-1029.

Family LUIDIIDÆ Verrill

Superambulacral plates usually present. Inferomarginal plates separated from adambulacral plates by a small intermediate plate throughout ray. Marginal and adambulacral plates corresponding in length and number. Fasciolar grooves between marginal plates usually well developed; paxillæ typical. Superomarginal plates aborted, represented by a series of paxillæ.

Genus LUIDIA Forbes (1839)

LUIDIA MACULATA Müller and Troschel. Plate 4, fig. 19.

Luidia maculata MÜLLER and TROSCHEL (1842); PERRIER (1875); DÖDERLEIN (1888); KOEHLER (1895, 1910); CLARK (1916, 1921); FISHER (1919); MORTENSEN (1934).

The only specimen collected has eight arms banded dark gray and white. Diameter of disc 20 millimeters, diameter of arm 80. R, 90 millimeters; r, 12; R = 7.5r. Exact locality not recorded. University of the Philippines E-737.

Family ARCHASTERIDÆ Viguier

Thick and massive marginal plates bearing spines or spiniform papillæ. Abactinal skeleton with simple spiniform spicules, with pseudopaxillæ, or with true paxillæ. Actinal interradial areas with compressed plates. Pedicellariæ often present. No superambulacral plates.

Genus ARCHASTER Müller and Troschel (1840)

ARCHASTER TYPICUS Müller and Troschel. Plate 3, figs. 14 to 18.

Archaster typicus MÜLLER and TROSCHEL (1840); FISHER (1919).
Astropecten stellaris GRAY (1840).
Archaster nicobaricus MOBIUS (1859).

Most common and most numerous starfish found along sandy-muddy shore of Varadero Bay, Small Balatero Cove, and adjacent waters. During low tide many individuals are exposed and seen one over the other, apparently in the act of amplexus. General ground color of abactinal side ranging from grayish brown to dark gray or ash gray mottle with irregular darker areas of no uniform pattern. Irregular alternation of lighter and darker areas along superomarginal plates. Oral surface white, except tube feet, which are greenish white. In some specimens a few inferomarginal plates slightly darker. Individuals with four, six, and seven arms occasionally found. Some specimens with a few stout spines at upper median edge of superomarginal plates, one spine to a plate. Superomarginal plates 30 to 45.

Inferomarginal plates provided with a single prominent lateral flattened spine. Measurement of largest specimen: R, 75 millimeters; r, 15. Average R, 60 millimeters; r, 12; R = 5r. Paxillæ of median radial row distinct with 7 to 12 spinelets, lateral ones with 4 to 5. Lateral paxillæ arranged in distinct rows with their spinelets projecting. University of the Philippines E-616, E-617, E-749, E-785, E-813.

ARCHASTER ANGULATUS Müller and Troschel.

Archaster angulatus MÜLLER and TROSCHEL (1842); DE LORIOL (1885); FISHER (1919).

A rare species, occasionally seen together with *A. typicus*, from which it can be told by the presence of 2 or 3 enlarged squamiform spinelets at outer end of inferomarginal plates. Rays narrower and more slender than in *A. typicus;* superomarginals encroaching conspicuously upon abactinal area.

No signs of superomarginal spines; median radial row of paxillæ very regular, spinelets 12 to 14, more centrally situated paxillæ with 6 to 8, much crowded spinelets obscuring distinct arrangement of paxillæ in rows. University of the Philippines E-887.

Family GONIASTERIDÆ Forbes

Marginal plates thick and massive, disc large, primary apical plates usually conspicuous, abactinal and actinal intermediate plates tessellate; abactinal plates polygonal, circular, or stellate, sometimes united by internal radiating ossicles, or forming a close mesh with numerous secondary intermediate plates; plates bearing a central tabulum, paxilliform in structure, or flat, naked, or covered with granules, or bearing an enlarged spine. Papulæ usually confined to radial areas. Plates obscured by a tough skin of varying thickness, which is superficially smooth, or covered with granules or with granules and pedicellariæ. Tube feet with large sucking discs. Superambulacral ossicles present, rudimentary, or absent. Pedicellariæ foraminate, excavate, or bivalved.

Genus HIPPASTERIA Gray (1866)

HIPPASTERIA PHILIPPINENSIS sp. nov. Plate 4, figs. 21 and 22.

A small species, only two examples so far collected from among rocks near Gabino point, Varadero Bay. One specimen has the abactinal side a combination of dirty green on disc and rays and yellowish brown on interbrachial regions. Oral side yellowish brown speckled with light green. The other specimen pinkish red on centrodorsal region around anal opening and along rays, and dark green on interbrachial region and surrounding circular pinkish red around anal opening. On oral side pinkish red confined to rays and dark green to interambulacral and centro-oral disc, giving a flowerlike appearance with five petals. After preservation and drying one specimen turned reddish brown, the green practically all disappearing.

Body flat and slightly pentaradiate, with marginal border of disc almost straight and arms triangular. Oral surface as a whole nearly flat. Abactinal plates circular and markedly separated by narrow poriferous areas. Plates covered with numerous fine granules. Centrodorsal plates surrounding the 6 or 7 anal plates each with one large conspicuous rounded granule. Some plates of disc and those bordering superomarginal plates with similar large granules besides the finer ones. Each superomarginal with 2 to 6 similar granules. Abactinal plates of interbrachial region as well as those along superomarginals with 1 or more valvate pedicellariæ; a few specimens with 2 and some with none. Supero- and inferomarginals devoid of pedicellariæ. Superomarginals very large, corresponding in level with inferomarginals, which they closely resemble.

Actinal plates well marked and not separated by a poriferous region, with more or less of a pavement arrangement, each pavement composed of hexagonal tiles covered by numerous fine granules with 1 or 2 valvate pedicellariæ. Adambulacral spines in two series with 5 furrow spines. Mouth plates somewhat large but not very conspicuous. Each plate has the form of a scalene triangle with 18 furrow spines. At outer angle next to angular furrow spines 4 conical spines arranged in series. Next to this series another one with 10 granular spines. Rest of mouth plates covered with granules. R, 18 millimeters; r, 11; R = 1.63r.

Type specimen (University of the Philippines, E-953) deposited in the Philippine National Museum, Bureau of Science.

Genus STELLASTER Gray, 1847

STELLASTER INCEI GRAY. Plate 5, fig. 30.

Stellaster incei GRAY (1847); SLADEN (1889); DÖDERLEIN (1896); KOEHLER (1910); BROWN (1910); SIMPSON and BROWN (1910); H. L. CLARK (1916, 1921).
Stellaster belcheri GRAY (1847); SLADEN (1889).
Stellaster gracilis MOBIUS (1859).

Apparently rare. Specimens in collection collected by members of first expedition in 1912 from Puerto Galera Bay. Not a single specimen has been encountered by the writers since then.

Our specimens agree in all respects with the description and illustration of Fisher (1919). University of the Philippines E-783.

Family OREASTERIDÆ Fisher

Tergal ossicles always reticulated with more or less extensive pore areas. Interambulacral plates never intercalated, the investing granules not projecting from their side so as to separate ossicles from one another, nor limited to base, but always passing some way up the sides of spines or tubercles, when such are developed.

Genus OREASTER Müller and Troschel (1842)

OREASTER NODOSUS (Linnæus). Plate 5, fig. 28; Plate 15, fig. 90.

Asterias nodosa LINNÆUS (1758).
Pentaceros turritus PERRIER (1875).
Oreaster nodosus BELL (1884*a*); CLARK (1908, 1921); FISHER (1919).

Abactinal surface varying between dirty green, greenish brown, brownish orange, orange, brownish red, and reddish orange. In some specimens interbrachial region lighter, usually brownish or grayish. Tubercles varying from dark green to greenish violet. In some specimens distal third of ray greenish violet. Oral side diverse in color like aboral side. Inferomarginal plates with small actinal plates of various shades of green.

Dorsal simple or branched tubercles on disc 5; those of ray varying in number as well as in form with size and age. Two abnormal specimens with 4 rays only, one having 3 dorsal tubercles with a sign of injury on the bivium where the madreporite is located, hence no madreporite visible.

Most specimens were taken from Hondura muddy-grassy shoal of Varadero Bay, from wide shallow grassy shoal of Calapan near the wharf, and from the sandy-muddy grassy shoal of Carot, Lingayen Gulf. They are apparently inhabitants of sandy-muddy-grassy shoals and not of coral reefs. University of the Philippines E-732, E-733, E-752, E-837, E-838, E-844, E-886.

OREASTER NODOSUS var. HONDURÆ var. nov. Plate 14, fig. 82.

Aboral side together with base of tubercles generally green. Some abactinal and superomarginal plates grayish brown with tips of tubercles light orange. Dorsal tubercles 4, with 8 or 9 carinal tubercles. Proximal first tubercles with a lateral tubercle on each side. In interbrachial arch above superomarginals 1 to 4 small tubercles; along sides of ray above superomarginals 2 to 5 small tubercles; distal superomarginals well developed and conspicuous, with 1 to 2 low tubercles; all tubercles capped with big conspicuous teatlike granules surrounded by smaller ones. Abactinal plates and poriferous areas (papulæ) arranged in longitudinal series on each ray, 7 rows of plates and 8 rows of papulæ; abactinal plates on disc irregular, and papular areas conspicuously bigger than plates. Supero- and inferomarginal plates 18; series of adambulacral armatures 2, and furrow spines 6. Valvate sessile pedicellariæ one on each of smaller plates without tubercles; madreporite elongated. Collected from Hondura grassy shoal, Varadero Bay.

The type specimen (University of the Philippines E-1044) is deposited in the Philippine National Museum, Bureau of Science.

OREASTER ALVEOLATUS (Perrier). Plate 6, figs. 31 and 32.

Pentaceros alveolatus PERRIER (1875); KOEHLER (1910).
Oreaster alveolatus BELL (1884*a*); FISHER (1919).

Habitat similar to that of *O. nodosus*, from which this species differs in the presence of prominent distal superomarginal and inferomarginal spines and of very prominent abactinal spines which are conical, heavy, and granular with a prominent bare conical sharp tip arranged radially, interradially, and usually within the apical area. Specimens obtained from shallow grassy shoal of Calapan, a few small ones from Hondura shoal, Varadero Bay. University of the Philippines E-603, E-734, E-759, E-761.

OREASTER DŒDERLEINI Goto. Plate 15, fig. 88.

Oreaster doederleini GOTO (1914).

The unique specimen was collected several years ago from the neighborhood of Port Galera Bay. Exact location not recorded. Body depressed, slightly concave below and convex above. Arm tips upturned. Interbrachial arcs entirely open. Superomarginal plates 21. Inferomarginals confined to actinal side and larger than superomarginals. Abactinal plates arranged in rows parallel with lateral borders of body. Distinct carinal series of plates in each arm raised into tubercles bearing a teatlike spine at tip. Madreporite pear-shaped, comparatively large but not very conspicuous, with very fine convoluted furrows on the surface and located well out of central pentagon formed by apical tubercles. R, 150 millimeters; r, 55. University of the Philippines E-857 (K-300).

Family PENTACEROTIDÆ Gray

With unequally developed marginal plates, the superior series frequently masked or hidden in membrane. Abactinal skeleton reticulate. Plates with large isolated tubercles or spinelets, or granulose, or covered with membrane. Actinal interradial areas with large pavementlike plates, which bear granules of unequal size.

Genus PENTACEROPSIS Sladen (1889)

PENTACEROPSIS TYLODERMA Fisher. Plate 5, figs. 25 and 26; Plate 14, figs. 78 and 79.

Pentaceropsis tyloderma FISHER (1913, 1919).

Philippine specimens collected from wide shallow grassy flat of Hondura, Varadero Bay, and of Calapan, Mindoro. Abactinal surface with general ground color of grayish brown confined to the granular plates, tip of rays blackish brown. Like in *Oreaster,* the color varies in different specimens. Actinal side light orange with adambulacral and ambulacral spines yellowish. Habitat the same as that of *O. nodosus* and *O. alveolatus*.

Series of subambulacral spines 1; no inferomarginal tubercles, except on the first few plates; distal superomarginals less prominent, without smooth tubercles; papular granules very much smaller than those of convex plates. Disc inflated, rays convex, much lower than disc; interbrachial arcs well rounded; rays broad, tapering toward rounded end. One series of subambulacral spines with 8 furrow spinelets, large triangular superomarginal plates, and apical tubercles; convex abactinal plates large and not very close together, medioradial series distinct and proximal plate large and conical. Average measurement: R, 70 millimeters; r, 35; $R = 2r$. University of the Philippines E-606, E-699, E-738, E-836, E-950, E-1033.

PENTACEROPSIS TYLODERMA var. MINDORENSIS var. nov. Plate 5, fig. 27.

Collected from Hondura, Varadero Bay. Aboral disc and rays light green and purplish, the former confined to poriferous area and the latter to plates. Oral side light orange. Ten dorsoradial plates of disc with medium-sized tubercles, the rest together with those of rays, same as typical species. Tips of rays more pointed.

Supero- and inferomarginal plates 12; two proximal and three distal inferomarginals with medium-sized tubercles; series of adambulacral armatures 2, furrow spines 5 to 6. R, 35 millimeters; r, 20; R = 1.75r.

Type specimen (University of the Philippines E-1034) deposited in the National Museum, Bureau of Science.

PENTACEROPSIS OBTUSATUS (Bory de Saint Vincent).

Asterias obtusatus BORY DE SAINT VINCENT (1827).
Oreaster obtusatus MÜLLER and TROSCHEL (1842).
Pentaceros obtusatus PERRIER (1875).
Pentaceropsis obtusatus SLADEN (1889).

Collected from Hondura, Varadero Bay. Aboral disc dark green, the rest, together with rays, middle superomarginals, and tip of rays gray, speckled with darker gray or grayish black in some carinal plates. Oral side yellow or light orange.

Aboral plates covered with granules, some of these with teat-like granules at center and arranged in radial series, five rows from interbrachial to proximal half of ray and three rows from middle to tip of ray. Papulæ likewise arranged in series, each with 2 or 3 pores. Series of adambulacral armature 2, furrow spines 5, the 2 lateral spines very short. Distal superomarginals and inferomarginals conspicuous, the latter bearing tubercles. University of the Philippines E-1036.

Genus CULCITA Agassiz (1835)

Body pentagonal or roundish. Poriferous areas separate or more or less continuous, a marginal zone of variable width free from papulæ. Nonporiferous areas sometimes forming patches of variable sizes in midst of poriferous areas, sometimes with spines or tubercles as far as ventral margin of body. Ventral surface finely granulated and with coarse pearl-shaped, flattened or rod-shaped granules. Inner adambulacral spines usually 5, at most 7.

Key to the varieties of Culcita novæ-guineæ in Port Galera Bay.

*a*¹. Poriferous areas small.
  *b*¹. Poriferous areas with spines.
    *c*¹. Dorsal tubercles all spiniform. Spines of poriferous areas mostly smaller than those of nonporiferous area; coarse granules of ventral side sometimes separated into groups by intervening fine granulation.................... *C. novæ-guineæ.*
    *c*². Poriferous areas round and covered with small spines entirely separated from one another by a continuous network of wide nonporiferous areas free from spines; coarse granulation of ventral side very weakly developed.
C. novæ-guineæ var. *grex.*
  *b*². Poriferous areas free from spines, small, roundish, separated by well-developed network of nonporiferous area.
C. novæ-guineæ var. *plana.*

a^2. Poriferous areas large, prominent.

b^1. Poriferous areas 3- to 6-sided, separated by rows of large spines and large nonporiferous patches........ *C. novæ-guineæ* var. ***typica.***

b^2. Poriferous areas continuous, with only small nonporiferous patches between; dorsal side uniformly covered with numerous coarse spines .... *C. novæ-guineæ* var. ***acutispinosa.***

CULCITA NOVÆ-GUINEÆ Müller and Troschel. Plate 16, figs. 92 and 93.

Goniaster sebœ GRAY (1840).
Goniodiscus sebœ MÜLLER and TROSCHEL (1842).
Culcita novæ-guineæ MÜLLER and TROSCHEL (1842); DÖDERLEIN (1896); GOTO (1914); FISHER (1919).
Culcita pulverulenta PERRIER (1869).

The unique specimen was obtained from corals of northwest Channel of Port Galera Bay. Poriferous areas with spines mostly smaller than those of nonporiferous areas. Coarse granules of ventral side segregated into groups by intervening fine granulation. Young specimen 85 millimeters in diameter and 40 thick at the center. R, 50 millimeters; r, 45. University of the Philippines E-849.

CULCITA NOVÆ-GUINEÆ var. GREX Goto.

Culcita grex MÜLLER and TROSCHEL (1840).
Culcita novæ-guineæ var. *grex* GOTO (1914).

Color ranges from yellow to purplish violet, the former more predominant. Two colors intergrade in some poriferous areas. Isolated conspicuous white truncated pedicellariæ present in some papulæ. Actinal side generally brownish yellow, lighter at center and darker at periphery with coarse granules. Adambulacral spines and furrow spines range from yellowish brown to purplish orange outward to tip of ray.

Nonporiferous areas of abactinal side continuous, well spaced, generally deep green. Poriferous areas circular, discontinuous, covered with spines. R, 120 millimeters; r, 110; R = 1.09r; diameter, 220; thickness, 65. One specimen (University of the Philippines E-926) collected from Northwest Channel among coral reefs.

CULCITA NOVÆ-GUINEÆ var. PLANA Goto. Plate 7, figs. 35 and 36; Plate 8, fig. 39; Plate 16, fig. 98.

Culcita plana HARTLAUB (1892).
Culcita novæ-guineæ var. *plana* GOTO (1914).
Culcita novæ-guineæ plana FISHER (1919).

Four specimens collected together with *Culcita novæ-guineæ* var. *typica* from coral reefs of Port Galera Bay. Aboral side a combination of deep green, yellow, and purplish violet.

Poriferous areas small, roundish, and separated by a well-developed network of nonporiferous areas almost free from spines. Papular areas near margin granular and slightly spinous. Nonporiferous (interpapular) areas generally deep green, sometimes with yellow spots, usually plain and finely granular. Marginal region of oral side with color combination similar to that of aboral, with larger and distinctly spinous papular areas. Main part of oral side yellowish green, speckled with yellow and purplish granules. Ambulacral, adambulacral, and furrow spines reddish orange, darker distally than proximally; tube feet purplish. Furrow spines 3 to 7, increasing in number proximally. Four specimens each 125 millimeters in diameter, 60 thick; 200 in diameter, 85 thick; 230 in diameter, 75 thick; and 220 in diameter, 65 thick, respectively. Last two obtained from first coral-reef shoal (first plateau) and from western side of Northwest Channel.

The largest specimen has the following measurements: R, 140 millimeters; r, 130. University of the Philippines E-848, E-850 (K-29), E-895, E-926.

CULCITA NOVÆ-GUINEÆ var. TYPICA Goto. Plate 15, figs. 84 and 85; Plate 16, figs. 96 and 97.

Culcita novæ-guineæ var. *typica* GOTO (1914).

The most common variety of *C. novæ-guineæ,* mostly encountered in the first coral reef shoal of Port Galera Bay and in Nortwest Channel.

Poriferous areas large and 3- to 6-sided, merging into one another, separated at places by rows of large granular spines of nonporiferous areas. Spines of nonporiferous areas more prominent and larger than those of poriferous areas. Tubercles on actinal surface crowded and more or less compact at midde of interambulacral area. Average, 200 millimeters in diameter and 90 thick. University of the Philippines E-739 (K-28), E-840, E-841, E-851 (K-31), E-852 (K-32), E-853, E-854 (K-27), E-855 (K-30).

CULCITA NOVÆ-GUINEÆ var. ACUTISPINOSA Goto. Plate 7, figs. 37 and 38; Plate 8, figs. 39 and 40; Plate 14, fig. 75.

Culcita acustispinosa BELL (1883).
Culcita novæ-guineæ var. *acutispinosa* GOTO (1914).

United papular areas markedly spinous, yellow, deep orange, or greenish brown. Yellow confined mostly to distal sides of indistinct ray, although sparsely visible on disc. Finely granular interpapular areas dark green. Oral side greenish yellow, speckled with green and brown confined to coarse granules. Adambulacral spines and tips of furrow spines yellowish orange to deep purple outward to tip of rays. Newly preserved specimens deep bluish violet.

Poriferous or papular areas uniformly covered with numerous coarse spines and connected by small nonporiferous patches. Furrow spines 4 to 6. One specimen 125 millimeters in diameter, 60 thick; two 230 in diameter, 65 thick; one 180 in diameter, 80 thick. In large specimens R, 120 millimeters; r, 110; R = 1.092r. Collected from the western side of Northwest Channel and from the second coral reef shoal of Port Galera Bay. University of the Philippines E-849, E-914, and E-1050.

Genus HALITYLE Fisher, 1913

HALITYLE REGULARIS Fisher. Plate 14, fig. 76 and 77.

Halityle regularis FISHER (1913, 1919).

Apparently a deep-sea form. The unique specimen was obtained from a fish trap in North Channel, Port Galera Bay, at a depth of about 10 fathoms, among corals.

Marginal and inferomarginal plates well-defined; no tubercles or spines on abactinal and actinal plates; abactinal plates numerous, forming very regular triangular papular areas arranged in regular series. Abactinal surface finely granular, with 2-jawed granuliform pedicellariæ. Actinal plates sharply marked off by sutural grooves and covered with a close mosaic of unequal, smooth, very compact granules. Adambulacral tubercles 2 to 3, large; compact, perpendicular furrow comb with 8 to 11 spinelets. R, 125 millimeters, r, 90; R = 1.4r. University of the Philippines E-842.

Genus CHORIASTER Lutken (1869)

CHORIASTER GRANULATUS Lutken. Plate 15, figs. 86 and 87.

Choriaster granulatus LUTKEN (1871); GOTO (1914); FISHER (1919).

Poriferous areas as in *Culcita* confined to abactinal surface, irregular in shape, arranged in a double series of two in each arm up to distal third only, separated by fine, uniform compact granules; also found in interbrachial region of abactinal surface. Madreporite somewhat concave, well exposed and elliptical in outline, covered with irregularly radiating fine grooves and located midway between center of disc and margin.

In preserved specimens, poriferous areas dark brown, nonporiferous pinkish brown. Unique specimen (University of the

Philippines E-856) taken from North Channel, Port Galera Bay. R, 120 millimeters; r, 60; R = 2r.

Family GYMNASTERIIDÆ Perrier

Genus GYMNASTERIA Gray (1840)

GYMNASTERIA CARINIFERA (Lamarck). Plate 8, figs. 43 and 44; Plate 16, figs. 94 and 95.

Asterias carinifera LAMARCK (1816).
Asterope carinifera MÜLLER and TROSCHEL (1840); CLARK (1921).
Asteropsis carinifera MÜLLER and TROSCHEL (1842).
Gymnasteria spinosa GRAY (1840).
Gymnasteria inernis GRAY (1840).
Gymnasteria biserrata VON MARTENS (1866).
Gymnasteria carinifera VON MARTENS (1866); SLADEN (1889); GOTO (1914).

Apparently rare, only three specimens having been collected, two from corals of Port Galera Bay and one from Cebu. The color agrees exactly with the description of Clark (1921). Skeletal plates covered with humid leathery membrane. Each superomarginal plate bears on outer border a stout, short conical spine projecting obliquely outwards, so that the sides of arms are somewhat serrated. University of the Philippines E-714, E-735, E-736.

Family LINCKIIDÆ Perrier

Marginal plates comparatively well-developed, always contingent. Disc small, rays long and cylindrical. Abactinal skeleton tessellate. Superambulacral plates usually present, except in *Fromia*. Pedicellariæ, if present, excavate or foraminate. Abactinal plates without internal supplementary plates, not forming paxilliform tabula. Abactinal and marginal plates granulose, not bearing spines.

Genus FROMIA Gray (1840)

Key to the species of Fromia.

a[1]. Superomarginal plates decreasing in size distally with a fair degree of uniformity, not conspicuously swollen. Second series of actinolateral plates well developed, extending more than half the length of ray; series of actinal papulæ at base of ray 2, rarely 3.

b[1]. Rays short, wide. Abactinal surface of each ray covered by about 3 irregular series of large, somewhat swollen plates mingled with much smaller ones; rays 5; R = 3.5r................ *F. indica.*

b[2]. Rays long, narrow.

c[1]. No actinal pedicellariæ.

d[1]. Abactinal surface covered with a uniform coat of fine granules; furrow spinelets 2 or 3; R = 5r. *F. pacifica.*

d^2. Abactinal granulation coarse, granules of each plate forming a distinct group, central granules same as those of margin; furrow spinelets 2; R = 4.5r. *F. elegans.*

c^2. Abundant actinal pedicellariæ; R = 4.5r................ *F. eusticha.*

a^2. Large and small superomarginal plates regularly alternate. Abactinal plates irregularly arranged in series, furrow spinelets 3; R = 4r. *F. japonica.*

FROMIA INDICA Perrier.

Scytaster indicus PERRIER (1869).
Fromia indica PERRIER (1875); KOEHLER (1910); CLARK (1921).

Disc and rays flat, with numerous small abactinal plates and few large ones in about 7 or 8 irregular longitudinal series on each ray. Actinal surface with stout spinelets grouped together forming low paxillæ. In some rays supero- and inferomarginals irregular. Rays short but pointed. Series of adambulacral armatures 3, furrow spinelets 2. R, 35 millimeters; r, 10, R = 3.5r. University of the Philippines E-1046.

FROMIA PACIFICA Clark.

Fromia pacifica CLARK (1921).

Superomarginal plates decreasing in size distally, with a fair degree of uniformity and not conspicuously swollen. Abactinal plates small and numerous, about 7 irregular longitudinal series on each ray. Abactinal plates covered with a uniform coat of fine granules. Plates of actinal surface covered with stout spinelets. Series of actinolateral plates 3 proximally, the second extending up to middle of ray and the third becoming rudimentary. Furrow spinelets 2 or 3. Rays tapering gradually and becoming slender distally. R, 50 millimeters; r, 10; R = 5r. University of the Philippines E-612.

FROMIA ELEGANS Clark. Plate 9, figs. 47 and 48; Plate 10, figs. 51 and 52.

Fromia elegans CLARK (1921).

A small starfish found among corals in Port Galera Bay and other places. Most common species of *Fromia* found at station. Body brick red with abactinal plates light brick red. Ambulacral, adambulacral, and furrow spines together with paxillæ on oral side uniformly brick red.

Abactinal granulation coarse; granules of each plate forming a distinct group with central granules, same in size as those of margin, furrow spinelets 2. R, 50 millimeters; r, 11; R = 4.5r. University of the Philippines E-600, E-601, E-611, E-892, E-773 (K-13).

FROMIA EUSTICHA Fisher. Plate 9, figs. 49 and 50.

Fromia eusticha FISHER (1913, 1919).

Long, slender, and evenly tapering rays with very regularly arranged abactinal plates in series. Marginal plates very regular. Superomarginal plates 18, encroaching conspicuously upon abactinal surface. Inferomarginals 20. Furrow spines 3 on proximal half of ray and usually 2 on distal half. Abundant actinal pedicellariæ with circular madreporite. R, 45 millimeters; r, 10; breadth of ray at base, 10; R = 4.5r. University of the Philippines E-771 (K-12).

FROMIA JAPONICA Perrier. Plate 9, figs. 45 and 46.

Fromia major KOEHLER (1895, 1910).

Fromia japonica PERRIER (1881, 1884); DE LORIOL (1891); FISHER (1919).

Superomarginal plates 20, regularly alternating large and small. Granules surrounding papular pores slightly larger than those covering plates. Abactinal plates irregularly arranged in series. Inferomarginal plates 19. Actinal plates arranged in distinct series of four proximally and reduced to one distally. Furrow spines mostly 3. R, 50 millimeters; r, 12; breadth of ray at base, 12; R = 4r. University of the Philippines E-772 (K-10).

Genus LEIASTER Peters (1852)

LEIASTER SPECIOSUS von Martens. Plate 17, figs. 108 and 109.

Leiaster speciosus VON MARTENS (1866); SLADEN (1889); CLARK (1921).

Three specimens in collection taken from corals in Port Galera Bay. Gorgeously brilliant red.

Pedicellariæ very inconspicuous, becoming noticeable only after drying. Pedicellariæ few, hardly one to each papula, usually found on margin of papular area and sometimes between two papulæ. Double-bladed valvate pedicellariæ enlarged at middle. Entire body covered by thick tough skin concealing outline of oval granular plates, arranged in regular longitudinal and transverse series. Longitudinal series of abactinal and marginal plates 7, regular longitudinal series of slightly sunken papular areas 8. Adambulacral spines slender and of uniform width, marked by a shallow groove between base and tips. Furrow spines united by continuous membrane. Actinal spines heavy, subcylindrical, a little longer than furrow spines. Largest specimen: R, 250 millimeters; r, 25; smaller: R, 150 millimeters;

r, 15; R = 10r. University of the Philippines E-716, E-746, E-762.

Genus LINCKIA Nardo (1834)

Key to the species of Linckia.

a[1]. Granulation of actinal surface extended to sides of ambulacral grooves so that furrow spines are separated from each other by vertical series of minute granules.
 b[1]. Rays relatively short and stout; one madreporite; usually blue.
  c[1]. Median radial area free from papulæ. R = 8.5r (average). *L. lævigata.*
  c[2]. Median radial area not free from papulæ. R = 5.3r. *L. lævigata* var. *honduræ.*
 b[2]. Rays long and slender, 5 or 6, R = 6r; madreporites 2; no blue coloration .... *L. multifora.*
a[2]. Granulation of actinal surface not extended into ambulacral grooves; furrow spines not separated by granules.......... *L. guildingii.*

LINCKIA LÆVIGATA (Linnæus). Plate 15, figs. 89 and 91.

Pentadactylosaster miliaris LINCK (1733).
Asterias lævigata LINNÆUS (1758).
Linckia lævigata NARDO (1834); LUTKEN (1871); FISHER (1919); CLARK (1921).
Ophidiaster lævigata MÜLLER and TROSCHEL (1840).
Ophidiaster clathrata GRUBE (1864).
Linckia typus NARDO (1834).
Linckia crassa GRAY (1840).
Linckia brownii GRAY (1840).
Linckia miliaris VON MARTENS (1866).

Common large linckiid among corals in Port Galera Bay. In life both aboral and oral sides range from sky blue to marine blue and are usually uniform throughout. In some specimens the aboral side light blue and the oral light orange. Different specimens, however, show some slight differences in shade or intensity of blue. Young specimens usually lighter blue; average length of rays 150 millimeters, with one madreporite. No papular areas on oral side. Usually 5 short, stout rays, occasionally 4; some specimens with one or two rays shorter than the others. University of the Philippines E-605, E-607, E-747, E-748, E-751, E-757, E-758, E-871, E-896, and E-927.

LINCKIA LÆVIGATA var. HONDURÆ var. nov. Plate 14, fig. 83.

Of the same color as *L. lævigata*. Differs however in size, arrangement of papular areas, number of rows of plates below inferomarginal plates, and furrow spines. Abactinal plates and papular areas arranged in alternating rows, this arrangement very regular laterally but somewhat irregular dorsally. Median radial area as in *L. multifora* not free from papulæ. Below inferomarginal plates 4 rows of plates proximally and 3 rows distally. Furrow spines separated by very few granules in a perpendicular series. R, 80 millimeters; r, 15. Collected from Hondura shoal. Type specimen (University of the Philippines E-1040) deposited in the Philippine National Museum.

LINCKIA MULTIFORA (Lamarck). Plate 2, figs. 11 and 12.

Asterias multifora LAMARCK (1816).
Linckia leachii GRAY (1840).
Linckia multiforas GRAY (1866).
Linckia multiforis VON MARTENS (1866).
Linckia costæ RUSSO (1894).
Linckia multifora LUTKEN (1871); DE LORIOL (1885); FISHER (1919); CLARK (1921); HOLLY (1932).

A rare form with only two specimens obtained from corals in Port Galera Bay. Abactinal plates and papular areas irregularly arranged in 6 and 7 rows, respectively, between superomarginals. No median radial area free from papulæ. Madreporite 1. The subambulacral series of enlarged granules separated from furrow spines by 1 series of small granules. One specimen with 6 rays, others with 5. Rays not uniform in length. Longest ray 42 millimeters; shortest 30; radius of disc 7. University of the Philippines E-721.

LINCKIA GUILDINGII Gray. Plate 14, figs. 80 and 81.

Scytaster stella DUCHASSAING (1850).
Ophidiaster ehrenbergii MÜLLER and TROSCHEL (1842).
Ophidiaster ornithopus MÜLLER and TROSCHEL (1842).
Linckia pacifica GRAY (1840).
Linckia diplax MÜLLER and TROSCHEL (1842).
Linckia nicobarica LUTKEN (1871).
Linckia ornithopus VERRILL (1871).
Linckia ehrenbergii DE LORIOL (1885).
Linckia guildingii GRAY (1840); SLADEN (1889); FISHER (1919); CLARK (1921).

Not common, only four specimens, three adult and one young, collected from corals in Port Galera Bay. Arm radius of adult 220 millimeters. Color dull grayish brown. This is so far the biggest linckiid found at the station. No abactinal plates conspicuously enlarged and swollen. Intermarginal poriferous areas not in a continuous series. Abactinal plates relatively small and numerous; papular areas large in 8 to 12 or more series, median ones very irregular and difficult to determine; papulæ numerous and small; size large, R, 220 millimeters. Rays relatively long;

color in young living specimens dull reddish or purple, more or less variegated with darker, becoming purplish, reddish brown, uniformly yellow-brown in the adult. University of the Philippines zoölogical collection E-604, E-672, E-1053.

Genus OPHIDIASTER Agassiz (1835)

OPHIDIASTER GRANIFER Lutken. Plate 2, figs. 9 and 10; Plate 6, fig. 34.

Ophidiaster granifer LUTKEN (1871); CLARK (1921).

Several specimens of this small species were obtained from under rocks among coral reefs in Port Galera Bay. In life abactinal side irregularly banded or mottled with purplish red and brownish gray. Anal opening surrounded by a small purplish red spot; rest of disc brownish gray; proximal third or fourth of arm purplish red; rest brownish gray, mottled with purplish red. Oral side yellowish brown speckled with tiny spots of purplish red.

Abactinal plates and papular areas distinctly arranged in 5 and 6 rows, respectively; markedly granular. Adambulacral spines distinctly conical and separated by fine granules. Furrow spines 3, the middle larger and arranged slightly obliquely, appearing as a double series of furrow spines. R, 30 millimeters; r, 7. University of the Philippines E-602, E-879, E-978.

OPHIDIASTER SQUAMEUS Fisher. Plate 13, figs. 69 and 70.

Ophidiaster squameus FISHER (1906); CLARK (1921).

A rare form; only one specimen has been collected during low tide at Gabino point under a rock. In life, abactinal side reddish purple, mottled with dull violet and grayish brown. Madreporite conspicuous, deep orange. Actinal side orange and reddish purple mottled with brown. Orange confined to adambulacral and ambulacral spines.

Abactinal plates covered with granules of different sizes and arranged in distinct longitudinal series. Poriferous areas arranged in eight longitudinal series. Anal opening surrounded by 6 conspicuous anal granules. Adambulacral spine about 50, higher than wide, conical, more conspicuous than those in *O. granifer*. Ambulacral region with 1 series of spines. R, 37 millimeters; r, 6; R = about 7r. University of the Philippines E-948.

Genus NARDOA Gray (1840)

Key to the Port Galera species of Nardoa.

a^1. Abactinal plates very slightly convex to markedly convex, but none high enough to be hemispherical or tuberculate.

b[1]. Abactinal plates larger than papular areas.

c[1]. Abactinal plates on distal part of ray not markedly and abruptly different from those on basal part. Abactinal plates elliptical in contour. Adambulacral spinelets in 3 series. Granules surmounting depressed convex plates, nearly uniform in size, polygonal, close set, two or three times the size of granules in depressions between plates...... *N. variolatus.*

c[2]. Abactinal plates on distal part of ray markedly and abruptly smaller and more crowded than on basal part.

d[1]. No intermarginal or actinal papulæ. Abactinal plates roundish, 7 to 9 on basal third of ray; adambulacral armature in 3 series; abactinal papular areas with granules conspicuously larger than others. *N. squamulosa.*

d[2]. With intermarginal series of papulæ.

e[1]. Abactinal plates 10 across ray at base, smaller and less convex; rays shorter and thicker, not especially attenuate at tip; adambulacral armature in 2 series .... *N. novæ-caledoniæ.*

e[2]. Abactinal plates larger, 9 to 11 across ray; at base larger; adambulacral armature in 3 series. *N. mollis.*

b[2]. Abactinal plates smaller than papular area.

c[1]. Abactinal plates 10 to 12 across base of ray. Lateral abactinal plates smaller and irregular; with an intermediate series of papulæ; furrow spines 4; rays long, slender, and tapering to a sharp point.................................. *N. lemonnieri.*

c[2]. Abactinal plates smallest of any known species, at least 12 to 13 across ray at base, those of distal third or fourth small and crowded, but the area not conspicuously differentiated from rest of abactinal surface; lateral abactinal plates abruptly much smaller than regular superomarginals, which are thus very conspicuous; a single series of actinal intermediate plates extending to the end of the ray; adambulacral armature 3 to 5 spines................................ *N. pauciforis.*

a[2]. Some abactinal plates hemispherical or nearly so, others less markedly convex or else variably convex or hemispherical, subcylindrical, or subconical; tubercles as high as their breadth at base.

b[1]. Abactinal plates very numerous and nearly all equal, some conspicuously more convex than others, the most prominent hemispherical, but not so high as wide. Tubercles scattered, small, 2 millimeters or less in diameter.. *N. tuberculata.*

b[2]. Abactinal plates very unequal in size, larger ones forming thick subconical or dome-shaped tubercles covered with granules. Abactinal tubercles 30 or 40, large, 3 to 5 millimeters in diameter .... *N. frianti.*

NARDOA VARIOLATUS (Lamarck). Plate 11, figs. 57 and 58.

Asterias variolatus LAMARCK (1816).
Linckia variolata NARDO (1834).

Nardoa variolata GRAY (1840); SLADEN (1889); CLARK (1921).
Nardoa agassizii GRAY (1840).
Nardoa variolatus FISHER (1919).

Occasionally found among corals in Port Galera Bay. Abactinal plates much larger than papular areas, elliptical in contour. Adambulacral spinelets in 3 series. Granules covering abactinal plates nearly uniform in size, two or three times the size of the granules in the depressions between the plates. University of the Philippines E-593.

NARDOA SQUAMULOSA Koehler. Plate 12, figs. 67 and 68.

Nardoa squamulosa KOEHLER (1910); FISHER (1919).

A rare species found among living corals of Port Galera Bay. Abactinal plates large, in 7 to 8 irregular rows at base of ray, becoming more irregular at distal part, covered with larger central granules and smaller peripheral ones. Adambulacral armature in 3 series with 3 or 4 furrow spines. $R = 5\frac{1}{2}r$. University of the Philippines E-618, E-875.

NARDOA NOVÆ-CALEDONIÆ (Perrier). Plate 11, figs. 59 and 60.

Scytaster novæ-caledoniæ PERRIER (1875).
Scytaster gamophia PERRIER (1875).
Nardoa novæ-caledoniæ SLADEN (1889); FISHER (1919); CLARK (1921).

Found among corals of Port Galera Bay. Closely resembles *N. variolatus,* from which it differs in the size of distal abactinal plates and the central granules on plates which are very conspicuous. Abactinal plates smaller and less convex. Intermarginal series of papulæ present. Length of ray variable. Adambulacral armature in 2 series with 4 furrow spines. $R = 5r$. University of the Philippines E-615, E-874.

NARDOA MOLLIS de Loriol. Plate 11, figs. 61 and 62.

Nardoa mollis DE LORIOL (1891); FISHER (1919).
Nardoa bellonæ KOEHLER (1910).

Found among coral reefs of Port Galera Bay. Abactinal plates larger, 9 to 11 across ray at base, those of distal third crowded. Numerous conspicuous pedicellariæ in papular areas. Distal third of ray narrower than the rest. Adambulacral armature in 3 series with 3 or 4 furrow spines. $R = 7\frac{1}{2}r$. University of the Philippines E-595, E-873.

NARDOA LEMONNIERI Koehler. Plate 10, figs. 55 and 56.

Nardoa lemonnieri KOEHLER (1910); FISHER (1919).

Apparently rare, only one specimen in the collection, taken by members of 1912 expedition from Port Galera Bay. Easily recognized because of its long, slender, tapering ray with rather sharp extremity. Agrees with the description of Fisher 1919. University of the Philippines E-872.

NARDOA PAUCIFORIS (von Martens). Plate 10, figs. 53 and 54; Plate 12, figs. 63 and 64.

Linckia pauciforis VON MARTENS (1866).
Nardoa finschi DE LORIOL (1891).
Nardoa pauciforis SLADEN (1889); FISHER (1919); CLARK (1921).

Occasionally found among corals of Port Galera Bay. Abactinal side with 6 or 7 alternate reddish brown and orange brown bands, extending to ambulacral groove. Abactinal plates small, 12 across ray at base, those of distal third small and crowded, lateral abactinal plates abruptly much smaller than the regular superomarginals which are very conspicuous; adambulacral armature in 3 series with 3 to 5 furrow spines. R, 130 millimeters; r, 20; usually R = 7r. University of the Philippines E-594, E-596, E-750, E-899.

NARDOA TUBERCULATA (Müller and Troschel). Plate 14, fig. 74.

Ophidiaster tuberculatus MÜLLER and TROSCHEL (1840).
Nardoa tuberculata GRAY (1840, 1866); SLADEN (1889); KOEHLER (1910); FISHER (1919); CLARK (1921).
Scytaster tuberculatus PERRIER (1875).

Most common species of genus found among corals of Port Galera Bay. Told from *N. frianti* by its low and broad tubercles. In life brown-yellow with dark blood-red transverse bands. Adambulacral armature in 3 series, with 4 and 5 furrow spines. R, 130 millimeters; r, 20; R = 6½r. University of the Philippines E-597, E-609, E-613, E-743, E-864.

NARDOA FRIANTI Koehler. Plate 12, figs. 65 and 66.

Nardoa frianti KOEHLER (1910); FISHER (1919); CLARK (1921).

A very well-marked species found among corals of Port Galera Bay; not very common. In life pinkish red, rays with 3 to 4 red indistinct bands. Papular areas light violet, those of distal third and above superomarginals deeper violet. Red band on oral side more distinct but irregular. Abactinal plates unequal in size, larger ones forming thick subconical or dome-shaped tubercles covered with granules. Abactinal tubercles numerous, 30 or more, covered with conical granules which are large and conspicuous at center. Adambulacral armature in 3 series, with furrow spines ranging from 2 to 4. R = 8r. University of the Philippines E-599, E-742, E-891.

Order SPINULOSA Perrier

Pedicellariæ few or absent, never forcipiform; abactinal skeleton reticulate or imbricated, sometimes absent; abactinal spines always present, usually numerous, isolated in groups, or forming regular fascicules and pseudopaxillæ; marginal plates usually inconspicuous; papulæ dorsal only or also intramarginal and actinal; ambulacral plates not crowded and compressed, actinostome with prominent adambulacral plates; tube feet with well-developed sucking disc, usually biserial; mouth plates medium-sized or large.

ASTERINIDÆ

Marginal plates small, in some forms inconspicuous and with their axes convergent. Abactinal skeleton composed of imbricating and usually lamelliform plates, notched on one side and bearing spines at free margin; or irregular rounded plates with tufts of spinelets. Actinal interradial areas with imbricating plates bearing spines. No pedicellariæ.

Genus ASTERINA Nardo (1834)

ASTERINA (PATIRIELLA) EXIGUA (Lamarck). Plate 6, fig. 33.

Asterias exigua LAMARCK (1816).
Asterina calcarata KOEHLER (1909).
Asterina exigua PERRIER (1875), KOEHLER (1910); CLARK (1923).
Patiriela exigua VERRILL (1913); FISHER (1919); CLARK (1928).

Most common small starfish found in rocky and stony shore line. Specimens collected from rocks near "shipwreck point" of Varadero Bay and from Recodo of Paniquian Island, Port Galera. Others from Saint Paul Bay, Palawan. Rays 4 to 7. Color resembles that of the bottom where they are found, speckled with reddish green of various shades.

Abactinal plates covered with stout, short, and stunted spines, appearing like granules. Actinal plates with single large pointed spine. Furrow spines 3, marginal mouth spines 4. R, 12 millimeters; r, 10. University of the Philippines E-598, E-740.

ASTERINA CORONATA EUERCES Fisher. Plate 4, fig. 20.

Asterina cristata euerces FISHER (1917).
Asterina coronata euerces FISHER (1918, 1919).

Small starfishes found under rocks near Gabino Point, Varadero Bay. Color in life, a combination of brownish gray and deep green on aboral side; brownish gray confined to interbrachial region and tip of rays; latter color confined to central disc and rays, except anal opening. Oral side yellowish brown speckled with dirty green patches. Abactinal secondary plates and papulæ few. Abactinal spinelets smaller and more pointed or less united at base, forming a tuft of spinelets, some of which are crescent-shaped. Those of disc, around anal region, smaller. Tufts of 4 or 5 spinelets on actinal side more or less uniform. One series of adambulacral spines with 7 or 8 furrow spines and 8 or 9 marginal mouth spines. R, 18 millimeters; r, 9. University of the Philippines E-632, E-949.

ASTERINA CORONATA PUERTO-GALERÆ subsp. nov. Plate 4, figs. 23 and 24.

Collected from North Channel of Port Galera Bay. Resembles *Asterina coronata euerces* in number of spinelets (10 to 15) on inconspicuous abactinal plates of radial part of ray and of actinal plates adjacent to adambulacral plates (4 or 5). Resembles *Asterina coronata cristata* in the absence of abactinal pedicellariæ and in the number of furrow spines, usually 6. Differs from both in number of marginal mouth spines (15) and in their being united by a membrane leaving the distal fifth free. It resembles both in general appearance as well as in size. Biggest specimen: R, 18 millimeters; r, 8. Type specimen of new subspecies (University of the Philippines E-626) deposited in the Philippine National Museum.

Family ECHINASTERIDÆ Verrill

Abactinal skeleton reticulate, often irregular, formed of small imbricating plates, bearing isolated or grouped spines. Disc sometimes large but usually small, with rays elongate and often subcylindrical. Septum single, interbrachial. Actinostomial margin defined by adambulacral plates. Ambulacral tube feet biserial. Pedicellariæ rarely present.

Subfamily ACANTHASTERINÆ Sladen

Disc large, rays numerous. Armed with large isolated spines covered with membrane beset with calcareous granules. Madreporiform bodies numerous. Forciform pedicellariæ present.

Genus ACANTHASTER Gervais (1841)

ACANTHASTER PLANCI (Linnæus). Plate 8, fig. 41; Plate 16, fig. 99; Plate 17, figs. 104 and 105.

Asterias planci LINNÆUS, 1758.
Asterias echinites ELLIS and SOLANDER (1786).
Stellonja echinites AGASSIZ (1835).
Echinaster ellisi (*part*) GRAY (1840).
Acanthaster echinus GERVAIS (1841).

Echinaster solaris MÜLLER and TROSCHEL (1842).
Acanthaster echinites LUTKEN (1871); PERRIER (1875); DÖDERLEIN (1888).
Acanthaster planci VERRILL (1914); FISHER (1919); CLARK (1921).

Common among corals and rocks in Port Galera Bay and Sabang Cove. The largest specimen so far collected measures 100 millimeters in diameter from tip to tip of ray. Aboral side with a general background of grayish blue, distal three-fourths of ray uniformly blue, the lateral together with proximal fourth mottled with purple and red granules; disc bluish, mottled with light yellowish and purplish granules; base of column of spines uniformly bluish black. Abactinal spines long, acicular, borne on high columns or pedicels; spines of disc, including pedicels, 10 to 25 millimeters long, those at distal two-thirds of ray usually much stouter and longer, 25 to 40 millimeters. Actinal spines with fine granulation, or in large part nearly smooth; 3 conspicuous furrow spines with very short, stubby spinelets at both ends; madreporites 4 to 8. Rays 12 to 17; average length of ray 120 millimeters; $R = 2r$. University of the Philippines E-685, E-744, E-745, E-760, E-843, E-894, E-1031.

ACANTHASTER MAURITIENSIS de Loriol. Plate 8, fig. 42.

Acanthaster mauritiensis DE LORIOL (1885).

Only one specimen obtained from "ship-wreck point" of Varadero Bay. Color duller than in *A. planci;* tip of spines slightly pinkish orange. Abactinal spines distinctly short, 3 to 4 millimeters, those of disc not reaching one-sixth the length of ray. Spines of ray 5 to 7 millimeters, slightly longer than those of disc. Furrow spines 3, middle spine much larger than the lateral ones. Rays 15; R, 43 millimeters; r, 25. University of the Philippines E-1032.

Subfamily ECHINASTERINÆ Viguier

Disc small or medium-sized, rays 5 or 6. Spinulation small and simple; spinelets isolated or in groups. Pedicellariæ absent.

Genus ECHINASTER Müller and Troschel (1840)

ECHINASTER CALLOSUS von Marenzeller. Plate 13, figs. 71 and 72; Plate 17, figs. 106 and 107.

Echinaster callosus VON MARENZELLER (1885); KOEHLER (1910); FISHER (1919).

Found among corals in Port Galera Bay, near Northwest Channel. Disc quite small, rays a trifle swollen above base.

Papular areas sharply limited by superomarginal plates, no intermarginal or actinal papulæ. Rods irregularly branched, scattered on outer layer of integument. Stout conical spine on every fourth or fifth superomarginal and inferomarginal. Similar large tubercular spines found irregularly scattered all over abactinal surface. Average length of arm 80 millimeters; arms of largest specimen 150 millimeters long. University of the Philippines E-610, E-741.

ECHINASTER LUZONICUS (Gray). Plate 5 fig. 29; Plate 13, fig. 73.

Othilia luzonica GRAY (1840).
Othilia eridanella MÜLLER and TROSCHEL (1842); PERRIER (1875); DE LORIOL (1893); DÖDERLEIN (1896); KOEHLER (1910).
Echinaster eridanella MÜLLER and TROSCHEL (1842); CLARK (1921).
Echinaster luzonicus MÜLLER and TROSCHEL (1842); CLARK (1921).

Apparently common among corals in Port Galera Bay. Abactinal side dark olive brown. A few specimens almost black, roughened with fine spines irregularly intermixed with single pore papulæ. Preserved specimens rusty or red-brown, or light er with slight shade of orange-brown. Retracted papulæ resembling sunken pits. Surface of disc and ray corrugated. Oral surface slightly lighter in color. Rays 4 to 7, 6 in most specimens, cylindrical, often very slender, not uniform in length; adambulacral plates usually with a distinct subambulacral spinelet, so that no conspicuous bare area on each side of the furrow is visible; actinal spinelets numerous and small. Occasionally a single arm regenerates into a whole animal. One specimen has a small bud with four rays attached to the abactinal disc, apparently caused by injury followed by regeneration. Average length of ray 70 millimeters, longest 100; radius of disc 15. University of the Philippines E-608, E-619, E-669, E-731, E-755, E-756, E-897.

ECHINASTER PURPUREUS Savigny. Plate 16, figs. 100 to 103.

Echinaster purpureus SAVIGNY (1809); GRAY (1866); CLARK (1921).
Othilia purpurea GRAY (1840); FISHER (1919).
Echinaster fallax MÜLLER and TROSCHEL (1842); PERRIER (1875); DE LORIOL (1885); KOEHLER (1910).

A rare species found with *E. luzonicus* in the same coral-reef region. Differs from *E. luzonicus* in having stout and terete rays. Subambulacral spinelets absent, a wide bare space with or without spinelets near marginal spinelet. One specimen with 5 rays of unequal length and one with 7. Resembles *E. luzonicus* in color and in general appearance. University of the Philippines E-730, E-885.

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ILLUSTRATIONS

PLATE 1

FIG. 1. *Astropecten polyacanthus*, aboral side (E-801).
2. *Astropecten polyacanthus*, oral side (E-801).
3. *Astropecten polyacanthus*, aboral side (partly destroyed) (E-754).
4. *Astropecten polyacanthus*, oral side (E-754).
5. *Astropecten phragmorus*, aboral side (E-1005).
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PLATE 2

FIG. 7. *Astropecten polyacanthus*, aboral side (E-684).
8. *Astropecten polyacanthus*, oral side (E-684).
9. *Ophidiaster granifer*, aboral side (E-602).
10. *Ophidiaster granifer*, oral side (E-602).
11. *Linckia multifora*, aboral side (E-721).
12. *Linckia multifora*, oral side (E-721).

PLATE 3

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15. *Archaster typicus*, aboral side (E-749).
16. *Archaster typicus*, oral side (E-749).
17. *Archaster typicus*, aboral side (E-785).
18. *Archaster typicus*, oral side (E-785).

PLATE 4

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20. *Asterina coronata euerces*, aboral and oral sides (E-953).
21. *Hippasteria philippinensis* sp. nov., aboral side (E-953).
22. *Hippasteria philippinensis* sp. nov., oral side (E-953).
23. *Asterina coronata puerto-galeræ* subsp. nov., aboral side (E-626).
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PLATE 5

FIG. 25. *Pentaceropsis tyloderma*, aboral side (E-836).
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27. *Pentaceropsis tyloderma* var. *mindorensis* var. nov., aboral side (E-1034).
28. *Oreaster nodosus*, aboral side (E-886).
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30. *Stellaster incei*, oral and aboral sides (E-783).

PLATE 6

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PLATE 7

FIG. 35. *Culcita novæ-guineæ* var. *plana,* aboral side (E-848).
36. *Culcita novæ-guineæ* var. *plana,* oral side (E-848).
37. *Culcita novæ-guineæ* var. *acutispinosa,* aboral side (E-849).
38. *Culcita novæ-guineæ* var. *acutispinosa,* oral side (E-849).

PLATE 8

FIG. 39. *Culcita novæ-guineæ* var. *plana,* aboral side (E-926).
40. *Culcita novæ-guineæ* var. *acutispinosa,* aboral side (E-914).
41. *Acanthaster planci,* aboral side (E-843).
42. *Acanthaster mauritiensis,* aboral side (E-1032).
43. *Gymnasteria carinifera,* aboral side (E-714).
44. *Gymnasteria carinifera,* oral side (E-714).

PLATE 9

FIG. 45. *Fromia japonica,* aboral side (E-772).
46. *Fromia japonica,* oral side (E-772).
47. *Fromia elegans,* aboral side (E-600).
48. *Fromia elegans,* oral side (E-600).
49. *Fromia eusticha,* aboral side (E-771).
50. *Fromia eusticha,* oral side (E-771).

PLATE 10

FIG. 51. *Fromia elegans,* aboral side (E-892).
52. *Fromia elegans,* oral side (E-892).
53. *Nardoa pauciforis,* aboral side (E-750).
54. *Nardoa pauciforis,* oral side (E-750).
55. *Nardoa lemonnieri* aboral side (E-872).
56. *Nardoa lemonnieri,* oral side (E-872).

PLATE 11

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59. *Nardoa novæ-caledoniæ,* aboral side (E-874).
60. *Nardoa novæ-caledoniæ,* oral side (E-874).
61. *Nardoa mollis,* aboral side (E-873).
62. *Nardoa mollis,* oral side (E-873).

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FIG. 63. *Nardoa pauciforis,* aboral side (E-596).
64. *Nardoa pauciforis,* oral side (E-596).
65. *Nardoa frianti,* aboral side (E-891).
66. *Nardoa frianti,* oral side (E-891).
67. *Nardoa squamulosa,* aboral side (E-891).
68. *Nardoa squamulosa,* oral side (E-875).

PLATE 13

FIG. 69. *Ophidiaster squameus,* aboral side (E-948).
70. *Ophidiaster squameus,* oral side (E-948).
71. *Echinaster callosus,* aboral side (E-610).
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PLATE 14

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75. *Culcita novæ-guineæ* var. *acutispinosa,* aboral side (E-1050).
76. *Halityle regularis,* aboral side (E-842).
77. *Halityle regularis,* oral side (E-842).
78. *Pentaceropsis tyloderma,* aboral side (E-1033).
79. *Pentaceropsis tyloderma,* aboral side (E-950).
80. *Linckia guildingii,* aboral side (E-672).
81. *Linckia guildingii,* oral side (E-672).
82. *Oreaster nodosus* var. *honduræ* var. nov., aboral side (E-1044).
83. *Linckia lævigata* var. *honduræ* var. nov., oral and aboral sides (E-1040).

PLATE 15

FIG. 84. *Culcita novæ-guineæ* var. *typica,* aboral side (E-739).
85. *Culcita novæ-guineæ* var. *typica,* oral side (E-739).
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87. *Choriaster granulatus,* oral side (E-856).
88. *Oreaster doederleini,* aboral side (E-857).
89. *Linckia lævigata,* aboral and oral sides (E-605).
90. *Oreaster nodosus,* aboral side (E-752).
91. *Linckia lævigata,* aboral side (E-927).

PLATE 16

FIG. 92. *Culcita novæ-guineæ,* aboral side (E-847).
93. *Culcita novæ-guineæ,* oral side (E-847).
94. *Gymnasteria carinifera,* aboral side (E-736).
95. *Gymnasteria carinifera,* oral side (E-736).
96. *Culcita novæ-guineæ* var. *typica,* aboral side (E-851).
97. *Culcita novæ-guineæ* var. *typica,* oral side (E-851).
98. *Culcita novæ-guineæ* var. *plana,* aboral side (E-895).
99. *Acanthaster planci,* aboral side (E-744).
100. *Echinaster purpureus,* aboral side (E-730).
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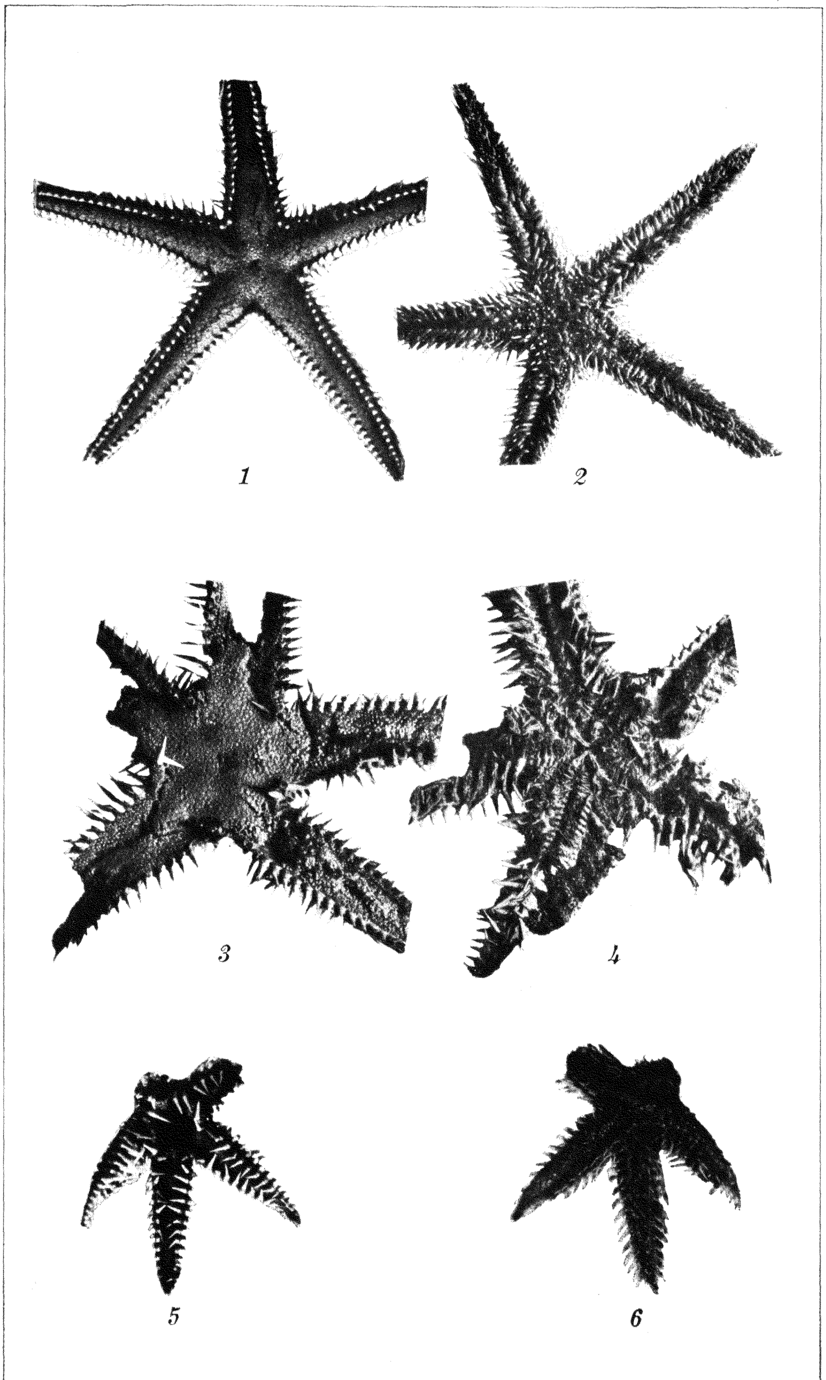
PLATE 17

FIG. 104. *Acanthaster planci,* aboral side (E-745).
105. *Acanthaster planci,* oral side (E-745).
106. *Echinaster callosus,* aboral side (E-741).
107. *Echinaster callosus,* oral side (E-741).
108. *Leiaster speciosus,* oral side (E-746).
109. *Leiaster speciosus,* oral side (E-746).



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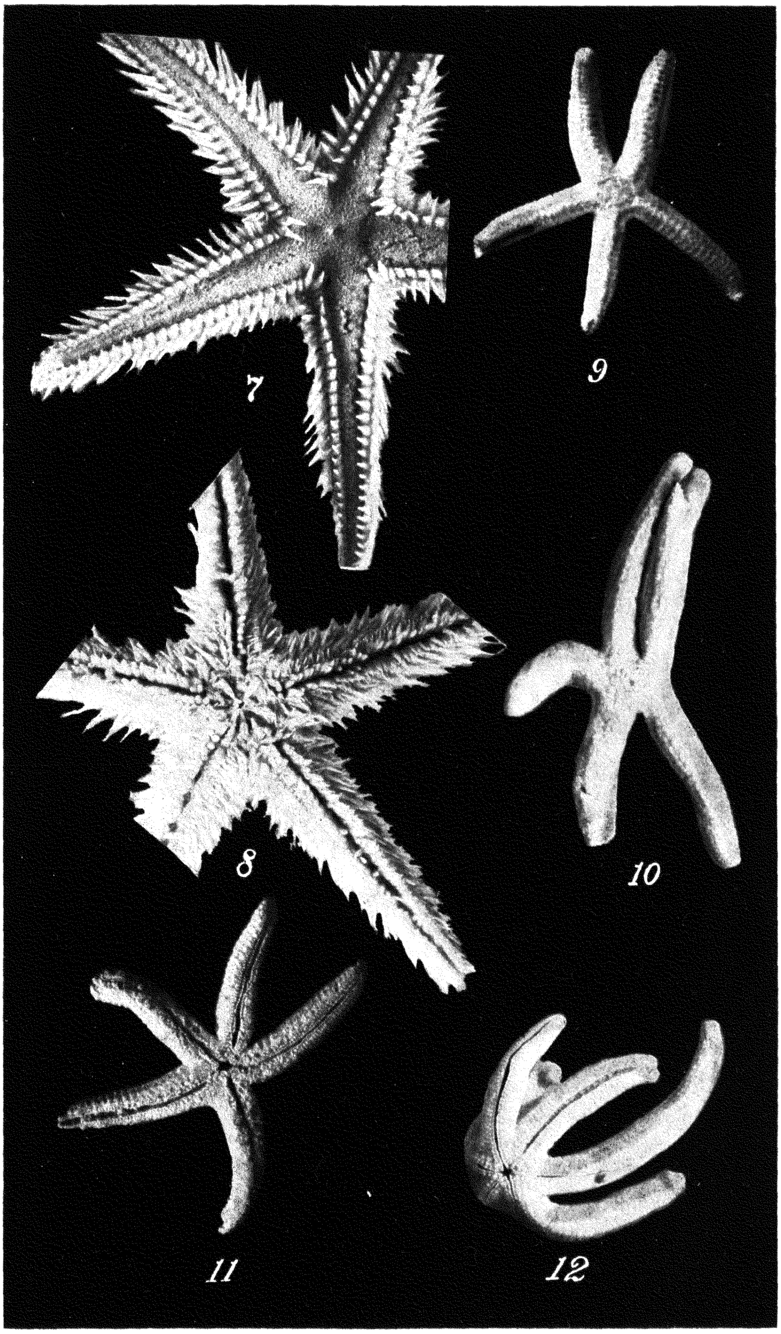

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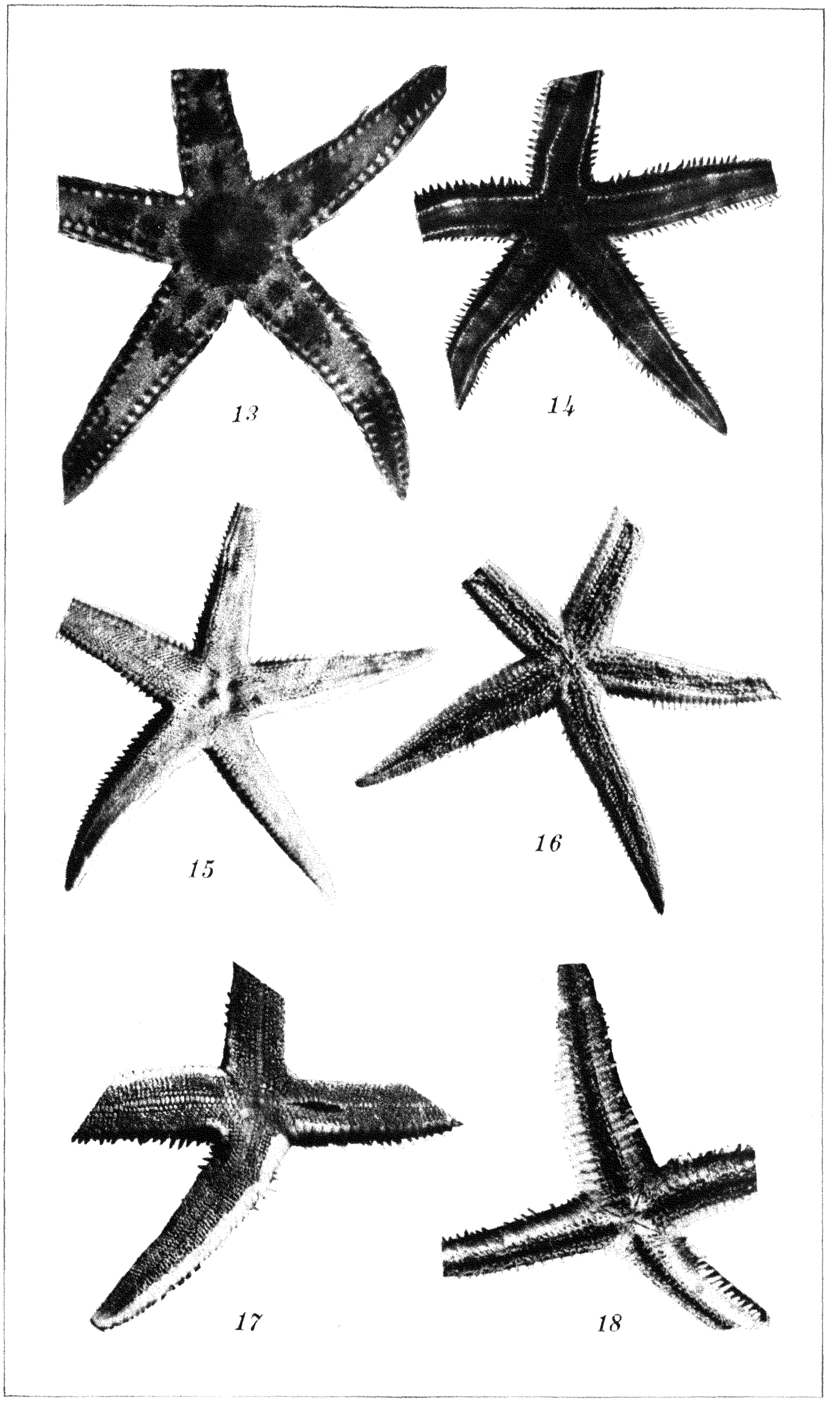

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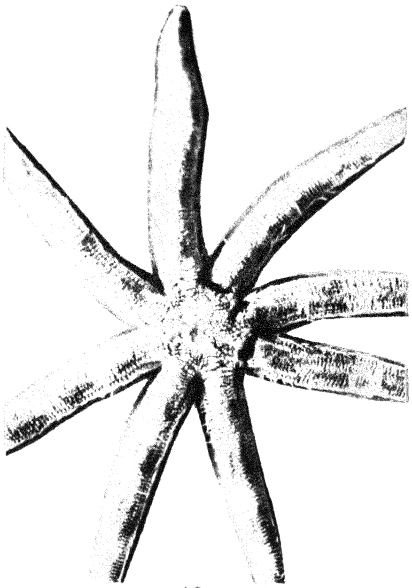

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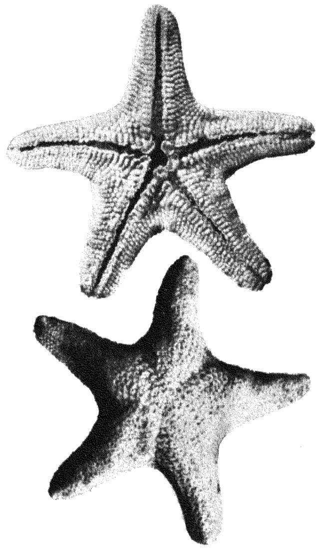

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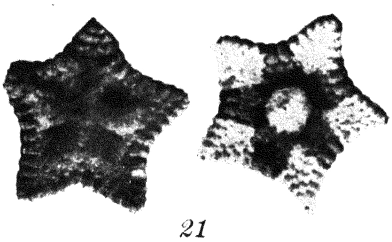

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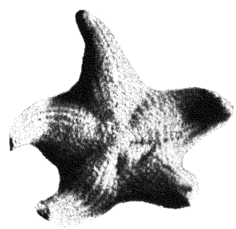

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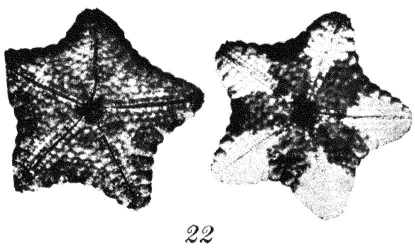

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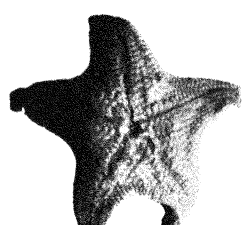

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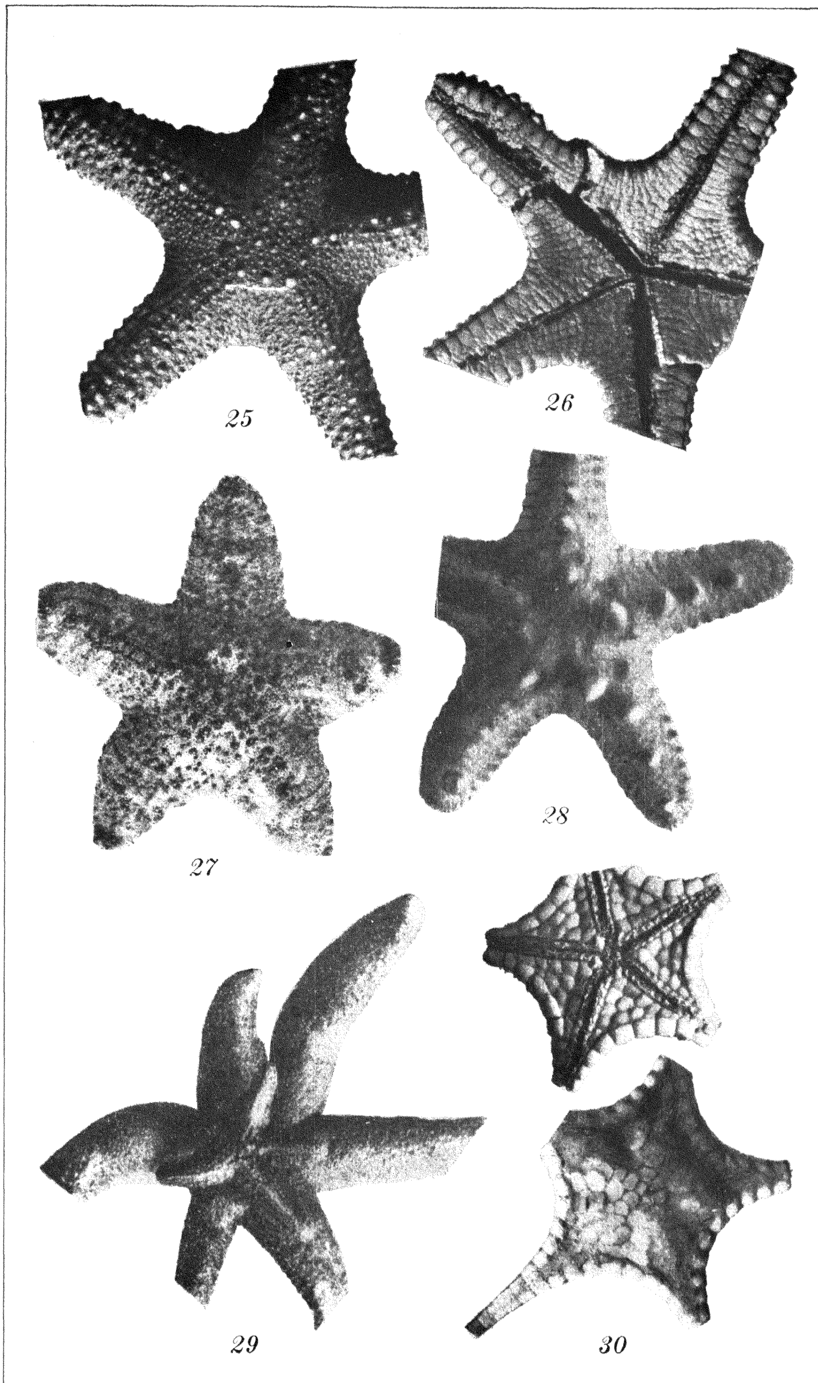

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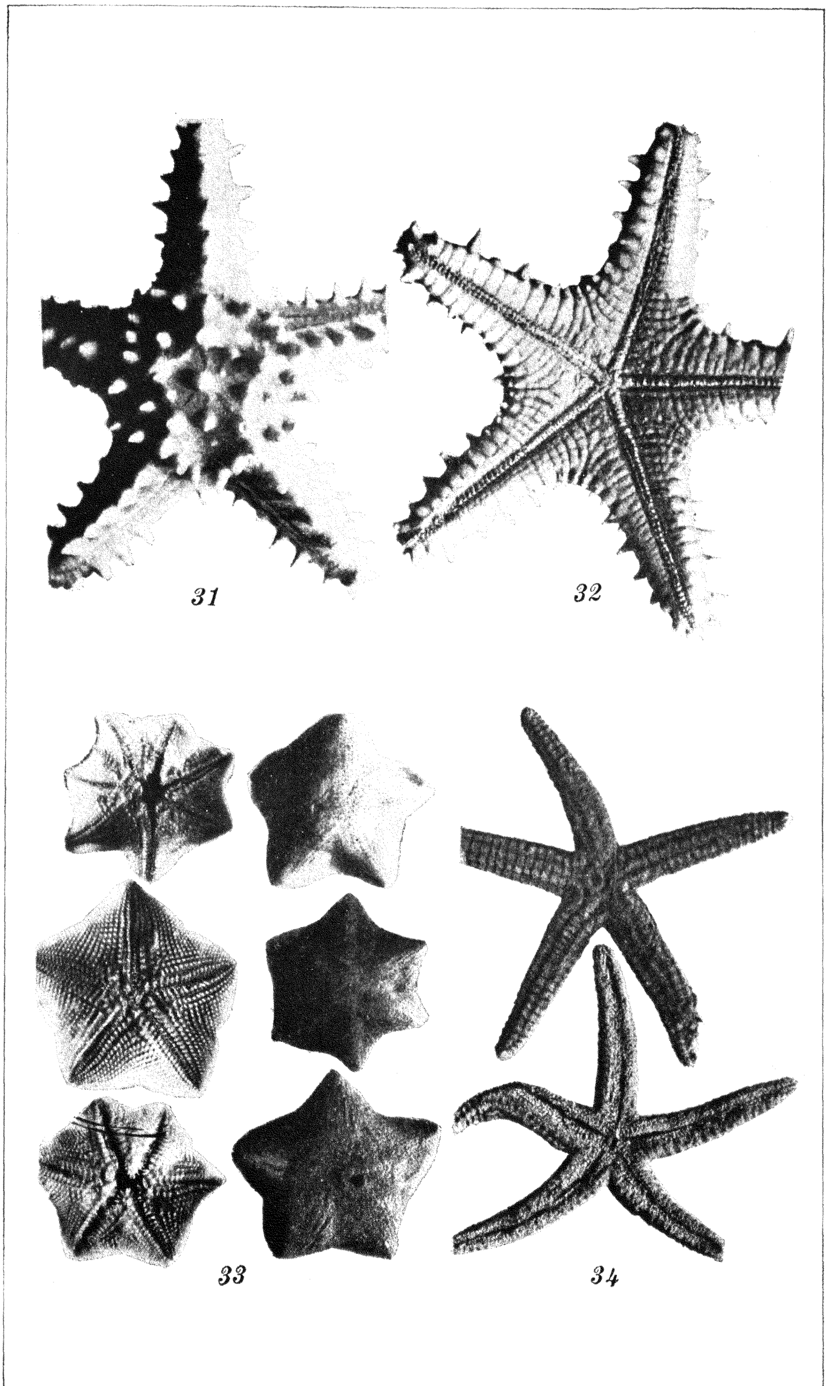

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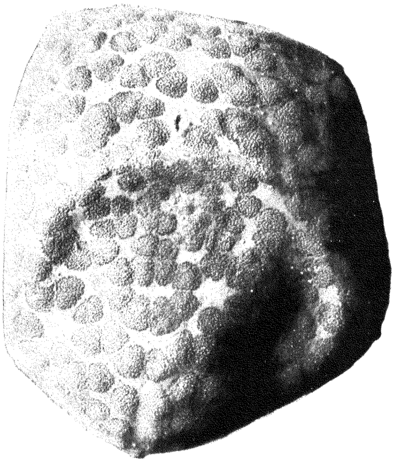

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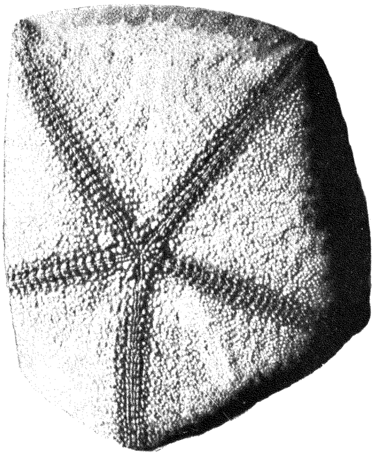

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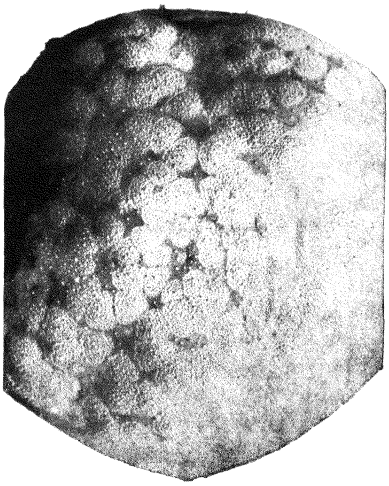

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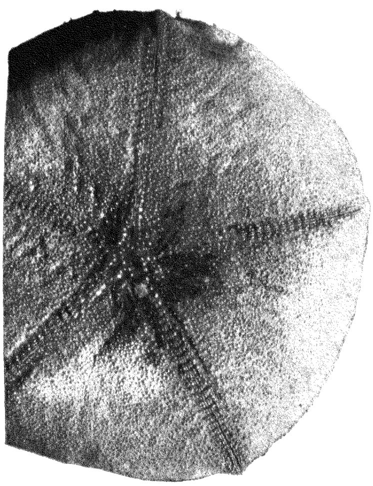

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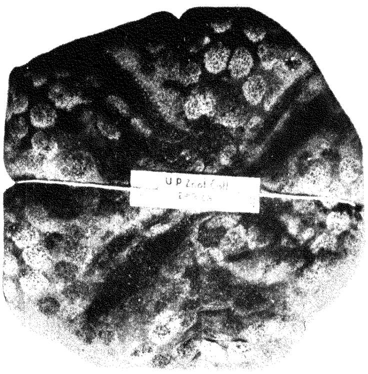

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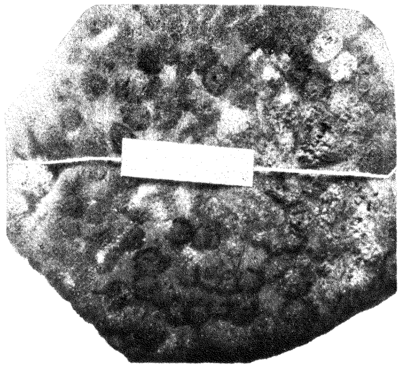

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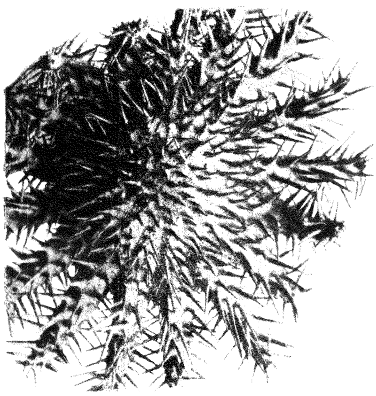

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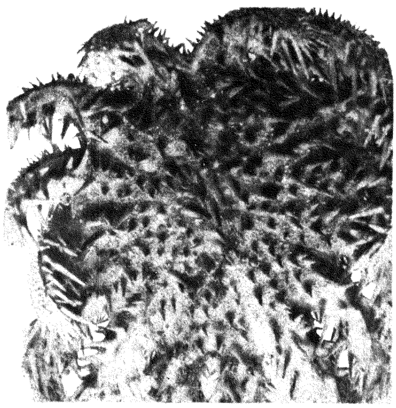

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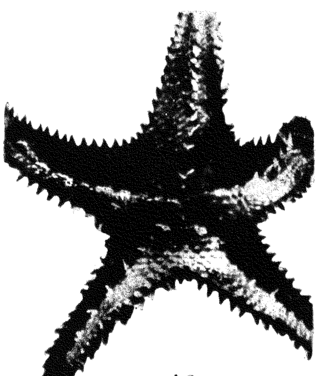

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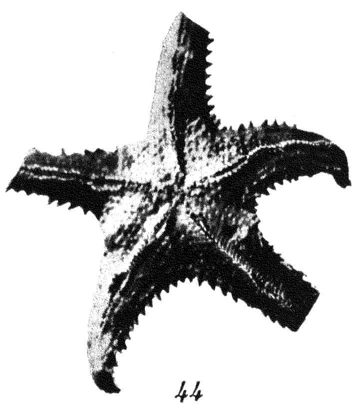

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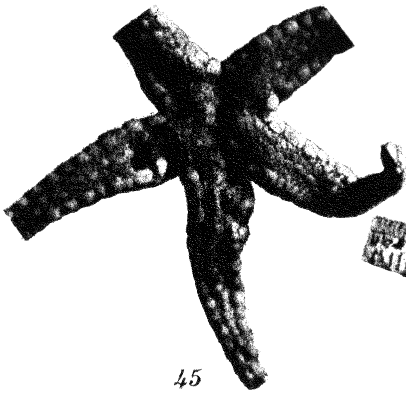

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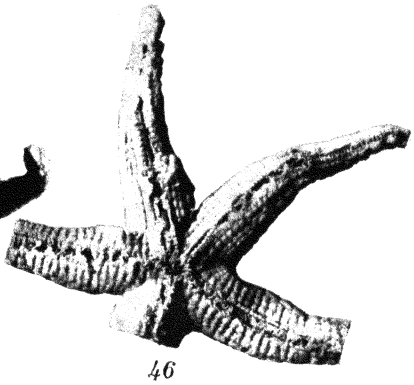

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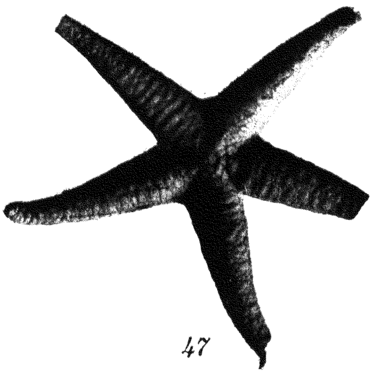

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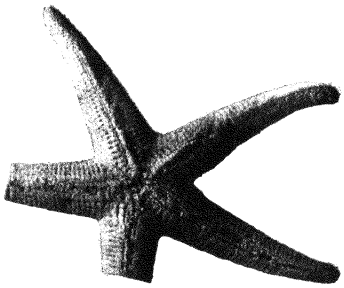

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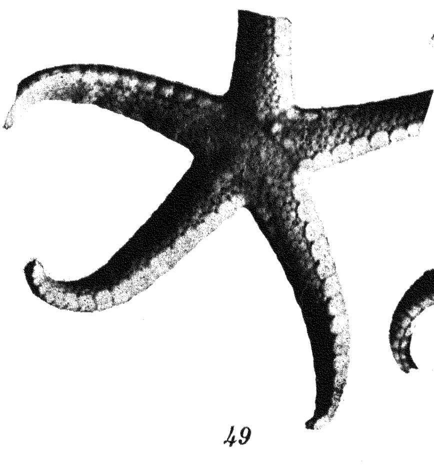

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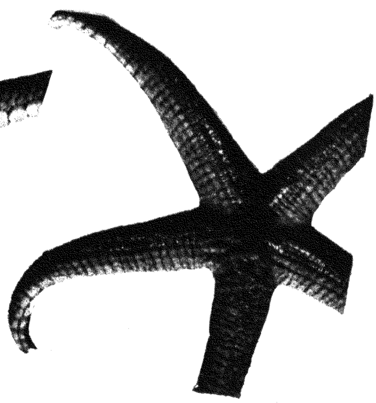

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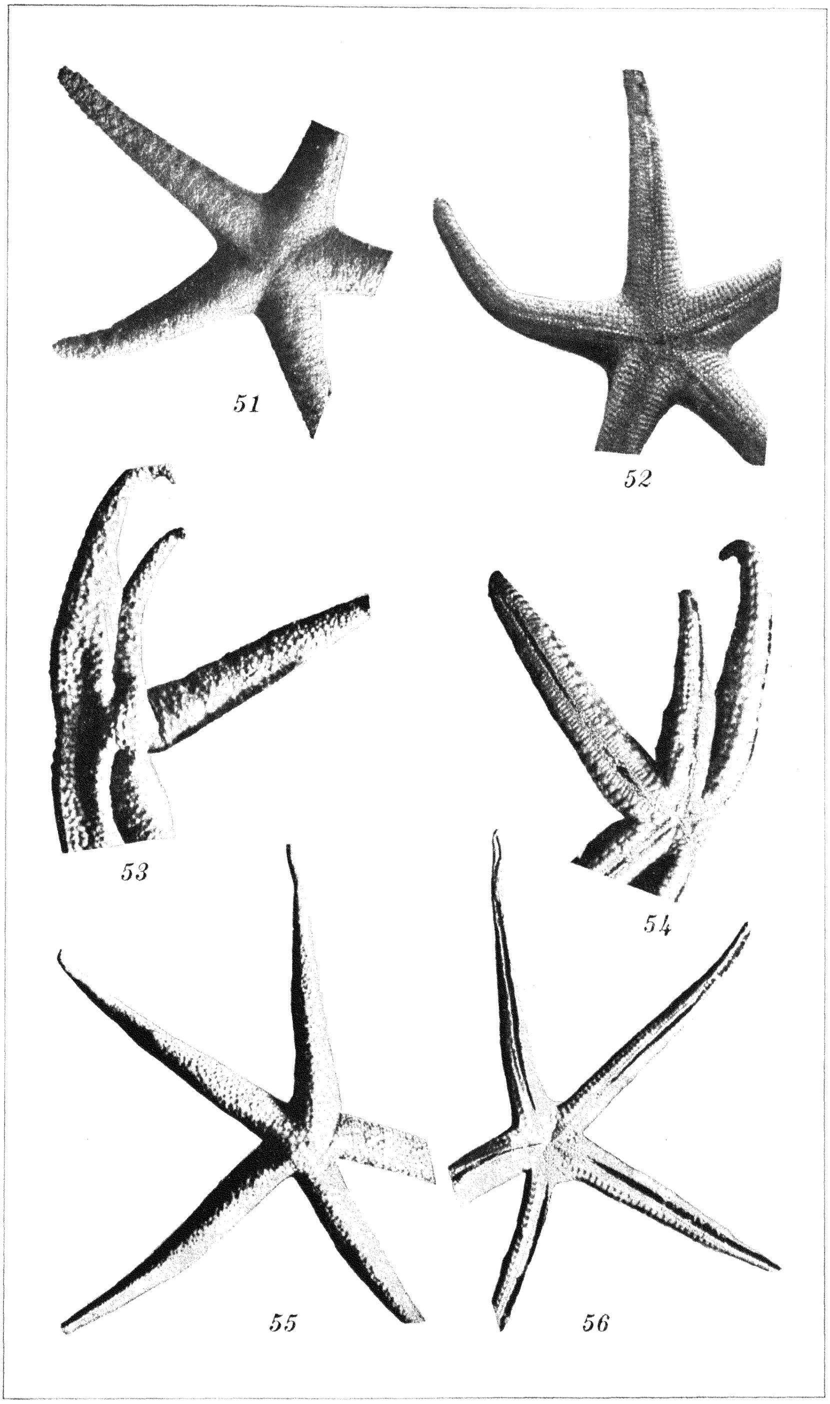

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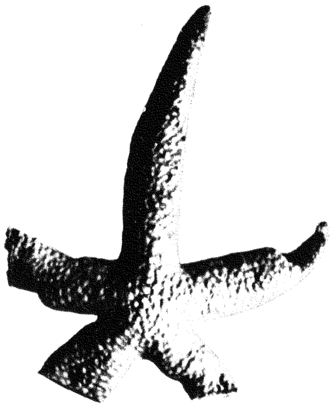

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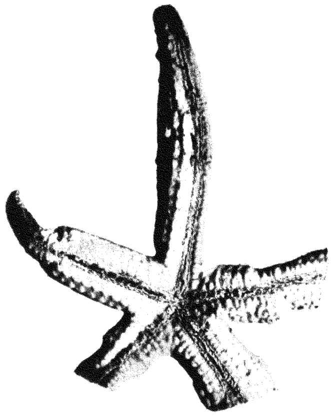

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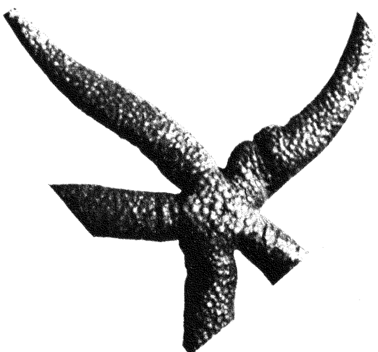

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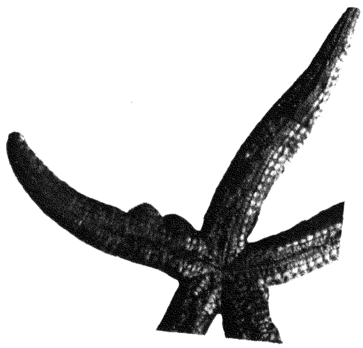

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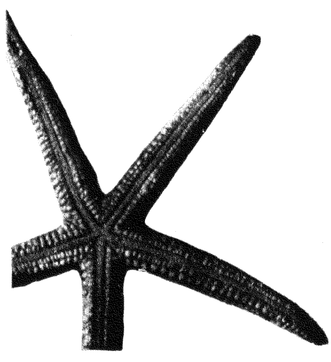

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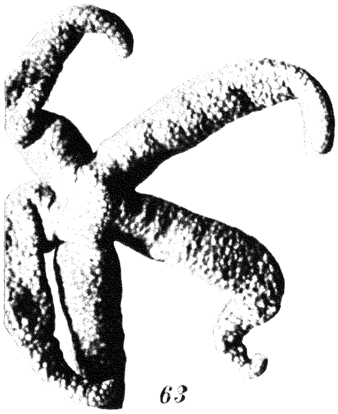

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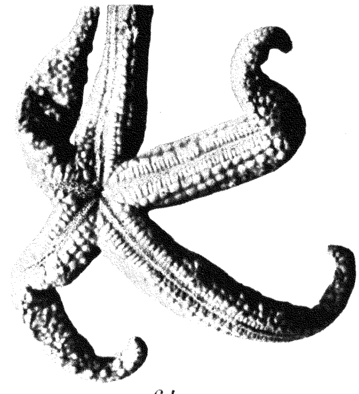

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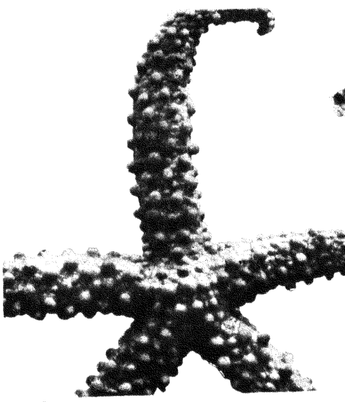

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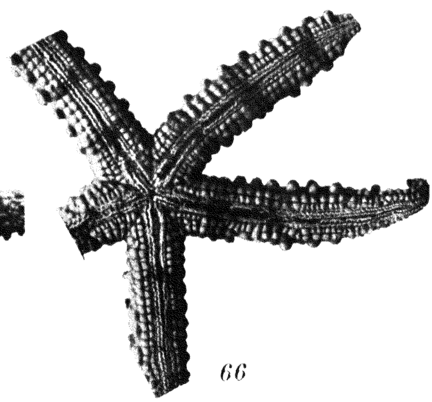

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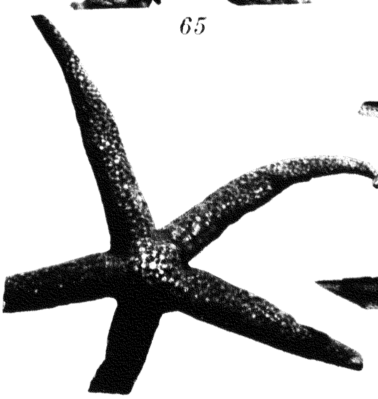

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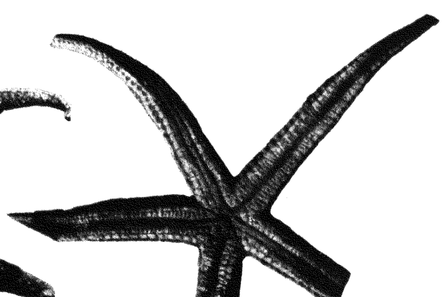

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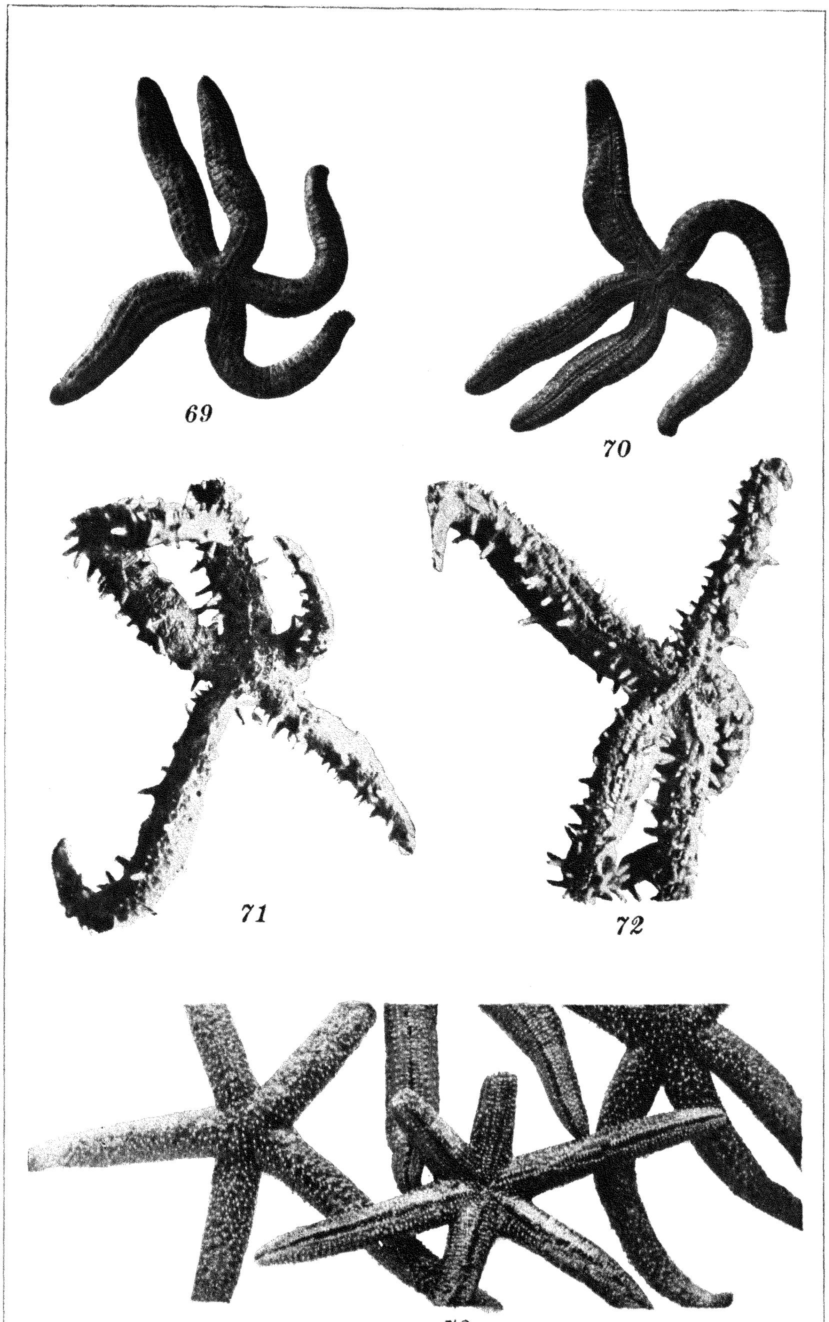

PLATE 13.

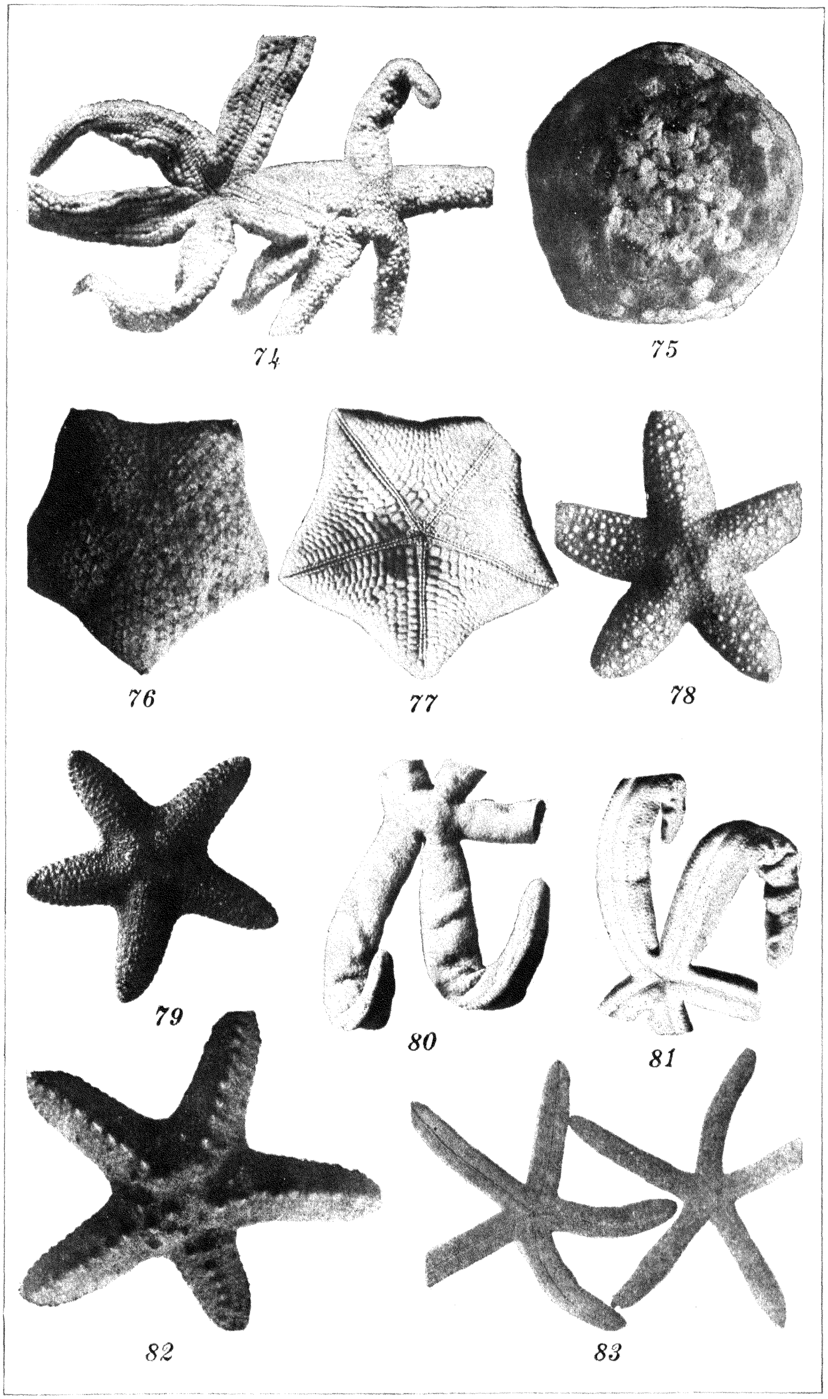

PLATE 14.

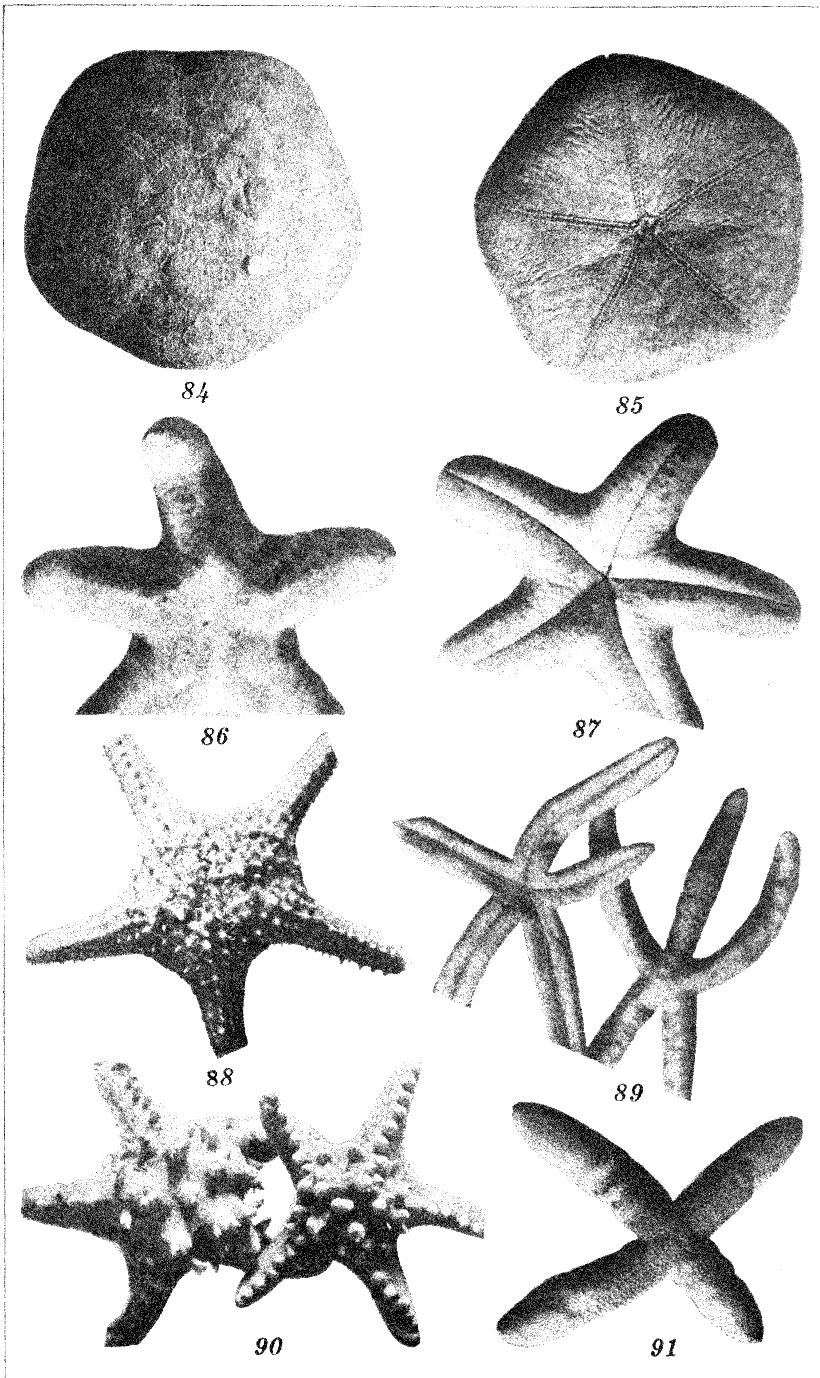

PLATE 15.

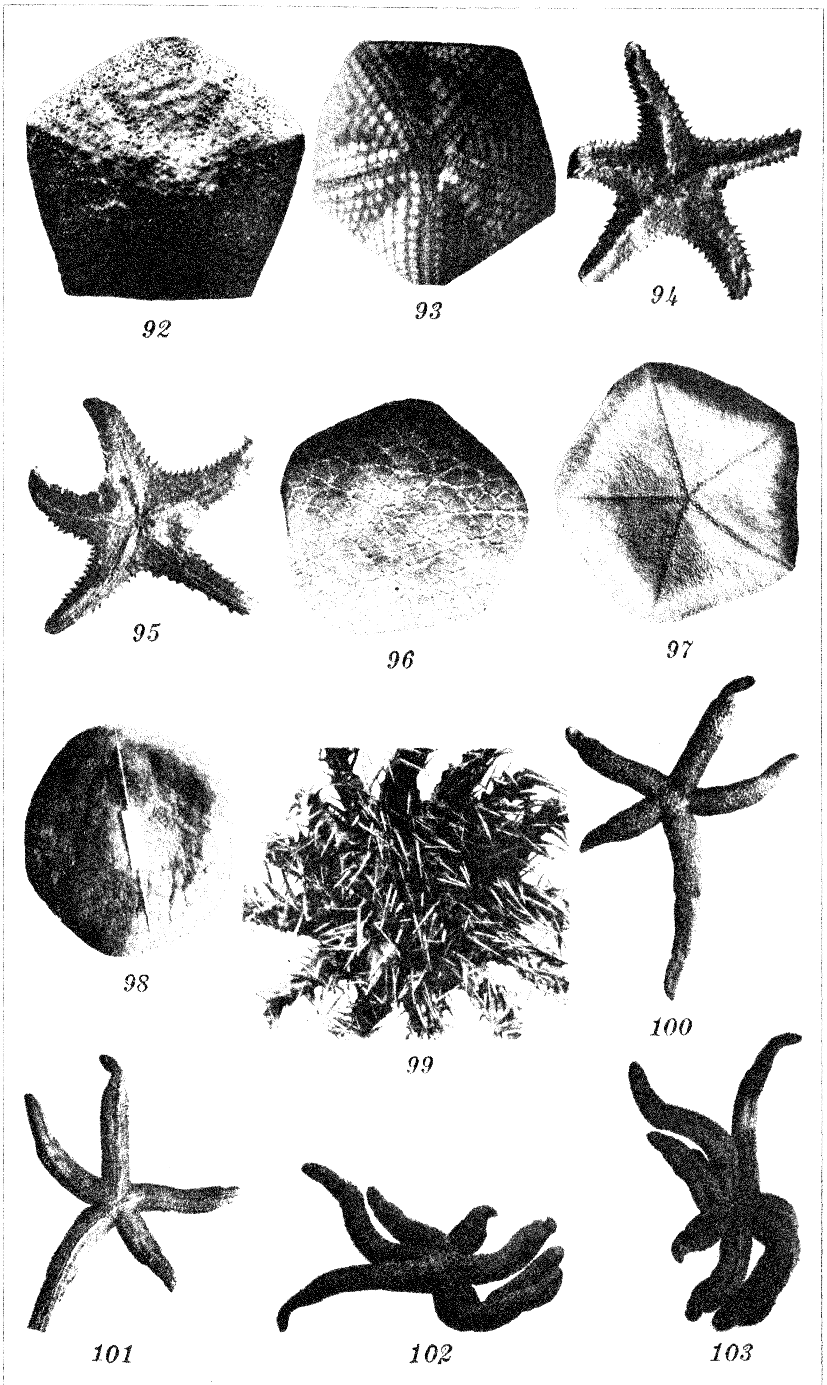

PLATE 16.

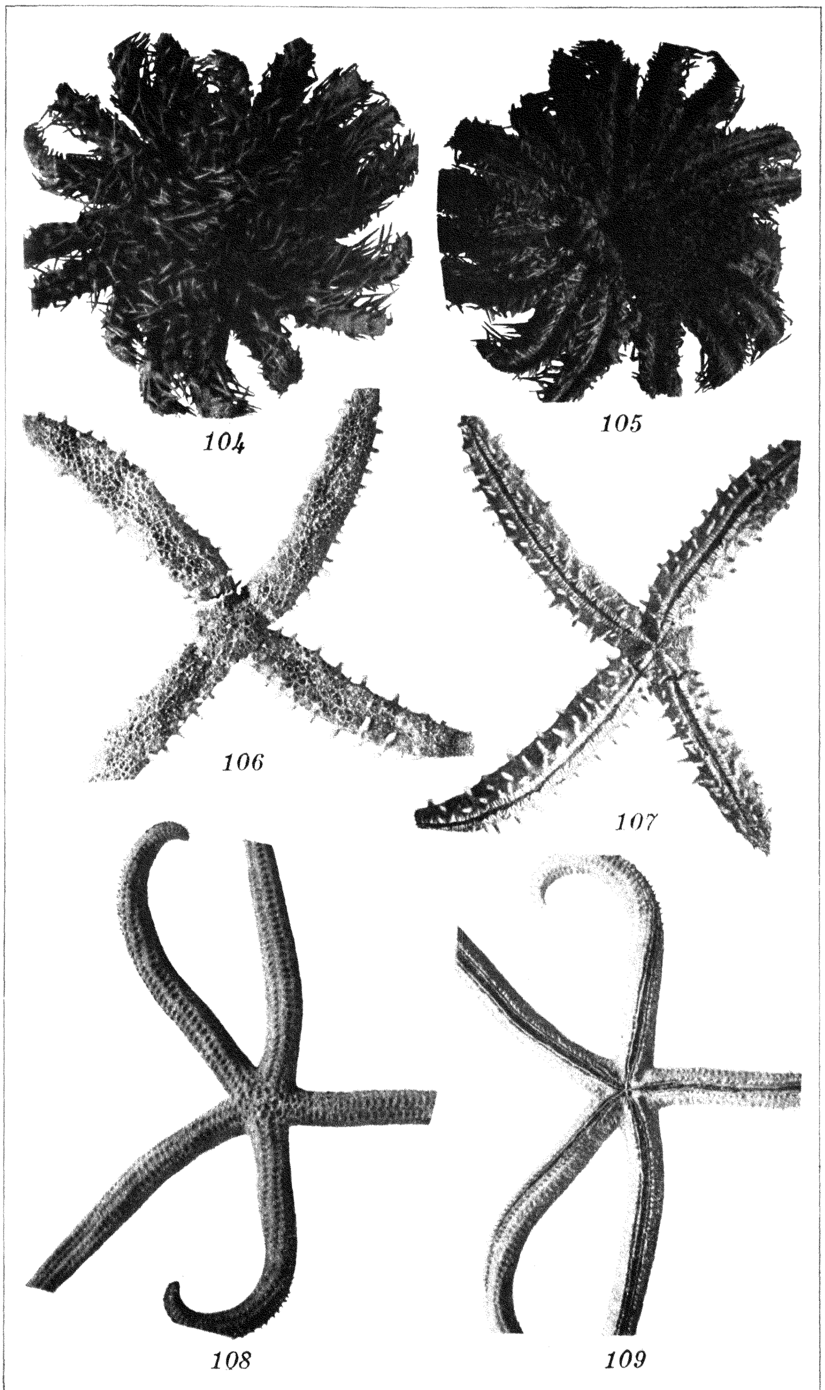

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PLATE 17.

ECOLOGICAL STUDIES ON MARINE RELICS AND LAND-LOCKED ANIMALS IN INLAND WATERS OF NIPPON

By Denzaburo Miyadi

Of the Seto Marine Biological Laboratory, Nippon

TWO TEXT FIGURES

During my investigations on the fresh-water fisheries and benthonic fauna of Japanese lakes I had opportunity to observe many marine relics and land-locked animals. As these animals have so far received very little attention on the part of zoölogists, I will here give a review of them from the ecological and zoögeographical points of view.

MARINE RELICS

By marine relics we understand those animals which have been cut off from the ocean and which persisted in bodies of water that gradually became fresh, so that they finally became fresh-water forms. Original stocks of them usually exist in the ocean, but no active immigration is possible under the present conditions. There are also many animals which have recently taken up life in fresh water by slowly migrating up rivers, and occasional visitors from the sea, but these are left out of consideration in this paper. We must here remember that no large groups of animals, except perhaps bony fishes, are believed to originate outside of the ocean, and the fresh-water fauna was formed by the oboceanic migration of marine animals.

In Nippon there are many marine relics, of which the animals enumerated below are representative. Nippon has never been subjected to glaciation, except in the high mountain regions, and accordingly our marine relics have a different origin from those found in some European and North American lakes, where they are closely associated with the glacial period. Our marine relics are distributed only in the lakes of marine origin (text fig. 1).

Neomysis intermedia (*Czerniavsky*) [*Schizopoda*].—This animal is found in numerous relic lakes of marine origin in Kamchatka, northern and southern Kuriles, Saghalin, Hokkaido, and

Honshu. In some lakes on the Japan seacoast of southern Honshu there occurs a closely related species, *Neomysis awatschensis* (Brand).

Exosphæroma oregonensis Dana [*Isopoda*].—The range of distribution of this animal includes Kamchatka, Alaska, Nippon, and southern China. In Nippon it is very common in the lakes of Kunasiri-sima (southern Kuriles). Curiously it is replaced in the neighboring island Etorohu-sima by *E. chinensis* Tat-

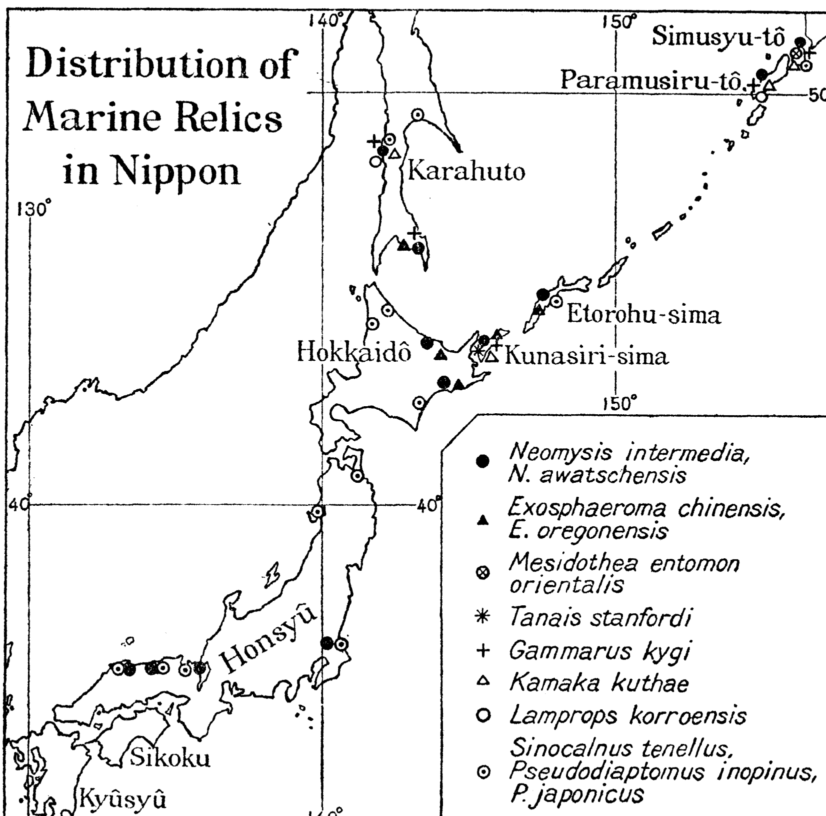

FIG. 1.

tersal, which was first described from brackish water near Shanghai, southern China. The list of localities of these animals may possibly be enriched by further research of relic lakes, especially on the Japan seacoast of Honshu.

Mesidothea entomon orientalis Gurjanowa [*Isopoda*].—*Mesidothea entomon* and its subspecies are distributed widely near the coast in the circumboreal regions and often appear in fresh water as marine relics. I have collected this animal in Bettobu-numa, Simusyu-to (northern Kuriles). Although this lake is somewhat tidal, the water is not very salty, and contains a chironomid of the *plumosus* group.

Tanais stanfordi Richardson [*Tanaidacea*] (*text fig. 2*).—This interesting animal was collected by the writer in two fresh-water lakes, Nikisiro-ko and Tohutu-ko, in Kunasiri-sima (southern Kuriles) and studied by Stephenson (1936). Another locality is a lagoon lake in Clipperton Island (about 10° north latitude and 112° west longitude) in the southern Pacific Ocean. No other species belonging to Tanaidacea is known to occur in fresh water.

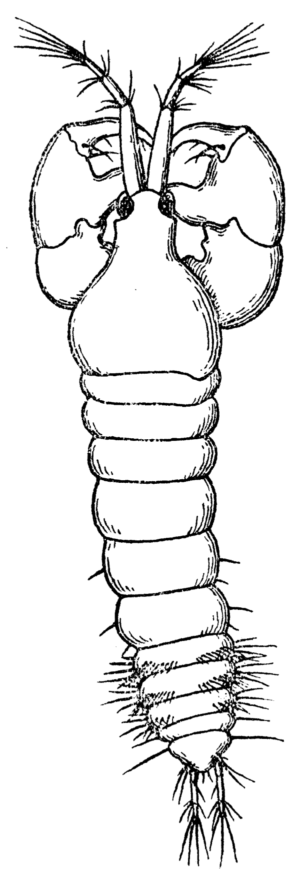

FIG. 2. *Tanais stanfordi* Richardson. (After K. Stephenson.)

Gammarus kygi Dershavin [*Amphipoda*].—This relic crustacean was found in some lakes in southern Saghalin, and northern and southern Kuriles. In Simusyu-to (northern Kuriles) it is restricted to the relic lakes near the seashore, while the lakes on the plateau are inhabited by *Gammarus pulex*.

Kamaka kuthæ Dershavin [*Amphipoda*].—An inhabitant of lagoon lakes of Kamchatka, southern Saghalin, and northern Kuriles.

Lamprops korroensis Dershavin [*Cumacea*].—This animal has the same distribution as *Kamaka kuthæ*. It occurs abundantly on shallow sandy bottoms.

Sinocalanus tenellus (*Kikuchi*) [*Copepoda*].—This copepod is found in the plankton in some lakes of southern Saghalin and Etorohu-sima (southern Kuriles). Its distribution is very wide, including Kamchatka, Alaska, Siberia, and China. Besides this species there are other relic copepods, such as *Pseudodiaptomus inopinus* Burkhart (in Kasumiga-ura and Koyama-ike in Honshu, and *P. japonicus* Kikuchi (in Suigetu-ko and Togo-ike in Honshu). The geographical distribution of these animals was well studied by Kikuchi.(4)

Platichthys stellatus (Pallas) and Kareius bicoloratus Basilewski [*Pleuronectidæ*].—Although it is somewhat inappropriate to include these flatfishes among marine relics because they are found in the estuaries too, they never appear in fresh-water lakes except in those of marine origin.

LAND-LOCKED ANIMALS

Land-locked animals are those confined in fresh-water habitats and which have lost their traditional habit of communicating between the ocean and the inland waters in the spawning season. While most marine relics are crustaceans, all land-locked animals are fishes. Although there are two sorts of such migratory fishes, anadromous and katadromous, only the former have land-locked species among them. It is well known that salmonoid and certain other fishes ascend the rivers to spawn. In some species, however, the young fish loses the habit to go back to the sea and remains in the stream for life. With regard to the origin of anadromous habits, Johnstone suggests that salmons were originally marine fishes, and that they have developed the habit of spawning in fresh water in order to protect their eggs from marine enemies.(17) The following fishes are known as land-locked animals in Nippon.

Oncorhynchus masou Brevoort [*Salmonidæ*].—This fish is found in northern Honshu and Hokkaido. In Hokkaido it is land-locked imperfectly, in that all females and some of the males go downstream with the first spring flood of melting ice after the hatch, while the rest of the males remain in the stream where they reach sexual maturity. The males with different habits exhibit different appearances, and the sea-run form is locally called 'Ginke-yamame'.[1] It is remarkable that the same fish is land-locked near the headwaters of the river Daikokei in Taiwan, Formosa, at an altitude of over 1,500 meters, at about 24° 16′ north latitude and 121° 18′ east longitude.(13) The water temperature there is about 14.7 to 17.2° C. in July, nearly as low as that of the mountain streams in Honshu. This region is the southern limit for the distribution of Japanese salmons, and here the fish is marooned, because the water temperature of the lower courses of the river and the adjacent seas is too high for it. The discontinuous occurrence of this northern fish in this tropical region may be due to a cold climate in the past, of which the glacial topography on the high mountains of Taiwan supplies

[1] Silvery char.

ample evidence. Moreover, the infestation of Formosan *O. masou* by a nematode, *Cystidicola salvelini* (Fujita), which has been known as a parasite of some salmonoid fishes in Hokkaido and Honshu(24) may be an indication of the past history of this fish.

Oncorhynchus rhodurus Jordan and McGregor [*Salmonidæ*].—This fish is found land-locked in the mountain streams of southern Honshu and Kyusyu, and is distinguished from *O. masou* by pink spots on the body surface. In this species too, the adults are often caught in the sea.

Oncorhynchus nerka (*Walbaum*) [*Salmonidæ*].—The red salmon, *O. nerka,* in the northern Pacific, has a habit of ascending the river with a lake in its course, and the young fish stays some years in the lake before entering the sea. Two land-locked forms of this fish are known in Nippon, one in Akan-ko in Hokkaido and the other in Tazawa-ko in northern Honshu. The former race has been successfully transplanted into various lakes both in Hokkaido and the mountain regions of Honshu, and is often confused with *O. adonis* Jordan and McGregor. The latter is dusky in color, very slimy, and its name is a synonym of *O. kawamuræ* Jordan and McGregor.

Salvelinus pluvius Hilgendorf [*Salmonidæ*].—This fish is found in the headwaters of the rivers in Honshu, and exhibits considerable differences in coloration and form from the marine *Salvelinus.* In Sikaribetu-ko in Hokkaido, where the communication of marine fishes is made impossible by a cascade, is found another land-locked form, *S. miyabei* Oshima, which is more closely related to *S. malma* (Walbaum) in the northern seas.(15)

Plecoglossus altivelis Temminck and Schlegel [*Plecoglossidæ*].—This fish was formerly placed in the family Salmonidæ, and has a restricted distribution in the Far East. It ascends the clear rivers in spring and descends to the lower course to spawn in autumn of the same year. The young fish enters the sea and lives as a translucent fry near the coast. Very few fishes survive their first spawning, which takes place within a year after the hatch.

A dwarf land-locked race of this fish is found in Biwa-ko in central Honshu and Ikeda-ko in southern Kyushu. Its origin in the former lake is quite recent, dating from the construction of an artificial dam across the effluent in 1901–1904. It is successfully transplanted into several lakes which it cannot reach in nature, and when the young fish is transferred into rivers it attains nearly the same size as the anadromous one.

Hypomesus olidus Pallas [*Osmeridæ*].—This fish is found land-locked in some relic lakes, as Kasumiga-ura and Kita-ura in Honshu. Although it propagates very well in many mountain lakes which it can never reach in nature, it becomes smaller year by year in the new habitats.

Salangichthys microdon [*Salangidæ*].—This ice fish ascends the river for a short distance in spring to spawn. A land-locked type of it is found in Kasumiga-ura. It is very small, about 6 cm long instead of 12, like the anadromous fish, and has a roundish body.

This and the foregoing species never appear land-locked in fresh-water lakes except in those of lagoon origin, and they may also be called marine relics in a wide sense.

Gasterosteus aculeatus aculeatus (*Linnæus*) *and G. aculeatus microcephalus* (*Girard*) [*Gasterosteidæ*].—*G. a. aculeatus* is distributed in northern Nippon as far as Kyushu,(1) where we recognize marine and land-locked types of this subspecies.(23) *G. a. microcephalus* is a land-locked form found in the Kurile Islands and central Honshu. Its morphological characteristics are given below.

Lampetra planeri (*Bloch*) [*Petromyzonidæ*].—In Nippon there are two species of lampreys,(12) the sea-run type *L. fluviatilis* (Linnæus) and the land-locked *L. planeri*. While the former is restricted to northern Nippon, the latter is found in southern Honshu and in Kyushu.

Although there are many other anadromous fishes in Nippon, no land-locked form is known of such common fishes as *Oncorhynchus keta* (Walbaum), *O. gorbuscha* (Walbaum) and *Leucopsarion petersi* Hilgendorf (Gobiidæ).

MORPHOLOGICAL AND ECOLOGICAL FEATURES

Animals of marine origin are well known to exhibit morphological, physiological, as well as ecological changes in fresh-water habitats. In general, marine animals become dwarfs in fresh water, especially when the habitat is small, this tendency often being regarded as an effect of overpopulation. The land-locked *Plecoglossus altivelis* in Biwa-ko is about one-third as long as the anadromous fish, but it resumes its original dimensions in a suitable habitat. The land-locked red salmon which was transplanted from Akan-ko in Hokkaido to Towada-ko in northern Honshu within a few years attained about one-third the length and one-twentieth the weight of the original stock. The comparative morphological study of marine relics carried out by Ekman is very incomplete in Nippon. According to K. Ikeda(3) the body length, and dorsal and pectoral spines become shortened in land-locked *Gasterosteus aculeatus aculeatus,* and the larger part of the scuta disappears in *G. a. microcephalus.* These phenomena are interpreted as a sort of neotomy, and the isolated races exhibit some characteristic changes in different habitats.

The land-locked and relic animals are usually stenothermal. The glacial marine relics are found in those lakes only which have cold water strata in the depth. The upper temperature limit for the occurrence of *Mysis relicta* is said to be 14° to 16.9° C. The marine relics in European and North American lakes are derived in the glacial period from the fauna of the Arctic Ocean, and cannot endure the high water temperature. The marine relics in Nippon have, on the contrary, no relationship with the glacial period, and some of them are eurythermal in nature. *Neomysis intermedia,* for example, is distributed widely in Kamchatka, northern and southern Kuriles, Saghalin, and Honshu as far as the innermost part of the bay of Kozima-wan in the Inland Sea. In such lakes as Kasumiga-ura, Kita-ura, and Koyama-ike, where *Neomysis* lives and which are all less than 10 meters deep, the summer temperature of the water may rise above 30° C. (Table 1). *Mesidotheæ entomon orientalis, Lamprops korroensis,* and *Kamaka kuthæ* may, on the other hand, be stenothermal, judging from their natural distribution in the northern regions.

TABLE 1.—*Physical and chemical characteristics of Koyama-ike in summer (observed by S. Yohimura, July 26, 1929).*

Depth.	Temperature.	pH.	Oxygen.	
m.	*°C.*		*Mg/1*	*Per cent.*
0	32.1	8.8	8.95	118
2	30.7	8.8	11.13	144
3	27.5	7.6	0	0
5	25.2	7.2		
8	21.2	7.3	0	0

Transparency 0.7 m.

Almost all land-locked animals in Nippon are northern relics or derived from the northern fauna, and stenothermal in nature. *Oncorhynchus masou, O. rhodurus,* and *Salvelinus pluvius* live in the headwaters only of the streams. The land-locked forms of *O. nerka* are caught most numerously in the strata with a temperature of about 12° C., and the land-locked three-spined sticklebacks prefer the cold spring; dyspnœa begins at the water temperature of 20° C.

Another characteristic of the glacial marine relics is that they are stenoöxybionts, and are found in those lakes only the deep cold water of which is rich in dissolved oxygen. In fresh water respiration is more difficult than in the ocean(18, 21) and *Mysis relicta* behaves as an euryoxybiont in the sea and a stenoöxybiont in fresh water. In Nippon many relic animals occur in lakes the deep water of which is destitute of dissolved oxygen in summer. This, however, is not sufficient reason to conclude that our marine relics are euryoxybionts, because in such lakes the animals live in shallow water, especially of sandy bottom, due to their greater adaptability to the change of water temperature. While *Mysis* lakes in Europe are usually of the oligotrophic *Tanytarsus* type, *Neomysis* lakes in Nippon belong to the eutrophic *plumosus* type.

In most cases the spawning of marine relics takes place in winter or early spring, as is the case in glacial marine relics.

GEOGRAPHY OF RELIC LAKES

The marine relics in Europe and North America appear in those lakes which were below sea level in the glacial period or just inside of the terminal moraines; the altitudes of these lakes may be over 130 meters above the present sea level, and the distance from the sea several hundred kilometers. In Nippon the highest lake where *Neomysis* appears is situated at an altitude of only 10 meters above the sea; namely, Seseki-numa and Syana-numa in Etorohu-sima; and all relic lakes lie near the coastal region. The deepest *Neomysis* lakes are Toro-numa in Etorohu-sima, 22.5 meters deep, and Tohutu-ko in Kunasiri-sima, 21.5 meters deep. Our lakes with relic fauna are either drowned valleys dammed up by sand dunes, or lagoons isolated from the ocean by the alluvia, which gradually became fresh, and they are distributed in the regions of land elevations. It is thought easier for marine animals to invade brackish waters in the Tropics than in cooler parts of the earth, because the presence of monocarbonates in the water helps in the elimination of carbon dioxide.(19) Pelseneer(17) also reviewed evidence which indicates that marine animals in tropical regions are at present becoming adjusted to fresh water, especially along the coast of southern Asia, where heavy rains considerably dilute the ocean. The marine relics and land-locked animals in Nippon are, according to our present knowledge, more numerous in northern than in southern regions (text fig. 1). Many of these animals are of northern origin and need the cold water. The northern sea has a lower salinity than the tropical sea, and is, I think, freshened as effectively by the melting ice as by the rain, if such is a condition for marine inhabitants to become fresh-water animals, and the low temperature makes respiration easier.

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For further literature the reader is referred to Thienemann[21] and Miyadi.[6]

ILLUSTRATIONS

TEXT FIGURES

FRESH-WATER DIATOMS FROM THE ENVIRONS OF VLADIVOSTOK

By B. W. Skvortzow
Of Harbin, Manchoukuo

ONE PLATE

The first sample of fresh-water diatoms from the environs of Vladisvostok was collected by me in the Summer of 1928, when I visited with Prof. V. M. Savich the Botanical Garden of Vladivostok University in the environs of Okeanskaia station, near Amur Bay, in a forest *Hypnum* bog. This bog was about 50 m from the sea shore, about 1 m wide and no more than 20 cm deep. The examination of the present collection gave the following results: (*a*) The diatom flora of this *Hypnum* bog must be regarded as associated with subærial diatoms. (*b*) Forty-two different forms of fresh-water diatoms have been recorded, in addition to several marine species, as *Coscinodiscus radiatus* Ehr., *Grammatophora oceanica* Ehr., *Synedra affinis* Kütz., *Cocconeis scutellum* Ehr. var. *japonica* Skv., and *Melosira* sp. They all have been deposited here by the wind with sea sand. (*c*) Among fresh-water forms predominate: *Eunotia lunaris, Eunotia alpina, Eunotia flexuosa, Gomphonema acuminatum* var. *coronata, Gomphonema angustatum, Gomphonema intricatum,* and various small *Pinnularia.* (*d*) Several interesting forms have been recorded in the collection, as *Melosira roeseana* var. *asiatica,* recently described from North Manchuria; *Eunotia monodon* var. *koreana,* reported as a fossil from South Korea; *Navicula lapidosa,* known from Europe; *Pinnularia Balfouriana* var. *stauroptera,* reported from Nippon and North Manchuria. (*e*) The following are described here for the first time: *Caloneis lepidula* var. *major* var. nov., *Pinnularia streptoraphe* var. *minor* var. nov., *Pinnularia streptoraphe* var. *interrupta* var. nov., *Cymbella ventricosa* var. *arcuata* var. nov., and *Cymbella turgida* var. *muscosa* var. nov.

All forms found in the above sample are briefly described below. The diagrams have been prepared by me.

MELOSIRA ROESEANA Rabh. Plate 1, fig. 28.

Melosira roeseana Rabh., VAN HEURCK, Synopsis (1880–1885) pl. 89, fig. 5.

Frustule barrel-shaped, with a thick membrane covered with longitudinal rows of small puncta, on side of valve appearing circular, with distinct marginal spines. Valve diameter 0.017 mm; Rows of puncta 8; puncta 18 in 0.01 mm. Infrequent. A subærial diatom, widely distributed. Reported from North Manchuria.

MELOSIRA ROESEANA Rabh. var. **EPIDENDRON** Grunow. Plate 1, fig. 34.

Melosira roeseana Rabh. var. *epidendron* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 89, figs. 17–18.

Frustule more robust, but with coarser striæ. Valve diameter 0.03 mm; striæ 16, puncta 18 in 0.01 mm. Infrequent.

MELOSIRA ROESEANA Rabh. var. **ASIATICA** Skvortzow. Plate 1, fig. 29.

Melosira roeseana Rabh. var. *asiatica* SKVORTZOW, Subærial diatom flora from Pin-Chian-Sheng Province, Manchoukuo. Philip. Journ. Sci. 65 (1938) 263–281, pl. 3, figs. 1 and 3.

Differs from the type in its more robust striæ and in the absence of marginal spines. Valve diameter 0.017 mm; striæ 5, puncta 18 to 20 in 0.01 mm. Infrequent. Reported from Manchuria.

TABELLARIA FENESTRATA (Lyngb.) Kützing.

Tabellaria fenestrata (Lyngb.) Kützing, FR. HUSTEDT, Bacillar. (1930) 122–123, fig. 99.

Valve linear, with capitate ends and undulate middle part. Length, 0.068 mm. Infrequent.

SYNEDRA AMPHICEPHALA Kützing.

Synedra amphicephala Kützing, FR. HUSTEDT, Bacillar. (1930) 156, fig. 173.

Valve linear-lanceolate, with subcapitate ends. Length, 0.037 mm; breadth, 0.0025. Striæ 15 in 0.01 mm. Infrequent.

EUNOTIA LUNARIS (Ehr.) Grunow.

Eunotia lunaris (Ehr.) Grunow, FR. HUSTEDT, Bacillar. (1930) 183, 184, fig. 249.

Valve lunate, linear, with broad-rounded ends. Length, 0.053 to 0.0102 mm; breadth 0.0034 to 0.0042. Striæ 15 in 0.01. Common.

EUNOTIA ALPINA (Naeg.) Hustedt.

Eunotia alpina (Naeg.), FR. HUSTEDT, Bacillar. (1930) 185, fig. 252.

Differs from the preceding species in its narrower valve. Length, 0.06 mm; breadth, 0.0017. Striæ 15 in 0.01 mm. Infrequent.

EUNOTIA FLEXUOSA Kützing. Plate 1, fig. 6.

Eunotia flexuosa Kützing, FR. HUSTEDT, Bacillar. (1930) 186, fig. 258.

Valve almost linear, with parallel margin and slightly capitate ends. Terminal nodules distinct, each with a long bayonet-shaped fissure in the middle part. Length, 0.12 mm; breadth, 0.003. Striæ 12 in 0.01 mm. Not common.

EUNOTIA MONODON Ehr. var. KOREANA Skv. Plate 1, fig. 35.

Eunotia monodon Ehr. var. *koreana* SKVORTZOW, Neogene diatoms from the environs of Gensan, Korea (1936) pl. 1, figs. 13, 14, 19, 20, 30, 33.

Valve linear, slightly lunate, dorsal margin moderately curved, ventral slightly concave. End broad and rounded. Length, 0.045 mm; breadth, 0.01. Striæ 6 in 0.01 mm. Infrequent. Reported as a fresh-water fossil from South Korea.

EUNOTIA BIGIBBA Kütz. Plate 1, figs. 7 and 16.

Eunotia bigibba Kütz., FR. HUSTEDT, Bacillar. (1930) 175, fig. 214.

Valve lunate, ventral slightly concave, dorsal bi-arcuate, ends obtusely capitate. Length, 0.02 to 0.042 mm; breadth, 0.0085. Striæ 11 to 12 in 0.01 mm. Not common.

COCCONEIS PLACENTULA (Ehr.) var. LINEATA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *lineata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 262.

Valve elliptical with broad ends. Length, 0.01 mm; breadth, 0.017. Infrequent.

CALONEIS LEPIDULA (Grun.) Cleve var. MAJOR var. nov. Plate 1, fig. 4.

Major quam forma typica. Longis valvis 0.056 mm; latis valvis 0.006. Striis 24 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with straight margin and rounded ends. Median line filiform, more robust in the middle with long comma-shaped terminal fissures and distinct central pores. Axial area linear, somewhat less than $\frac{1}{3}$ of the breadth of the valve, with suborbicular central area. Longitudinal marginal band distinct. Twice longer than the type. Length, 0.056 mm; breadth, 0.006. Striæ 24 in 0.01 mm. Infrequent. The type is known from Europe.

STAURONEIS PHOENICENTERON Ehr. fo. GRACILIS (Dippel). Plate 1, fig. 36.

Stauroneis phœnicenteron Ehr. var. *gracilis* Cleve, DIPPEL, Diatomeen der Rhein-Mainebene (1905) 82, fig. 174.

Valve narrow-lanceolate with subacute ends. Length, 0.111 mm; breadth, 0.01. Striæ radiate, 18 in 0.01 mm. Infrequent.

NAVICULA LAGERHEIMII Cleve var. INTERMEDIA Hustedt. Plate 1, figs. 10 and 18.

Navicula Lagerheimii Cleve var. *intermedia* Hustedt, A. SCHMIDT, Atlas Diatom. (1930) pl. 370, fig. 22.

Valve elliptic-lanceolate with broad-rounded ends. Striæ radiate and punctate. Isolated puncta distinct. Length, 0.017 to 0.032 mm; breadth, 0.006 to 0.007. Striæ 20 to 21 in 0.01 mm. Common. A typical subærial diatom.

NAVICULA LAPIDOSA Krasske. Plate 1, fig. 31.

Navicula lapidosa Krasske, FR. HUSTEDT, Bacillar. (1930) 272, fig. 444.

Valve rhombical-elliptic with attenuate round ends. Striæ very fine, about 25 in 0.01 mm. Length, 0.0153 mm; breadth, 0.0068. Somewhat smaller than the type. Reported from Europe and northern Manchuria.

NAVICULA CONTENTA Grun. fo. BICEPS Arnott. Plate 1, fig. 26.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*c*.

Valve linear, slightly constricted in the middle. Ends broad-rounded and subcapitate. Length, 0.011 mm; breadth, 0.002. Striæ very fine, indistinct. Common. A subærial diatom.

NAVICULA CONTENTA Grunow fo. ELLIPTICA Krasske. Plate 1, fig. 27.

Navicula contenta Grun. var. *elliptica* Krasske, FR. HUSTEDT, Bacillar. (1930) 278.

Valve elliptical with broad ends. Length, 0.0085 mm; breadth, 0.002. Infrequent.

NAVICULA IGNOTA Krasske. Plate 1, fig. 19.

Navicula ignota Krasske, Beiträge zur Kenntnis der Diatomaceenflora der Alpen (1932) 116, pl. 1, fig. 19.

Valve linear-triundulate. Length, 0.019 mm; breadth, 0.005. Striæ 12 to 13 in 0.01 mm. Infrequent. Reported from North Manchuria and from Shanghai.

NAVICULA REINHARDTII Grunow.

Navicula Reinhardtii Grunow, FR. HUSTEDT, Bacillar. (1930) 301, fig. 519.

Valve elliptic-lanceolate, with very robust lineate costæ. Length, 0.052 mm; breadth, 0.015. Costæ 7 in 0.01 mm. Smaller than the type. Infrequent.

PINNULARIA SUBCAPITATA Greg.? Plate 1, figs. 14, 15, 21.

Pinnularia subcapitata Greg., FR. HUSTEDT, Bacillar. (1930) 317, fig. 571.

Valve linear-lanceolate, with slightly capitate ends. Central area a broad fascia. Length, 0.034 to 0.035 mm; breadth, 0.0042 to 0.006. Striæ 11 to 14 in 0.01 mm. Common.

PINNULARIA GIBBA Ehr. fo. SUBUNDULATA Mayer. Plate 1, figs. 12 and 13.

Pinnularia gibba Ehr. fo. *subundulata* Mayer, FR. HUSTEDT, Bacillar. (1930) 327, fig. 601.

Valve linear-lanceolate, moderately triundulate, with subcapitate ends. Length, 0.049 to 0.064 mm; breadth, 0.007 to 0.0085. Costæ 9 to 10 in 0.01 mm. Common.

PINNULARIA BREVICOSTATA Cleve.

Pinnularia brevicostata Cleve, FR. HUSTEDT, Bacillar. (1930) 329, fig. 609.

Valve linear, with rounded ends. Axial and central area uniting in a broad-linear space. Length, 0.124 mm; breadth, 0.017. Costæ 7 in 0.01 mm, not interrupted in the middle. Somewhat longer than the type. Median line straight. Common.

PINNULARIA BALFOURIANA Grun. var. STAUROPTERA Skvortzow. Plate 1, fig. 25.

Pinnularia Balfouriana Grun. var. *stauroptera* SKVORTZOW, Diatoms from Kizaki Lake, Nippon (1936) pl. 16, fig. 15.

Valve elliptic-lanceolate, with broad ends. Central area a broad transverse fascia. Length, 0.0187 mm; breadth, 0.005. Costæ 9 to 10 in 0.01 mm. Not common. Reported from Kizaki Lake, Nippon, and from North Manchuria.

PINNULARIA MICROSTAURON (Ehr.) Cleve. Plate 1, fig. 11.

Pinnularia microstauron (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 320, fig. 582.

Valve linear-lanceolate with subrostrate ends. Axial area enlarged and dilated in the middle in a broad transverse fascia. Length, 0.051 mm; breadth, 0.009. Costæ 9 in 0.01 mm. Infrequent.

PINNULARIA STREPTORAPHE Cleve var. MINOR var. nov. Plate 1, fig. 3.

Minor quam forma typica et costis latior. Longis valvis 0.081 mm; latis valvis 0.015. Costis 6 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with straight margins and subcuneate, rounded ends. Median line robust and distinctly complex. Central area suborbicular. Costæ moderately convergent at the ends, with distinct longitudinal band. Length, 0.081 mm; breadth, 0.015. Costæ 6 in 0.01 mm. Smaller than the type and more robust striæ. Common.

PINNULARIA STREPTORAPHE Cleve var. INTERRUPTA var. nov. Plate 1, figs. 1, 2.

Differt a typo valvis angustis, area centralis uni-biinterruptis. Longis valvis 0.107 ad 0.122 mm; latis valvis 0.017 ad 0.0187. Costis 6 ad 7. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve linear with parallel margins and subcuneate ends. Median line strongly complex. Axial area linear, somewhat less than a third of the breadth of the valve, in the middle uni- or bilaterally interrupted. Striæ slightly divergent in the middle and convergent at the ends. Longitudinal band very strong. Length, 0.107 to 0.122 mm; breadth, 0.017 to 0.0187. Costæ 6 to 7 in 0.01 mm. Common. Differs from the type in narrower valves and interrupted costæ in the middle part.

PINNULARIA GENTILIS (Donk.) Cleve var. SIBIRICA Skvortzow. Plate 1, fig. 5.

Pinnularia gentilis (Donk.) Cleve var. *sibirica* SKVORTZOW, Diatoms collected by D. Y. Okada in Nippon pl. 2, fig. 2.

Valve linear, slightly undulate in the middle and rounded ends. Median line strongly complex. Axial area narrow, less than ⅓ of the breadth of the valve. Costæ moderately divergent in the middle and convergent at the ends, 6½ to 7 in 0.01 mm. Length, 0.17 mm; breadth, 0.022. Differs from var. *sibirica* in its longer and broader valves. Common. Reported from Lake Kenon, near Chita, Transbaikalia, Siberia; and from Central Nippon.

PINNULARIA BOREALIS Ehr. Plate 1, fig. 9.

Pinnularia borealis Ehr., FR. HUSTEDT, Bacillar. (1930) 326, fig. 597.

Valve elliptic, with subtruncate ends. Costæ very robust. Length, 0.03 mm; breadth, 0.009. Costæ 5 in 0.01 mm. Common.

CYMBELLA VENTRICOSA Kützing var. **ARCUATA** var. nov. Plate 1, fig. 20.

Differt a typo valvis ventre directis, raphe leniter arcuatis. Longis valvis 0.024 mm; latis valvis 0.0085. Striis ventralis 12, dorsalis 8 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve semi-elliptic, straight at ventral and arcuate at the dorsal side. Median line arcuate. Axial and central areas indistinct. Length, 0.024 mm; breadth, 0.0085. Striæ, ventral 12, dorsal 8 in 0.01 mm. Differs from the type in its straight ventral margin and arcuate median line. Infrequent.

CYMBELLA TURGIDA (Greg.) Cleve. Plate 1, fig. 8.

Cymbella turgida (Greg.) Cleve, FR. HUSTEDT, Bacillar. (1930) 358, fig. 660.

Valve arcuate, ventral side centrally moderately gibbous. Median line almost straight. Length, 0.039 mm; breadth, 0.0085. Striæ 6 in 0.01 mm. Common.

CYMBELLA TURGIDA (Greg.) Cleve var. **MUSCOSA** var. nov. Plate 1, fig. 17.

Differt a typo valvis attenuatis cum polis productis et subacutis, ventre leniter undulatis, dorso arcuatis. Longis valvis 0.031 mm; latis valvis 0.007. Striis ventralis 8 ad 9, dorsalis 8 ad 9 in 0.01 mm. Habit. inter *Hypnum* in aquis dulcis stagnalis prope Vladivostok, Siberia Orientalis. Legit B. W. Skvortzow.

Valve lunate, with undulate ventral and gibbous dorsal side. Ends attenuate. Axial and central area indistinct. Median line about straight. Length, 0.031 mm; breadth, 0.007. Striæ dorsal and ventral 8 to 9 in 0.01 mm. Infrequent. Differs from the type in it elongate and subacute ends.

GOMPHONEMA PARVULUM (Kütz.) Grunow var. **EXILISSIMA** Grun. Plate 1, fig. 30.

Gomphonema parvulum (Kütz.) Grunow var. *exilissima* Grun., VAN HEURCK, Synopsis (1881–1885) pl. 25, fig. 2.

Valve lanceolate-clavate with the apex broader than the basis. Length, 0.02 mm; breadth, 0.0042. Striæ 14 in 0.01 mm. Infrequent.

GOMPHONEMA INTRICATUM Kütz. var. **PUMILA** Grunow. Plate 1, fig. 22.

Gomphonema intricatum Kütz. var. *pumila* Grunow, FR. HUSTEDT, Bacillar. (1930) 375, fig. 699.

Valve linear-clavate. Isolated puncta distinct. Length, 0.023 mm; breadth, 0.0042. Striæ 10 to 11 in 0.01 mm. Rare.

GOMPHONEMA ANGUSTATUM (Kütz.) Rabh. Plate 1, fig. 24.

Gomphonema angustatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 373, fig. 690.

Valve lanceolate-clavate, tapering from the middle to both ends. Length, 0.03 mm; breadth, 0.0051. Striæ 8 in 0.01 mm. Isolated puncta distinct. Common.

GOMPHONEMA INTRICATUM Kützing. Plate 1, figs. 32 and 33.

Gomphonema intricatum Kützing, FR. HUSTEDT, Bacillar. (1930) 375, fig. 697.

Valve narrow, lanceolate-clavate, with long subacute ends. Length, 0.034 to 0.035 mm; breadth, 0.005. Striæ 8 to 10 in 0.01 mm. Common.

GOMPHONEMA ACUMINATUM Ehr. var. CORONATA (Ehr.) W. Smith.

Gomphonema acuminatum Ehr. var. *coronata* (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 370, fig. 684.

Valve subconstricted-clavate, with apiculate apex. Length, 0.057 mm; breadth, 0.012. Striæ 12 in 0.01 mm. Very common.

EPITHEMIA ARGUS Kützing.

Epithemia argus Kützing, FR. HUSTEDT, Bacillar. (1930) 383, fig. 727*a*.

Valve moderately curved with subcapitate ends. Length, 0.054 mm; breadth, 0.009. Striæ, 10 in 0.01 mm. Infrequent.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 730.

Valve with straight ventral side and arcuate reflexed dorsal margin. Rare.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. fo. CAPITATA O. Müll.

Hantzschia amphioxys (Ehr.) Grun. fo. *capitata* O. Müll., FR. HUSTEDT, Bacillar. (1930) 394, fig. 748.

Valve linear, moderately curved, with capitate ends. Length, 0.061 mm; breadth, 0.007. Keel puncta 8, striæ 20 in 0.01 mm. Infrequent.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. VIVAX (Hantz.) Grunow.

Hantzschia amphioxys (Ehr.) Grun. var. *vivax* (Hantz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 394, fig. 750.

Valve linear-lanceolate, moderately curved, with long attenuate ends. Length, 0.125 mm; breadth, 0.01. Keel puncta 5, striæ 18 in 0.01 mm. Infrequent.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, fig. 23.

Nitzschia palea (Kütz.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear-lanceolate, parallel in the middle and attenuate at the ends. Length, 0.022 mm; breadth, 0.0025. Keel puncta 9 in 0.01 mm. Striæ indistinct. Common.

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ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Pinnularia streptoraphe* Cleve var. *interrupta* var. nov.
FIG. 3. *Pinnularia streptoraphe* Cleve var. *minor* var. nov.
4. *Caloneis lepidula* (Grun.) Cleve var. *major* var. nov.
5. *Pinnularia gentilis* (Donk.) Cleve var. *sibirica* Skv.
6. *Eunotia flexuosa* Kütz.
7. *Eunotia bigibba* Kütz.
8. *Cymbella turgida* (Greg.) Cleve.
9. *Pinnularia borealis* Ehr.
10. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
11. *Pinnularia microstauron* (Ehr.) Cleve.
FIGS. 12 and 13. *Pinularia gibba* Ehr. fo. *subundulata* Mayer.
14 and 15. *Pinnularia subcapitata* Greg?
FIG. 16. *Eunotia bigibba* Kütz.
17. *Cymbella turgida* (Greg.) Cleve var. *muscosa* var. nov.
18. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
19. *Navicula ignota* Krasske.
20. *Cymbella ventricosa* Kütz. var. *arcuata* var. nov.
21. *Pinnularia subcapitata* Greg?
22. *Gomphonema intricatum* Kütz. var. *pumila* Grun.
23. *Nitzschia palea* (Kütz.) W. Smith.
24. *Gomphonema angustatum* (Kütz.) Rabh.
25. *Pinnularia Balfouriana* Grun. var. *stauroptera* Skv.
26. *Navicula contenta* Grun. fo. *biceps* Arnott.
27. *Navicula contenta* Grun. fo. *elliptica* Krasske.
28. *Melosira roeseana* Rabh.
29. *Melosira roeseana* Rabh. var. *asiatica* Skv.
30. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
31. *Navicula lapidosa* Krasske.
FIGS. 32 and 33. *Gomphonema intricatum* Kütz.
FIG. 34. *Melosira roeseana* Rabh. var. *epidendron* Grun.
35. *Eunotia monodon* Ehr. var. *koreana* Skv.
36. *Stauroneis phoenicenteron* Ehr. fo. *gracilis* (Dippel).

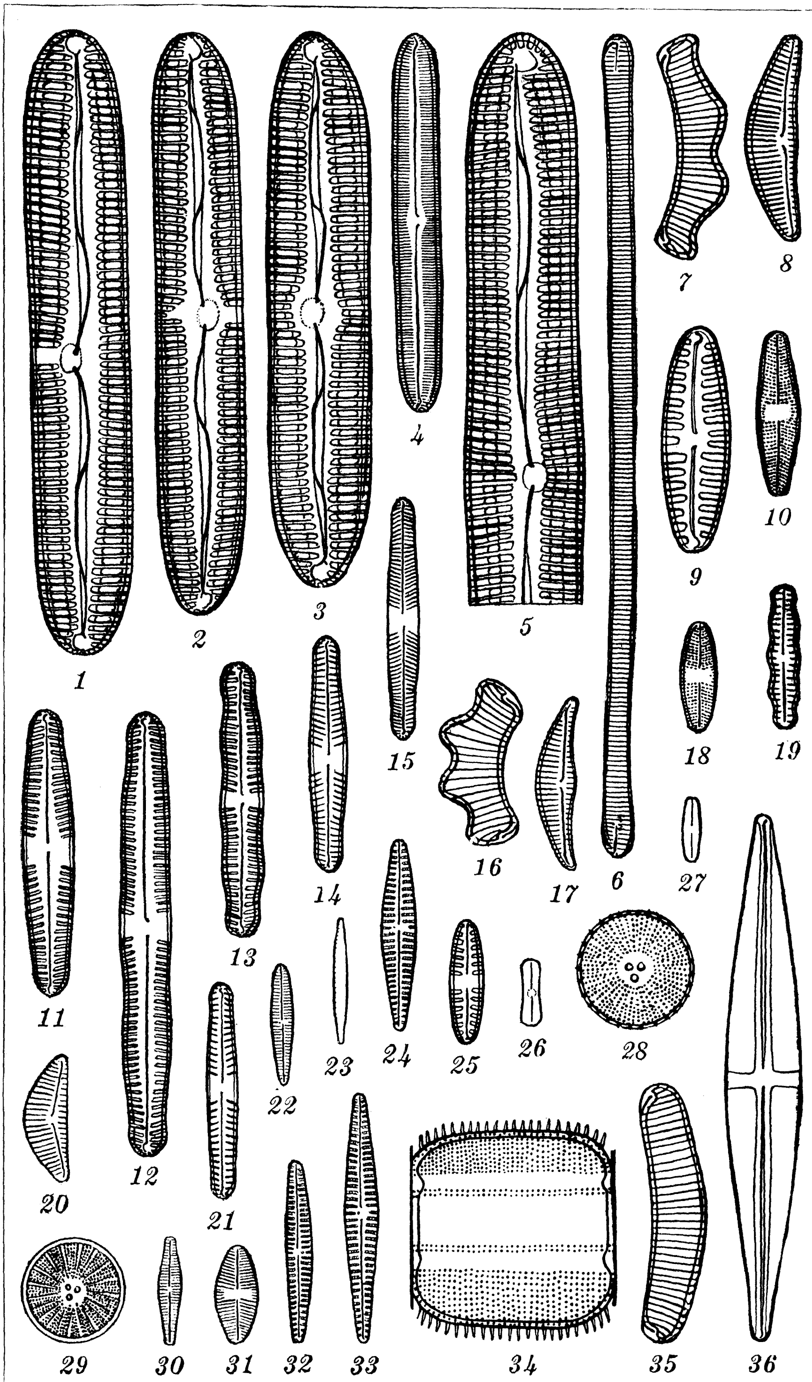
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PLATE 1.

SUBAËRIAL DIATOMS FROM PIN-CHIANG-SHENG PROVINCE, MANCHOUKUO

By B. W. Skvortzow
Of Harbin, Manchoukuo

FOUR PLATES

In 1936 I examined several small collections of subaërial diatoms from different parts of Eastern Asia. The material for this investigation consisted of three samples collected by me in Pin-Chiang-Sheng Province, Manchoukuo. Sample 1 was collected in Harbin, September 20, 1927, from the bark of *Ulmus manshurica* Nakai; sample 2 was collected in eastern Harbin, near Maoershan Railway Station, July 20, 1927, on mosses on rocks along a mountain river; sample 3 was collected in eastern Maoershan, near Mifun Station, September 5, 1927, in mosses on mountain rocks. Subaërial diatoms associated with blue-green algæ growing in the bark clefts of a Manchurian elm were removed with a hard brush, washed, and the sediment collected and boiled in acids. The mosses from rocks were submerged in water, squeezed by hand, and the greenish brown sediment examined for diatoms.

The examination of the three samples gave the following results: Fifty-nine forms were recognized, 32 per cent of which were new to science and about 90 per cent new to Manchoukuo. The most interesting finds were *Melosira roeseana* var *indica,* recently reported by me from Calcutta, India; *Stauroneis parvula* var. *rupestris,* found on rocks near Hangchow, Chekiang, China; *Pinnularia Balfouriana* var. *stauroptera,* known from Kizaki Lake, Nippon; *Hantzschia amphioxys* var. *compacta,* reported from Tibet. The forms found in greatest abundance on the bark of a Manchurian elm in Harbin were *Navicula Lagerheimii* var. *intermedia* and *Hantzschia amphioxys.* On the rock mosses of the Maoershan district *Melosira roeseana* var. *epidendron* and var. *asiatica, Achnanthes coarctata, Navicula Lagerheimii* var. *intermedia, Navicula Kotschii* var. *rupestris,* and *Hantzschia amphioxys* var. *compacta,* were the most prevalent. On the mosses from Mifun mountains *Melosira roeseana* var. *asiatica,* *Achnanthes coarctata, Navicula Lagerheimii* var. *intermedia, Navicula Kotschii* var. *rupestris, Navicula contenta* fo. *biceps* and fo. *parallela, Pinnularia lata* fo. *thuringiaca, Hantzschia amphioxys,* with var. *vivax* and var. *compacta,* were abundant.

Compared on the basis of the present collection, the subaërial diatom flora of North Manchuria has a comparatively large number of species in common with that of Europe, although the floristic composition is different. All fifty-nine subaërial diatoms found in the above samples from North Manchoukuo are described below. The diagrams have been made by me with the aid of Apochromat 2 mm of E. Leitz and Compens-Oculars Nos. 6, 8, and 12. In the following list of algæ the sample number after each species indicates the particular locality from which it was obtained.

MELOSIRA ROESEANA Rabh. Plate 2, fig. 19; Plate 3, figs. 5 and 12; Plate 4, figs. 4 and 22.

Melosira roeseana Rabh. VAN HEURCK, Synopsis (1881–1885) pl. 89, figs. 1–6; A. SCHMIDT, Atlas Diatom. (1893) pl. 176, figs. 7–14; FR. HUSTEDT, Die Kieselalgen (1927) Lief. I, 266, 267, fig. 112*a*, *b*.

Frustules in long fasciæ, attached to the moss filaments. Valve in zone view cylindrical, with rounded discus rim, covered with spines. Sulkus broad and very distinct. Kollum covered with longitudinal punctate lines. Valve height, 0.017 to 0.034 mm; breadth, 0.01 to 0.012. Striæ 9 in 0.01 mm. Valve in valve view circular, separated into three areas. Marginal area with a marginal rib with fine spines irregularly radiating. Diameter of outer areas about ⅓ that of valve, composed of radiating rows of beads; inner area a circular hyaline central space with two large beads. Common. Samples 2 and 3.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grunow. Plate 3, figs. 4 and 10.

Melosira roeseana Rabh. var. *epidendron* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 89, figs. 17, 18.

Differs from the type in its coarser structure. Valve height, 0.032 to 0.047 mm; breadth, 0.01 to 0.03. Striæ 14 in 0.01 mm. Radiating rows alternately longer and shorter. Marginal spines distinct. Central space with 1 to 5 isolated beads. Abundant. Sample 2.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grun. fo. PODOCYCLIA Grunow. Plate 3, fig. 6.

Melosira roeseana Rabh. var. *epidendron* Grunow fo. *podocyclia* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 89, figs. 19, 20.

Differs from var. *epidendron* by the presence of large pores around the valve. Valve height 0.03 mm; breadth, 0.024. Striæ 14 to 15 in 0.01 mm. Sample 2.

MELOSIRA ROESEANA Rabh. var. EPIDENDRON Grun. fo. SPINOSA fo. nov. Plate 3, fig. 2.

Valvis formae typicae consimilis, area centralis spinosa. Longis valvis 0.06 mm; latis valvis 0.04 ad 0.051. Striis 15 in 0.01 mm. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Differs from var. *epidendron* Grun. by the presence of small spines in the center of the valve. Infrequent. Sample 2.

MELOSIRA ROESEANA Rabh. var. INDICA Skvortzow. Plate 4, fig. 5.

Melosira Roeseana Rabh. var. *indica* SKVORTZOW, Diatoms from Calcutta, India (1935) 180, pl. 1, fig. 1.

Differs from the type in broad marginal zone with a diameter of about $\frac{1}{5}$ of the valve with large, robust spines. Diameter of the valve, 0.04 to 0.045 mm. Striæ 9 in 0.01 mm. Infrequent. Sample 3. Reported from Calcutta, India.

MELOSIRA ROESEANA Rabh. var. ASIATICA var. nov. Plate 3, figs. 1 and 3.

Valvis 0.013 and 0.037 mm metientibus, striis marginalibus radiantibus hyalinis, circiter 0.008 and 0.009 in 0.01 mm, jugis radiantibus punctatis, ad marginem valve 5 ad 6 dispositis. Area centrali hyalina, tribus maculis ornata, maculis valvis infra in intervalla macularum valvi positis. Spinis marginalibus nullo. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve view circular, with distinct marginal area without marginal spines. The outer area composed of the extension of the radiating 29 to 31 rows of beads. Each row at the marginal part is composed of 5 to 6 chains of beads, diminishing slightly to the central space. Rows radial, alternately longer and shorter, with distinct interspaces opposite the origin of the latter. Central space hyaline, with three isolate large beads. Valve breadth, 0.013 mm; valve height 0.02 to 0.022. Radiating rows 3 to 5; beads in marginal part 8 to 9; beads on the inner part 18 to 20 in 0.01 mm. Common. Samples 2 and 3. Differs from the type in its radiating beaded area similar to the *Stephanodiscus carconensis* Grun., and in the absence of marginal spines.

FRAGILARIA CAPUCINA Desm. var. MESOLEPTA (Rabh.) Grunow.

Fragilaria capucina Desm. var. *mesolepta* (Rabh.) Grunow, FR. HUSTEDT, Bacillar. (1930) 138, fig. 128.

Valve linear, constricted in the middle. Ends subrostrate. Length, 0.0238 mm; breadth, 0.0025. Striæ 18 in 0.01 mm. Rare. Sample 2.

SYNEDRA ULNA (Nitzsch) Ehr. var. AMPHIRHYNCHUS (Ehr.) Grunow.

Synedra ulna (Nitzsch) Ehr. var. *amphirhynchus* (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1914) pl. 302, figs. 23–26.

Valve narrow linear-lanceolate, with attenuate capitate ends. Length, 0.17 mm; breadth, 5. Striæ 8 in 0.01 mm. Filaments only. Rare. Sample 2.

EUNOTIA PRAERUPTA Ehr. Plate 1, figs. 12, 13, and 46.

Eunotia praerupta Ehr., A. SCHMIDT, Atlas Diatom. (1911) pl. 273, figs. 12, 14, 25.

Valve lunate-curvate, with arcuate dorsal side and moderately curvate ventral. Ends subrostrate and broad-round. Terminal nodules distinct. Length, 0.037 to 0.057 mm; breadth, 0.01 to 0.017. Striæ 12 to 15 in 0.01 mm. Common. Samples 2 and 3.

EUNOTIA PRAERUPTA Ehr. var. INFLATA Grun. fo. CURTA. Plate 1, fig. 27.

Eunotia praerupta Ehr. var. *inflata* Grun. fo. *curta* A. SCHMIDT, Atlas Diatom. (1911) pl. 273, fig. 8.

Differs from the type in its broad, inflated ends. Length, 0.022 mm; breadth, 0.0068. Striæ 9 in 0.01 mm. Rare. Sample 2.

EUNOTIA MONODON Ehr. var. MINOR (W. Smith) Hust. fo. BIDENS (W. Smith). Plate 1, figs. 35 to 37.

Eunotia monodon Ehr. var. *major* (W. Smith) Hust. fo. *bidens* (W. Smith), A. SCHMIDT, Atlas Diatom. (1911) pl. 273, figs. 35–38, 40.

Valve slightly lunate or nearly straight. Dorsal arcuate, biundulate. Ends broad-rounded. Ventral side moderately curvate. Length, 0.015 to 0.02 mm; breadth, 0.005. Striæ 12 in 0.01 mm. Common. Sample 2.

EUNOTIA BIGIBBA Kützing. Plate 1, fig. 38; Plate 2, fig. 11; Plate 3, figs. 8 and 9.

Eunotia bigibba Kützing, A. SCHMIDT, Atlas Diatom. (1913) pl. 290, figs. 9, 17–19.

Valve moderately curved, with distinct biundulate dorsal margin and slightly concave ventral. Ends broad subcapitate and distinctly abrupt. Length, 0.025 to 0.039 mm; breadth, 0.0085 to 0.01. Striæ 10 to 15 in 0.01 mm. Common. Sample 2.

EUNOTIA BIGIBBA Kütz. var. PUMILA Grunow. Plate 1, fig. 44.

Eunotia bigibba Kütz. var. *pumila* Grunow, FR. HUSTEDT, Bacillar. (1930) 175, fig. 25.

Smaller than the type. Length, 0.0153 mm; breadth, 0.0068. Striæ 15 in 0.01 mm. Shorter striæ between longer striæ on the margin of dorsal side distinct. Rare.

EUNOTIA BIGIBBA Kütz. var. RUPESTRIS var. nov. Plate 1, fig. 39.

Differt a typo crenae dorsali abruptis. Valvis longis 0.064 mm; valvis latis 0.013. Striis 10 in 0.01 mm. Habit. in rupestris muscoides prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Differs from the type in abruptly obtuse dorsal undulations. Length, 0.064 mm; breadth 0.013. Striæ 10 in 0.01 mm. Uncommon. Sample 2.

EUNOTIA GRACILIS (Ehr.) Ralfs. Plate 2, fig. 6.

Eunotia gracilis (Ehr.) Ralfs, FR. HUSTEDT, Bacillar. (1930) 185, fig. 253.

Valve linear, lunately curved. Ends capitate. Length, 0.069 mm; breadth, 0.005. Striæ 11 in 0.01 mm. Rare. Sample 2.

ACHNANTHES COARCTATA Breb. Plate 1, figs. 1 to 4.

Achnanthes coarctata Breb., VAN HEURCK, Synopsis (1881–1885) pl. 26, figs. 17–20.

Valve lanceolate, constricted in the middle. Ends subrostrate and obtuse. Upper valve with eccentric axial area. Lower valve with an oblique median line and rectangular broad central area. Length, 0.032 to 0.039 mm; breadth, 0.009 to 0.01. Striæ 12 in 0.01 mm, with robust puncta. Abundant. Samples 2 and 3. Reported from moist earth and in mosses.

FRUSTULIA VULGARIS Thwaites var. RUPESTRIS var. nov. Plate 4, fig. 18.

Differt a typo valvis marginem subplanis. Longis valvis 0.034 mm; latis valvis 0.006. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve narrow-lanceolate with attenuate broad ends. Axial and central areas and striæ indistinct. Median line straight. Length, 0.034 mm; breadth, 0.006. Rare. Sample 3.

Differs from the type in its middle undulate part.

DIPLONEIS RUPESTRIS sp. nov. Plate 1, fig. 9.

Valvis ellipticis ad marginem concavis, polis subcuneatis. Raphe distincta directa modice obliquiis. Area axillaris at centralis angusta linearis, area lateralis elliptico-lanceolatis et hyalinis. Striis radiantes, 18 ad 20 in 0.01 mm. Longis valvis 0.015 mm; latis valvis 0.005. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptic, with attenuate acute ends. Median line robust, distinct, and arcuate throughout. Furrows narrow lanceolate, light in color. Central area rectangular and narrow. Striæ slightly radiate, distinctly punctate, crossed by a distinct longitudinal band. Length, 0.015 mm; breadth, 0.0051. Striæ 18 to 20 in 0.01 mm. Rare. A peculiar species, akin to genus *Diploneis.*

STAURONEIS OBTUSA Lagerst. Plate 3, fig. 11.

Stauroneis obtusa LAGERST., Sotvattens-Diatomaceer fram Spitsbergen och Beeren Eiland (1873) 36, pl. 1, fig. 11.

Valve long-lanceolate with attenuate acute ends. Both ends with transverse round siliceous ribs. Median line filiform with distinct terminal fissures. Axial area narrow-linear, central area a broad rectangular fascia. Striæ radiate, punctate, about 16 to 17 in 0.01 mm. Length, 0.072 mm; breadth, 0.012. Rare. Sample 2. Known from Europe, from moist rocks in mountainous districts.

STAURONEIS PARVULA Grun. var. **RUPESTRIS** Skvortzow. Plate 1, fig. 22.

Stauroneis parvula Grun. var. *rupestris* SKVORTZOW, Subaërial diatoms from Hangchow, Chekiang Province, China, pl. 1, fig. 20.

Valve linear-lanceolate with parallel margins slightly interrupted in the middle and subrostrate ends. Striæ slightly radiate, about 30 in 0.01 mm. Length, 0.017 mm; breadth, 0.0034. Infrequent. Sample 2. Reported from moist rocks from environs of Hangchow, China.

STAURONEIS RUPESTRIS sp. nov. Plate 1, fig. 40.

Valvis lanceolatis cum polis subrostratis, obtusis et truncatis. Raphe directa. Area axillaris angusta inconspicuis. Area contralis vitta transversa nuda interruptis. Striis transversis radiantibus, 15 in 0.01 mm. Longis valvis 0.015 mm; latis valvis 0.0042. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear-lanceolate, with broad subrostrate ends. Median line filiform, axial area very narrow. Central area a broad rectangular fascia. Striæ distinctly radiate, about 15 in 0.01 mm, not coarser at the ends. Length, 0.015 mm; breadth, 0.0042. Rare. Sample 2. Akin to *Stauroneis montana* Krasske.

NAVICULA LAGERHEIMII Cleve var. INTERMEDIA Hust. Plate 1, figs. 14, 31, and 42; Plate 2, fig. 8; Plate 4, figs. 13, 14, 16, 17, 19, 23, and 24.

Navicula Lagerheimii Cleve var. *intermedia* Hustedt, A. SCHMIDT, Atlas Diatom. (1930) pl. 370, fig. 22.

Navicula pseudoseminulum SKVORTZOW, Diatoms recoltees par le Pere E. Licent dans le Nord de la Mandjourie (1935) 40, pl. 9, fig. 27.

Navicula Lagerheimii Cleve var. *intermedia* Hust., SKVORTZOW, Subaërial diatoms from Hangchow, Chekiang, China (1937) pl. 1, fig. 33.

Valve lanceolate with distinct broad margins. Axial area narrow, central area a broad fascia not reaching the margin. Isolated puncta indistinct from one side of fascia. Striæ radiate, distinctly punctate, about 18 to 21 in the middle and 22 to 25 at the ends. Common. Samples 1, 2, and 3. Reported by me in 1935 as *Navicula pseudoseminulum* Skv. Only now I have recognized the marginal isolated puncta. Abundant in Harbin, associated with blue-green algæ.

NAVICULA LAGERHEIMII Cleve var. ROBUSTA var. nov. Plate 4, figs. 8 and 9.

Major quam forma typica et area centralis obscuro. Longis valvis 0.045 mm; latis valvis 0.015. Striis radiantes 20 ad 21 in 0.01 mm. Habit. in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve lanceolate-elliptic, with broad-rounded ends and robust siliceous membrane. Median line filiform. Axial area narrow, central a transverse fascia, not reaching the margin. Isolated puncta indistinct. The space between the central pores dark. Striæ radiate, 20 to 21 in 0.01 mm crossed by longitudinal blank undulating bands. Differs from var. *intermedia* Hust. in robust large valves and the dark space between the central pores. Sample 3.

NAVICULA LAGERHEIMII Cleve var. OVATA Skvortzow. Plate 4, figs. 6, 10, and 20.

Navicula Lagerheimii Cleve var. *ovata* SKVORTZOW, Subaërial diatoms from Shanghai, pl. 1, figs. 5, 6, 24.

Differs from the type in ovate valves with broad obtuse ends. Length, 0.01 to 0.0136 mm; breadth, 0.0051 to 0.0068. Striæ about 20 in 0.01 mm. Common. Samples 1 and 2. Reported from bark of trees in Shanghai.

NAVICULA LAGERHEIMII Cleve var. LANCEOLATA var. nov. Plate 4, figs. 11 and 12.

Valvis ellipticis-lanceolatis cum polis rostratis et obtusis. Longis valvis 0.0255 mm; latis valvis 0.0068. Striis 18 in 0.01 mm. Habit. in truncus arborum prope Harbin et in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit. B. W. Skvortzow.

Valve elliptic-lanceolate with subrostrate ends. Length, 0.0255 mm; breadth, 0.0068. Striæ 18 in 0.01 mm. Infrequent. Samples 1 and 3.

NAVICULA MUTICA Kützing. Plate 1, fig. 5, 23, and 26; Plate 2, fig. 5.

Navicula mutica Kützing, FR. HUSTEDT, Bacillar. (1930) 274, 275, fig. 453*a*.

Valve linear with straight median line with central pores and terminal fissures curved in the same directions. Central area a broad transverse fascia, reaching nearly to the margin with distinct isolated puncta. Striæ punctate, 15 to 17 in 0.01 mm. Length, 0.0136 to 0.049 mm; breadth, 0.006 to 0.01. Very common. Samples 2 and 3. Differs from *Navicula Lagerheimii* Cleve var. *intermedia* Hust. in its more robust striæ and more distinct isolated puncta.

NAVICULA MUTICA Kütz. var. RHOMBICA var. nov. Plate 2, figs. 16 and 17.

Differt a typo valvis rhombicis cum polis productis. Longis valvis 0.034 ad 0.04 mm; latis valvis 0.012 ad 0.014. Striis 15 in 0.01 mm. Poro solitario distinctis. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve rhombical-lanceolate with undulate middle part. Axial area narrow, central a rectangular fascia. Striæ distinct, punctate, about 15 in 0.01 mm. Length, 0.034 to 0.04 mm; breadth, 0.012 to 0.014. Rare. Sample 2. Differs from the type in its rhombical shape.

NAVICULA KOTSCHYI Grun. var. RUPESTRIS var. nov. Plate 1, fig. 32; Plate 2, fig. 3.

Differt a typo valvis elongatis, productis, subacutis, striis transversis et robustris. Longis valvis 0.042 ad 0.068 mm; latis valvis 0.014 ad 0.018. Striis 11 ad 15 in 0.01 mm. Habit. in rupestris muscosis prope Maoershan et Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptic-lanceolate with attenuate, subacute ends. Median line straight, with terminal pores curved in the same directions. Central area a rectangular fascia with a distinct isolated puncta near the central nodules. Striæ radiate, punctate, in irregular longitudinal undulating bands. Length, 0.042 to 0.068 mm; breadth, 0.014 to 0.018. Striæ 11 to 15 in 0.01 mm. Differs from the type in its elongate valves, attenuate towards the subacute ends. Striæ more robust. Differs from *Navicula pseudodemerarae* Hust.[1] in having irregular longitudinal blank undulating bands. Very common. Samples 2 and 3.

NAVICULA OCELLATA sp. nov. Plate 1, fig. 41.

Valvis ellipticis cum polis rotundatis. Raphe directa cum polis terminalibus dilatatis. Area axillaris angusta, medio valvae area centralis suborbiculata cum poro solitario inter nodulis centralis. Structura punctata, punctis in striis 18 ad 20 in 0.01 mm transversalis et longitudinalis radiantes ordinatis. Longis valvis 0.024 mm; latis valvis 0.013. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve broad, elliptic-lanceolate. Median line straight and filiform. Axial area narrow-linear, central broad-suborbicular with isolated puncta between the central nodules. Striæ radiate, punctate, in longitudinal blank bands. Length, 0.024 mm; breadth, 0.013. Striæ 18 to 20 in 0.01 mm. Differs from *Navicula mutica* Kütz. in the presence of isolated puncta between the central pores.

NAVICULA OCELLATA sp. nov. var. POLYMORPHA var. nov. Plate 2, fig. 18.

Differt a typo valvis elongatis ellipticis, poro solitario marginalis, area centralis fronte viza robusta suborbiculata, pone-minoribus. Longis valvis 0.034 mm; latis valvis 0.014. Striis 18 in 0.01 mm. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve elliptical with broad ends. Median line straight, axial area narrow, central broad and suborbicular. The central area from one side of the valve is broader and larger than from the other, with an isolated punctum only on one side. Striæ radiate, fine, about 18 in 0.01 mm with indistinct longitudinal blank bands. Length, 0.034 mm; breadth, 0.014. Uncommon. Sample 2.

NAVICULA LAPIDOSA Krasske. Plate 1, fig. 48.

Navicula lapidosa Krasske, FR. HUSTEDT, Bacillar. (1930) 272, 273, fig. 444.

Valve rhombic-elliptic, with broad ends. Axial area very narrow, central area a broad stauros, widened and truncate out-

[1] A. Schmidt, Atlas Diatom. (1930) pl. 370, fig. 9.

wards. Striæ radiate, not punctate, about 22 in 0.01 mm. Length, 0.015 mm; breadth, 0.009. Rare. Sample 2.

NAVICULA IGNOTA Krasske. Plate 1, fig. 30.

Navicula ignota KRASSKE, Beiträge zur Kenntnis der Diatomaceenflora der Alpen (1932) 116, pl. 1, fig. 19; SKVORTZOW, Subaërial diatoms from Shanghai (1937) pl. 1, fig. 25.

Navicula Licenti SKVORTZOW, Diatoms recoltees par le Pere E. Licent dan le Nord de la Mandjourie (1935) 40, pl. 9, figs. 11, 29.

Valve linear-lanceolate, with triundulate margins. Axial area narrow, central broader. Striæ radiate, robust, middle 15, ends 18 to 20 in 0.01 mm, more distinct in the middle. Rare. Sample 2. Known from Europe. Recently reported from Shanghai and Hangchow, China.

NAVICULA CONTENTA Grunow. Plate 1, fig. 17.

Navicula contenta Grunow, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*a*.

Valve linear, broad and slightly triundulate, with broad-obtuse ends. Length, 0.01 mm; breadth, 0.0034. Sample 2. A common subaërial diatom. In the Far East reported from Shanghai, and Hangchow, China.

NAVICULA CONTENTA Grun. fo. **PARALLELA** Petersen. Plate 1, fig. 18.

Navicula contenta Grun. fo. *parallela* Petersen, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*b*.

Differs from the type in its parallel margins. Common. Samples 2 and 3.

NAVICULA CONTENTA Grun. fo. **BICEPS** Arnott. Plate 1, figs. 10, 11, and 16.

Navicula contenta Grun. fo. *biceps* Arnott, FR. HUSTEDT, Bacillar. (1930) 277, fig. 458*c*.

Valve linear, constricted in the middle. Ends broad-rounded. Length, 0.0085 to 0.012 mm; breadth, 0.0025. Striæ indistinct. Abundant. Samples 2 and 3. Reported from Shanghai.

NAVICULA CONTENTA Grun. fo. **ELLIPTICA** Krasske. Plate 1, fig. 25.

Navicula contenta Grun. fo. *elliptica* Krasske, FR. HUSTEDT, Bacillar. (1930) 278.

Valve elliptic, with attenuate broad-rounded ends. Length, 0.0136 mm; breadth, 0.0034. Common. Sample 2.

NAVICULA PERPUSILLA Grunow. Plate 1, fig. 21.

Navicula perpusilla Grunow, FR. HUSTEDT, Bacillar. (1930) 278, fig. 459.

Valve broad-elliptic, with enlarged middle part and broad-obtuse ends. Axial and central area broad-elliptic, about ½ of the valve diameter. Striæ very fine, radiate, about 35 in 0.01 mm. Length, 0.01 mm; breadth, 0.005. Common. Samples 2 and 3.

NAVICULA CONFERVACEA Kützing. Plate 1, fig. 20.

Navicula confervacea Kützing, FR. HUSTEDT, Bacillar. (1930) 278, fig. 460.

Valve elliptic-lanceolate, with narrow ends. Axial and central areas broad-lanceolate. Striæ marginal, radiate, 15 in 0.01 mm. Length, 0.012 mm; breadth, 0.0053. Not common. Sample 2. Smaller than the type.

NAVICULA GIBBULA Cleve. Plate 1, fig. 24.

Navicula gibbula Cleve, FR. HUSTEDT, Bacillar. (1930) 285, fig. 477.

Valve linear-elliptic, with slightly attenuate and broad-rounded ends. Median line filiform, robust, with short and indistinct terminal fissures and distinct central pores curved to one direction up to the margin of the central area. Striæ radiate, punctate, in the middle 12 to 15, at the ends 18 to 25 in 0.01 mm. Length, 0.02 to 0.0289 mm; breadth, 0.005 to 0.0068. Rare. Sample 2.

PINNULARIA CONVERGENS sp. nov. Plate 1, figs. 28 and 33.

Valvis lineari-lanceolatis cum polis subacutis. Raphe directis, raphe poris medianis approximatis, poris terminalibus sigmoides. Area axillaris sat dilatata, centralis transverse dilatata. Striæ convergentibus, nec radiantibus 15 ad 18 in 0.01 mm. Longis valvis 0.0175 ad 0.02 mm; latis valvis 0.0034. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear-lanceolate, attenuate towards the ends. Median line filiform, with bayonet-shaped terminal fissures and slightly curved central pores. Axial area dilated to a broad and long central area, forming a fascia. Striæ radiate, about 15 to 18 in 0.01 mm, not coarser at the ends, convergent. Length, 0.0175 mm; breadth, 0.0034. Differs from *Pinnularia leptosoma* Grun. in its convergent and not divergent striæ. Rare. Sample 2.

PINNULARIA FASCIATA Lagerst. Plate 1, fig. 29.

Pinnularia fasciata (Lagerst.) FR. HUSTEDT, Bacillar. (1930) 316, fig. 569.

Valve linear-lanceolate, with attenuate and rounded ends. Axial area narrow, broader near the central area. Central area a rectangular fascia. Central pores with linear markings on both sides. Striæ slightly radiate, about 24 in 0.01 mm. Length, 0.0187 mm; breadth, 0.0034. Rare. Sample 2.

PINNULARIA LATA (Breb.) W. Smith fo. THURINGIACA (Rabh.) A. Mayer. Plate 1, fig. 45; Plate 2, figs. 4, 9, and 10.

Pinnularia lata (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer, FR. HUSTEDT, Bacillar. (1930) 326, fig. 596.

Valve elliptic, with slightly truncate-rounded ends. Median line robust, with large comma-shaped terminal fissures and distinct robust central curved nodules. Axial area narrow, central area broad-suborbicular. Costæ robust, radiate, divergent in the middle and moderately convergent at the ends, 3 to 4 in 0.01 mm. Length, 0.047 to 0.069 mm; breadth, 0.012 to 0.02. Common in sample 2, rare in sample 3.

PINNULARIA BOREALIS Ehr. Plate 1, figs. 6 and 7.

Pinnularia borealis Ehr., FR. HUSTEDT, Bacillar. (1930) 326, fig. 597.

Valve linear-lanceolate, with obtuse or rostrate ends. Median line filiform, with comma-shaped terminal fissures. Axial and central area linear-lanceolate. Costæ robust, slightly radiate, about 4 to 5 in 0.01 mm. Length, 0.025 to 0.032 mm; breadth 0.0075 to 0.0085. Common. Samples 2 and 3.

PINNULARIA BOREALIS Ehr. var. RUPESTRIS var. nov. Plate 1, figs. 43 and 47.

Differt a typo valvis linearibus ad marginem parallelis. Longis valvis 0.088 ad 0.125 mm; latis valvis 0.012 ad 0.018. Costis 4 ad 5 in 0.01 mm, divergentibus, in media valvarum parte radiantibus, apice convergentibus. Habit. in rupestris muscosis prope Maoershan, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear, with parallel margins and broad-obtuse rounded ends. Median line linear, with large comma-shaped terminal fissures and distinct, slightly curved, central nodules. Axial area linear, central suborbicular. Costæ radiate, divergent in the middle and convergent at the ends, 4 to 5 in 0.01 mm. Length, 0.088 to 0.125 mm; breadth, 0.012 to 0.018. Differs from the type in its narrow linear valves with parallel margins. Infrequent. Sample 2.

PINNULARIA BALFOURIANA Grunow. Plate 1, fig. 15.

Pinnularia Balfouriana Grunow, FR. HUSTEDT, Bacillar. (1930) 326, fig. 599.

Valve linear-elliptic, with broad-rounded ends. Axial and central areas narrow-lanceolate. Costæ slightly radiate, 11 in 0.01 mm. Length, 0.0136 mm; breadth, 0.004. Infrequent. Sample 2.

PINNULARIA BALFOURIANA Grunow var. STAUROPTERA Skv. Plate 1, fig. 8.

Pinnularia Balfouriana Grunow var. *stauroptera* SKVORTZOW, Diatoms from Kizaki Lake, Nippon (1936) pl. 16, fig. 15.

Valve linear with broad-rounded ends. Length, 0.018 mm; breadth, 0.005. Costæ 9 in 0.01 mm. Infrequent. Sample 2. Reported from Nippon.

PINNULARIA ACROSPHAERIA Breb. Plate 2, fig. 7.

Pinnularia acrosphaeria Breb., A. SCHMIDT, Atlas Diatom. (1876) pl. 43, fig. 16.

Valve long-linear, with broad-capitate ends, and more or less gibbous in the middle. Median line filiform, with large comma-shaped terminal fissures and distinct central pores. Axial area broad linear, fine-punctate. Striæ radiate, 10 to 11 in 0.01 mm. Length, 0.093 mm; breadth, 0.01. Differs from the type in its broad-rounded ends. Rare. Sample 2.

PINNULARIA MAIOR (Kütz.) Cleve var. LINEARIS Cleve.

Pinnularia maior (Kütz.) Cleve var. *linearis* Cleve, PANTOCSEK, Fossile Bacillar. Ungarns (1903) 111, pl. 7, fig. 113.

Valve linear and not gibbous in the middle. Length, 0.17 mm; breadth, 0.02. Costæ 6 to 6½ in 0.01 mm. Rare. Sample 2.

PINNULARIA AESTUARII Cleve var. RUPESTRIS var. nov. Plate 4, fig. 7.

Minor quam forma typica et area centralis unilateralis. Longis valvis 0.064 mm; latis valvis 0.012. Costis 6 in 0.01 mm. Habit. in rupestris muscosis prope Mifun, Pin-Chiang-Sheng Province, Manchoukuo. Legit B. W. Skvortzow.

Valve linear, with parallel margins and rounded ends. Axial area narrow, central unilateral interrupted. Longitudinal bands indistinct. Length, 0.064 mm; breadth, 0.012. Costæ 6 in 0.01 mm. Differs from the type in its small size and in having a stauros only on one side of the valve. Sample 3.

EPITHEMIA ARGUS Kützing. Plate 1, fig. 34.

Epithemia argus Kützing, FR. HUSTEDT, Bacillar. (1930) 384, fig. 727*c*, *d*.

Valve arcuate and recurved. Length, 0.051 mm; breadth, 0.0085. Costæ 2, striæ 10 in 0.01 mm. Rare. Sample 2.

EPITHEMIA TURGIDA (Ehr.) Kützing. Plate 4, fig. 2.

Epithemia turgida (Ehr.) Kützing, FR. HUSTEDT, Bacillar. (1930) 387, fig. 733.

Valve semielliptic, with rostrate ends. Ventral margin constricted and slightly concave, dorsal margin arcuate. Length, 0.115 mm; breadth, 0.015. Costæ 3 to 4; striæ 9 in 0.01 mm. Infrequent. Sample 3.

EPITHEMIA ZEBRA (Ehr.) Kützing. Plate 4, fig. 21.

Epithemia zebra (Ehr.) Kützing, FR. HUSTEDT, Bacillar. (1930) 384, 385, fig. 729.

Valve semielliptic, with attenuate-rounded ends. Length, 0.059 mm; breadth, 0.01. Costæ 3, striæ 15 in 0.01 mm. Sample 3.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 740.

Valve semilanceolate, with reflexed end and centrally arcuate dorsal side. Length, 0.056 mm; breadth, 0.022. Sample 3.

HANTZSCHIA AMPHIOXYS (Ehr.) Grunow. Plate 2, figs. 12 and 13; Plate 4, fig. 15.

Hantzschia amphioxys (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1921) pl. 329, figs. 11, 12.

Valve linear-lanceolate, concave from ventral and convex from dorsal sides. Ends rostrate. Length, 0.0221 to 0.085 mm; breadth, 0.005 to 0.012. Keel puncta 5 to 9; striæ 18 to 20 in 0.01 mm. Common. Samples 1, 2, and 3. The largest forms, seen only in Harbin, are closely related to var. *maior* Grun.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. VIVAX (Hantz.) Grunow. Plate 2, fig. 2.

Hantzschia amphioxys (Ehr.) Grun. var. *vivax* (Hantz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 394, fig. 750.

Differs from the type in its elongate valves with attenuate subacute ends. Length, 0.17 mm; breadth, 0.01. Keel puncta 3 to 5; striæ 15 in 0.01 mm. Very common. Sample 2.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. COMPACTA Hustedt. Plate 2, fig. 1; Plate 4, fig. 3.

Hantzschia amphioxys (Ehr.) Grun. var. *compacta* HUSTEDT, Bacillar. aus Innerasien (1922) 145, pl. 10, fig. 42.

Two forms have been observed. One with the valve more robust than in the type, with short subrostrate ends. Length, 0.122 mm; breadth, 0.015. Keel puncta 4; striæ 13 in 0.01 mm. (Plate 2, fig. 1).

One with the valve longer than in the type, with elongate ends. Length, 0.144 mm; breadth, 0.014. Keel puncta 4, striæ 11 to 12 in 0.01 mm (Plate 4, fig. 3). Common. Samples 2 and 3. This variety was reported from Tibet.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. XEROPHILA Grunow. Plate 2, fig. 14.

Hantzschia amphioxys (Ehr.) Grun. var. *xerophila* GRUNOW, Diatomeen von Franz Josefs Land (1884) 47.

Differs from the type only in its coarser striæ. Length, 0.018 mm; breadth, 0.004. Keel puncta 8, striæ 25 in 0.01 mm. Infrequent. Sample 2.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. RUPESTRIS Grunow. Plate 4, fig. 1.

Hantzschia amphioxys (Ehr.) Grun. var. *rupestris* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 56, figs. 9, 10.

Differs from the type in its elongate ends. Length, 0.098 to 0.122 mm; breadth, 0.01. Keel puncta 3 to 5; striæ 12 to 16 in 0.01 mm. Sample 3.

NITZSCHIA TRYBLIONELLA Hantzsch. var. DEBILIS (Arnott) A. Mayer. Plate 1, fig. 19; Plate 2, fig. 15.

Nitzschia tryblionella Hantzsch var. *debilis* (Arnott) A. Mayer, FR. HUSTEDT, Bacillar. (1930) 400, fig. 759.

Valve elliptic, with short obtuse subacute ends. Length, 0.02 mm; breadth, 0.0085 to 0.01. Costæ 12 to 15 in 0.01 mm. Common. Sample 2. It was unexpected to see this diatom in mosses on rocks.

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HUSTEDT, FR. Bacillariophyta (Diatomeae). Die Süsswasser-Flora Mitteleuropas. Heft. 10. (1930).

HUSTEDT, FR. Bacillarien aus Innerasien. Stockholm (1922).

LAGERSTEDT, N. G. W. Sotvattens-Diatomaceen fram Spitsbergen och Beeren Eiland. Stockholm (1873).

PANTOCSEK, J. Fossile Bacilarien Ungarns. Berlin (1903).

SCHMIDT, A. Atlas Diatomaceenkunde. Leipzig (1874–1931).

SKVORTZOW, B. W. Diatoms from Calcutta, India. Philip. Journ. Sci. 58 (1935) 179.

SKVORTZOW, B. W. Diatomees recoltees par le Pere E. Licent dan le Nord de la Mandjourie. Tientsin (1935).

SKVORTZOW, B. W. Diatoms from Kizaki Lake, Honshu Island, Nippon. Philip. Journ. Sci. 61 (1936) 9.

SKVORTZOW, B. Subaërial diatoms from Hangchow, Chekiang Province, China. Bull. Fan. Memoir. Ints. Biology 7 (1937).

SKVORTZOW, B. W. Subaërial diatoms from Shanghai. Philip. Journn. Sci. 64 (1937) 443–451.

VAN HEURCK, H. Synopsis des Diatomees Belgiques. Anvers (1881–1885).

ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Achnanthes coarctata* Breb.
FIG. 3. *Achnanthes coarctata* Breb. (schematic).
4. *Achnanthes coarctata* Breb.
5. *Navicula mutica* Kütz.
FIGS. 6 and 7. *Pinnularia borealis* Ehr.
FIG. 8. *Pinnularia Balfouriana* Grun. var. *stauroptera* Skv.
9. *Diploneis rupestris* sp. nov.
FIGS. 10 and 11. *Navicula contenta* Grun. fo. *biceps* Arnott.
12 and 13. *Eunotia praerupta* Ehr.
FIG. 14. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
15. *Pinnularia Balfouriana* Grun.
16. *Navicula contenta* Grun. fo. *biceps* Arnott.
17. *Navicula contenta* Grun.
18. *Navicula contenta* Grun. fo. *parallela* Petersen.
19. *Nitzschia tryblionella* Hantzsch var. *debilis* (Arnott) **A. Mayer.**
20. *Navicula confervacea* Kütz.
21. *Navicula perpusilla* Grun.
22. *Stauroneis parvula* Grun. var. *rupestris* Skv.
23. *Navicula mutica* Kütz.
24. *Navicula gibbula* Cleve.
25. *Navicula contenta* Grun. fo. *elliptica* Krasske.
26. *Navicula mutica* Kütz.
27. *Eunotia praerupta* Ehr. var. *inflata* Grun. fo. *curta.*
28. *Pinnularia convergens* sp. nov.
29. *Pinnularia fasciata* (Lagerst.)
30. *Navicula ignota* Krasske.
31. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
32. *Navicula Kotschyi* Grun. var. *rupestris* var. nov.
33. *Pinnularia convergens* sp. nov.
34. *Epithemia argus* Kütz.
FIGS. 35 to 37. *Eunotia monodon* Ehr. var. *minor* (W. Smith) Hust. fo. *bidens* (W. Smith).
FIG. 38. *Eunotia bigibba* Kütz.
39. *Eunotia bigibba* Kütz. var. *rupestris* var. nov.
40. *Stauroneis rupestris* sp. nov.
41. *Navicula ocellata* sp. nov.
42. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
43. *Pinnularia borealis* Ehr. var. *rupestris* var. nov.
44. *Eunotia bigiba* Kütz. var. *pumila* Grun.?
45. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.

FIG. 46. *Eunotia praerupta* Ehr.
47. *Pinnularia borealis* Ehr. var. *rupestris* var. nov.
48. *Navicula lapidosa* Krasske.

PLATE 2

FIG. 1. *Hantzschia amphioxys* (Ehr.) Grun. var. *compacta* Hust.
2. *Hantzschia amphioxys* (Ehr.) Grun. var. *vivax* (Hantz.) Grun.
3. *Navicula Kotschyi* Grun. var. *rupestris* var. nov.
4. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.
5. *Navicula mutica* Kütz.
6. *Eunotia gracilis* (Ehr.) Rabh.
7. *Pinnularia acrosphaeria* Breb.
8. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
FIGS. 9 and 10. *Pinnularia lata* (Breb.) W. Smith fo. *thuringiaca* (Rabh.) A. Mayer.
FIG. 11. *Eunotia bigibba* Kütz.
FIGS. 12 and 13. *Hantzschia amphioxys* (Ehr.) Grun.
FIG. 14. *Hantzschia amphioxys* (Ehr.) Grun. var. *xerophila* Grun.
15. *Nitzschia tryblionella* Hantzsch var. *debilis* (Arnott) A. Mayer.
FIGS. 16 and 17. *Navicula mutica* Kütz. var. *rhombica* var. nov.
FIG. 18. *Navicula ocellata* sp. nov. var. *polymorpha* var. nov. The same valve from both sides.
19. *Melosira roeseana* Rabh.

PLATE 3

FIG. 1. *Melosira roeseana* Rabh. var. *asiatica* var. nov.
2. *Melosira roeseana* Rabh. var. *epidendron* Grun. fo. *spinosa* fo. nov.
3. *Melosira roeseana* Rabh. var. *asiatica* var. nov.; schematic.
4. *Melosira roeseana* Rabh. var. *epidendron* Grun.
5. *Melosira roeseana* Rabh.
6. *Melosira roeseana* Rabh. var. *epidendron* Grun. fo. *podocyclia* Grun.
7. *Pinnularia aestuarii* Cleve var. *rupestris* var. nov.
FIGS. 8 and 9. *Eunotia bigibba* Kütz.
FIG. 10. *Melosira roeseana* Rabh. var. *epidendron* Grun.
11. *Stauroneis obtusa* Lagerst.
12. *Melosira roeseana* Rabh.

PLATE 4

FIG. 1. *Hantzschia amphioxys* (Ehr.) Grun. var. *rupestris* Grun.
2. *Epithemia turgida* (Ehr.) Kütz.
3. *Hantzschia amphioxys* (Ehr.) Grun. var. *compacta* Hust.
4. *Melosira roeseana* Rabh.
5. *Melosira roeseana* Rabh. var. *indica* Skv.
6. *Navicula Lagerheimii* Cleve var. *ovata* Skv.
7. *Pinnularia aestuarii* Cleve var. *rupestris* var. nov.
FIGS. 8 and 9. *Navicula Lagerheimii* Cleve var. *robusta* var. nov.
FIG. 10. *Navicula Lagerheimii* Cleve var. *ovata* Skv.
FIGS. 11 and 12. *Navicula Lagerheimii* Cleve var. *lanceolata* var. nov.
13 and 14. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

FIG. 15. *Hantzschia amphioxys* (Ehr). Grun.
FIGS. 16 and 17. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
FIG. 18. *Frustulia vulgaris* Thw. var. *rupestris* var. nov.
19. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.
20. *Navicula Lagerheimii* Cleve var. *ovata* Skv.
21. *Epithemia zebra* (Ehr.) Kütz.
22. *Melosira roeseana* Rabh.
FIGS. 23 and 24. *Navicula Lagerheimii* Cleve var. *intermedia* Hust.

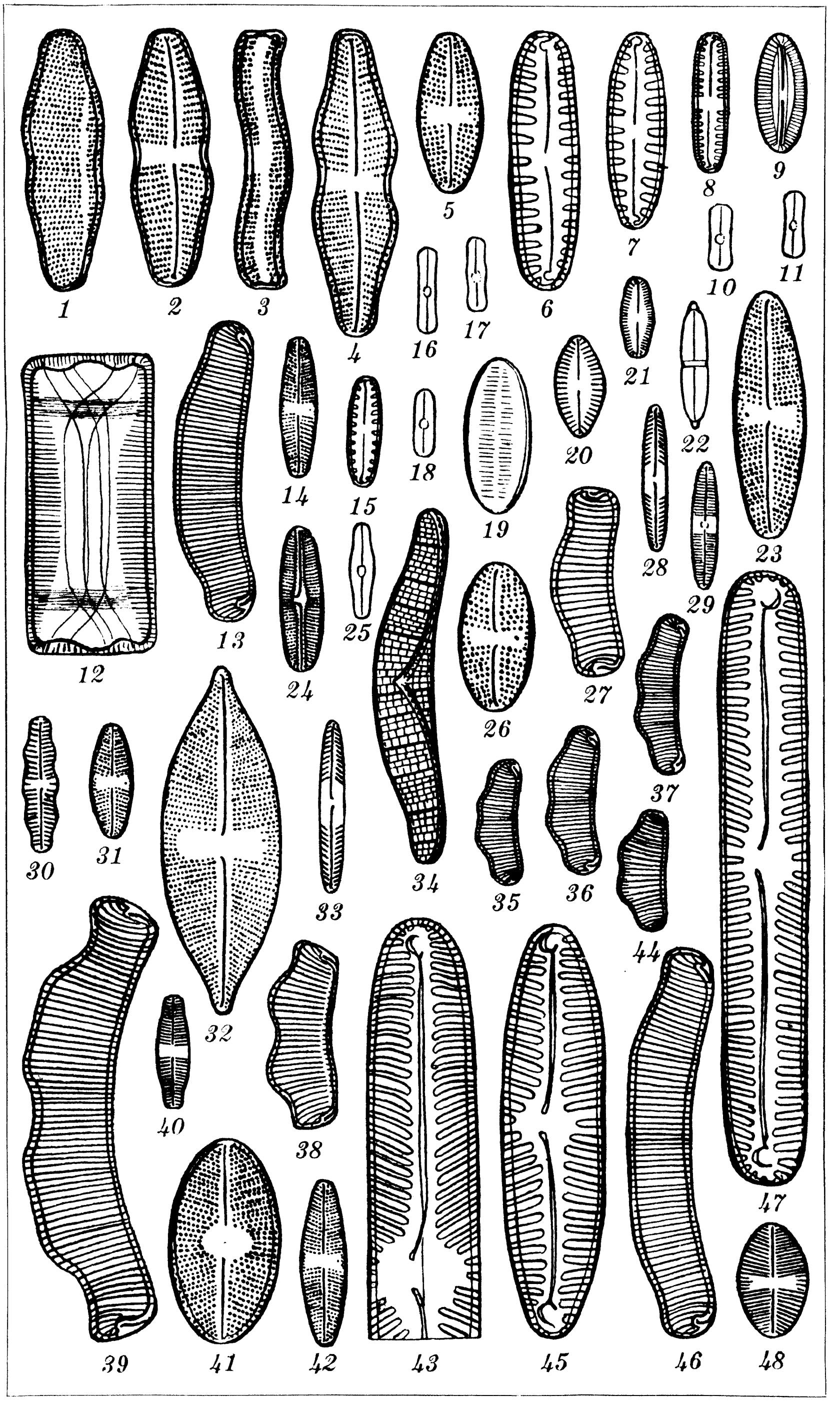
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PLATE 1.

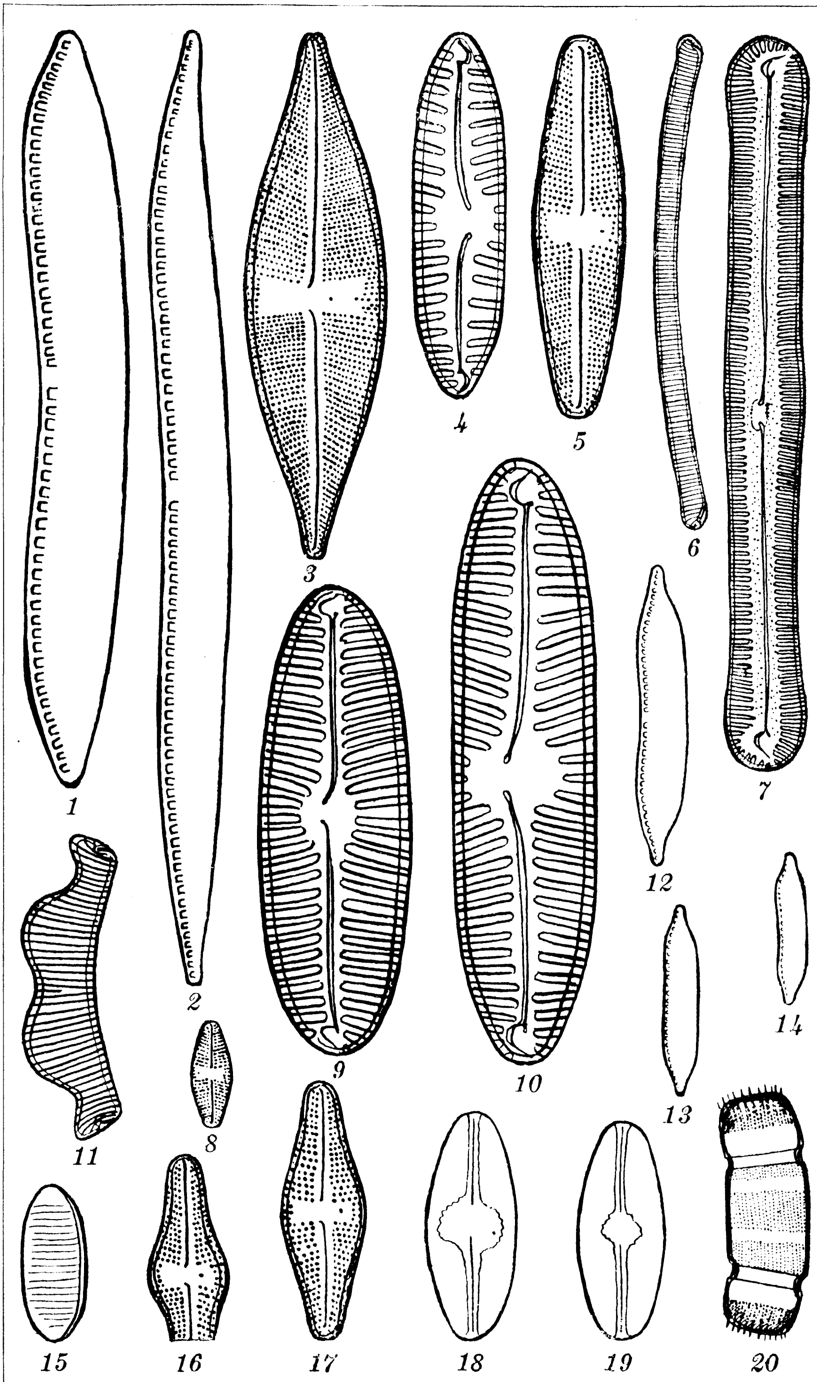

PLATE 2.

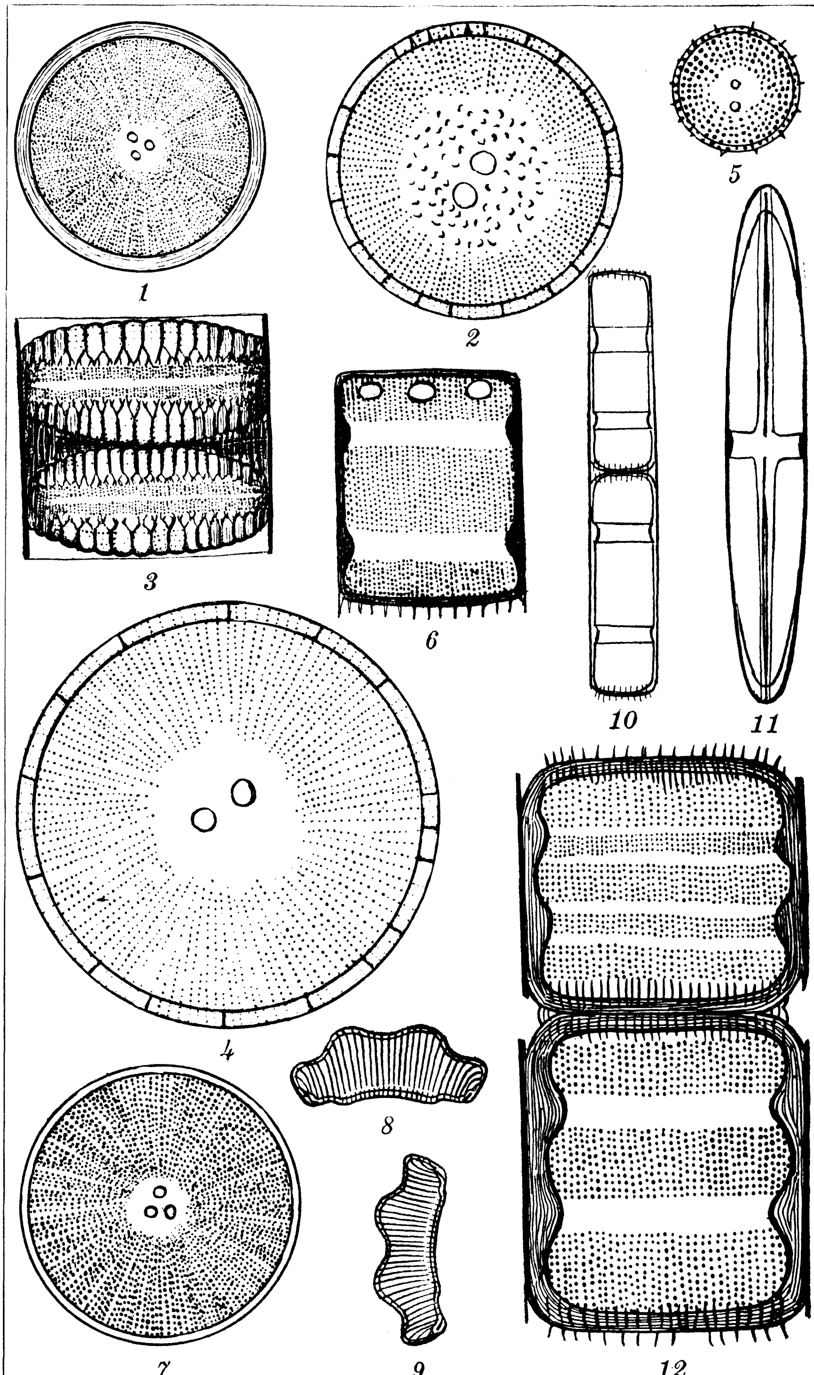

PLATE 3.

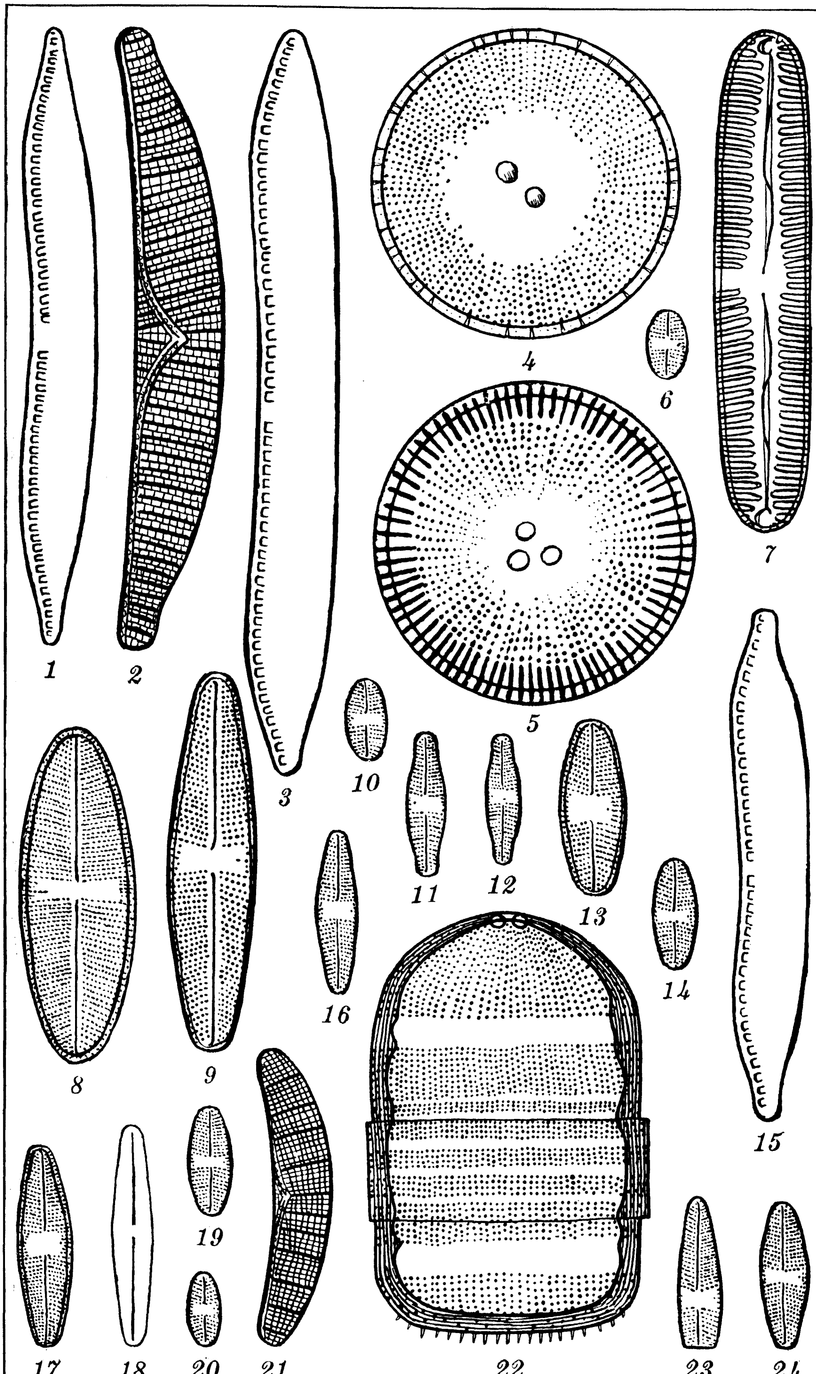

PLATE 4.

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. Standards on petroleum products and lubricants. Prepared by Committee D-2. Methods of testing, specifications, definitions, charts, and tables. The Society, 1937. 385 pp., illus. Price, $2.

American Society for Testing Materials. Symposium on lubricants, March 3, 1937. The Society, 1937. 89 pp., illus.

BALK, ROBERT. Structural behavior of igneous rocks (with special reference to interpretations by H. Cloos and collaborators). Memoir 5 of the Geological Society of America, Washington, D. C., 1937. 177 pp., maps, plates, illus.

BERKOW, SAM GORDON. Childless; a study of sterility, its causes and treatment. New York, Lee Furman, Inc. c1937. 307 pp., illus. Price, $3.

BRAGG, WILLIAM. Atomic structure of minerals. Ithaca, Cornell University press, 1937. 292 pp., illus., tables, plates, diagrs. Price, $3.75.

CARLSON, ANTON JULIUS, and VICTOR JOHNSON. The machinery of the body. Chicago, University of Chicago press, 1937. 580 pp., illus., tables, diagrs. Price, $4.

CURRAN, C. H., and CARL KAUFFELD. Snakes and their ways. New York, Harper & brothers, 1937. 285 pp., illus. Price, $3.50.

DAVIS, IRA C., and RICHARD W. SHARPE. Science; a story of progress and discovery. New York, Henry Holt & co., c1936. 491 pp., illus. Price, $1.72.

FURTADO, C. X. A commentary on the laws of botanical nomenclature. Gardens' Bulletin, v. 9, pt. 3, Oct. 9, 1937. pp. 223–284.

FURTADO, C. X. The nomenclature of types. Gardens' Bulletin, v. 9, pt. 3, Oct. 9, 1937. pp. 285–317.

GENNER, V. By-effects in salvarsan therapy and their prevention; with special reference to the liver function. Copenhagen, Levin & Munksgaard, 1936. 360 pp., tables.

GORTNER, ROSS AIKEN. Selected topics in colloid chemistry, with special reference to biochemical problems. Ithaca, Cornell University press, 1937. 169 pp., tables. Price, $2.50.

HILLIARD, CURTISS M. A textbook of bacteriology and its applications. rev. ed. New York, Ginn & co., c1936. Price, $3.50.

IRMINGER, J. O. V., and CHR. NOKKENTVED. Wind-pressure on buildings; experimental researches. Translated from the Danish by Alexander C. Jarvis and O. Brodsgaard. 1st and 2d series. Copenhagen, Danmarks Naturvidenskabelige Samfund, 1930, 1936. 2 vols. Price, 20 kr.

LINDSEY, ARTHUR WARD. The science of animal life. New York, Harcourt, Brace, and co., c1937. 656 pp., illus. Price, $3.75.

LORD, ELIZABETH EVANS. Children handicapped by cerebral palsy; psychological factors in management. With a medical explanation by Bronson Crothers. New York, The Commonwealth fund, 1937. 105 pp. Price, $1.25.

MILLIKAN, ROBERT ANDREWS, DUANE ROLLER, and ERNEST CHARLES WATSON. Mechanics, molecular physics, heat, and sound. New York, Ginn and company, c1937. 498 pp. Price, $4.

MILLIS, HARRY ALVIN. Sickness and insurance; a study of the sickness problem and health insurance. Chicago, University of Chicago press, c1937. 166 pp. Price, $2.

MOULTON, FOREST RAY, ed. The world and man as science sees them. With many linecut and halftone illustrations. Chicago, University of Chicago press, 1937. 533 pp. Price, $3.

MURRAY, D. STARK. Science fights death. London, Watts & company, 1936. 149 pp., illus. Price, 2s 6d.

MUSPER, K. A. F. R. Das erdöl und seine verwandten in den Philippinen. 1937. 17 pp., tables, maps.

PEACOCK, ALEXANDER H. Globe trotting with a surgeon. With photographs by the author. Seattle, The press of Lowman & Hanford co., 1936. 276 pp.

WILLIS, BAILEY, and ROBIN WILLIS. Geologic structures. 3d. ed., rev. New York, McGraw-Hill Book co., 1934. 544 pp., illus. Price, $4.

WISEMAN, JOHN D. H. Basalts from the Carlsberg Ridge, Indian Ocean, with an appendix on the radium content of some sub-oceanic basalts from the floor of the Indian Ocean, by J. H. J. Poole. (The John Murray expedition, 1933–34, Scientific Reports, v. 3, no. 1, Geological and mineralogical investigations.) London, The British Museum, 1937. 30 pp., plates, illus. Price, 2s 6d.

REVIEWS

Air Conditioning—Insulation; treats of the principles and applications of insulation as used to retard heat losses and gains, and to guard against fire, sound, vibration, condensation, and termites in buildings. By J. Ralph Dalzell and James McKinney. Chicago, American Technical Society, 1937. 301 pp., illus. Price, $2.50.

This book treats of the principles and applications of insulation as a means of (1) retarding heat losses and gains through structural parts of buildings; (2) preventing loss by fire; (3) controlling sound; (4) preventing vibration; (5) protecting buildings against termites; (6) protecting all mechanical parts against heat losses and freezing; and (7) preventing condensation.

The authors assume that the reader is familiar with simple mathematics, architectural details, design of ducts, and general heating and air-conditioning principles. All principles and methods of design or calculation are well explained and illustrated.

The book would be useful to students of insulation and to prospective builders of large buildings and hotels.—F. D. M.

Alcoholism in General Practice. By A. E. Carver, Thomas Hunt, and Sir William Willcox. London, Constable & Company, Ltd., 1936. 131 pp. Price, 7s 6d.

The book will find its chief usefulness in the library of the general practitioner, especially the internist, the alienist, and the medico-legal officer.

Because alcoholism is not so common in the Philippines as in temperate climates, local practical application of the information furnished by the authors will naturally be limited. It would, however, be a valuable clinical aid in the determination or verification of certain manifestations of alcoholism; namely, alcoholic neuritis as contrasted with other forms of peripheral neuritis; so-called alcoholic gastritis as differentiated from other gastric and abdominal conditions; and the various effects of alcohol on the renal and circulatory systems, especially the kidneys, the heart, and the blood pressure. It would also be profitable in the determination of whether alcohol has any etiological relationship with our cases of portal cirrhosis.

One very practical application of the book, especially important for medico-legal officers, is the aid it furnishes in the determination of drunkenness.

The book is sufficiently rich in the various suggestions (psychological, medicinal, institutional, and general) for the effective management of alcoholism in various phases.—G. F. A.

The Biological Control of Insects. With a Chapter on Weed Control. By Harvey L. Sweetman. Foreword by L. O. Howard. Ithaca, Comstock pub. co., inc., 1936. 461 pp., illus. Price, $3.75.

This is undoubtedly the most comprehensive and most useful book written so far on the biological control of insects. There are 14 chapters, with a foreword of appraisal of the book and its author by Dr. L. O. Howard, former chief of the U. S. Bureau of Entomology, himself one of the leading authorities on biological control. The first chapter deals with the theoretical basis of biological control, among the topics discussed being biotic potential and environmental resistance with special reference to parasites and predators. The whole of chapter 2 is devoted to the use of resistant varieties of plants as a means of controlling insect pests. In chapters 3, 4, and 5 are described the rôle that bacteria and fungi, viruses, protozoa, and parasitic invertebrate animals (nemathelminthes), respectively, play, and the extent to which these may be artificially utilized, in the control of insects. The greater portion of chapters 6, 7, and 8, indeed of the entire book, is chiefly devoted to insect parasites and predators. Chapter 9 deals with some of the biological relations of insect predators and parasites to their hosts.

From a practical standpoint, chapters 10 and 11 are most helpful. Chapter 10 covers the factors that should be considered in the utilization of insect parasites and predators. Chapter 11 deals with the points to be considered before actual introduction may be attempted, the qualities desired in parasites and predators, methods of handling, shipping, rearing, liberation, and other aspects.

Chapter 12 deals with the use of predatory vertebrate animals, such as toads, birds, mammals, and others. Chapter 13 presents the results of biological control, and those that are considered still in the experimental stage are reported and the limitations of biological control discussed. The biological control of pest plants (weeds) is the subject of the last chapter.

The book is provided with a glossary and a long list of references which appears to include the most important works on biological control; the index appears to be complete in every respect. It is apparent that the author has spared no effort to make the book really useful. It is truly authoritative and complete and constitutes a very handy and most valuable guide and reference to all interested in biology. To economic entomologists, in particular, who should be greatly benefited by it, the book is indispensable.—F. Q. O.

Foods; Their Selection and Preparation. By Louise Stanley and Jessie Alice Cline. New York, Ginn and company, c1935. 458 pp., illus. Price, $2.60.

This book is at its best used as a textbook for beginners' courses in the selection and preparation of food in colleges and teachers' colleges. Although the principles in this book have been the result of experimental work and research, the general aim of the book is to present the subject matter in the way most helpful to the housewife and dietitian.

The book contains twenty-five chapters, supplemented by illustrations in the form of photographs, diagrams, and tables. The first part of the book deals with the composition of food and the functions of different food nutrients. It gives the physiological and chemical factors responsible for digestion and absorption of foods. Tables showing the total requirements of each food nutrient to meet the needs of different individuals are also given.

The book not only explains how to utilize foodstuffs in their natural form but also describes the chemical phase of how the same foodstuffs and their by-products can be used more profitably.

Different chapters are devoted to fruits, cereals, and vegetables, respectively, giving their classification and composition, supplemented with valuable hints for buying them. Eggs, milk, and milk products are given very interesting and instructive chapters.

Very few recipes are included in this book, which is largely intended to explain the hows and whys of cooking.—C. A.

A Guide to the Mineral Gallery. British Museum of Natural History. 14th ed. 1937. 60 pp., plate, illus. Price, 6d.

In addition to technical and scientific catalogs, the Trustees of the Museum issue short popular guides to the collections in order to assist in the education of the general public which plays such an important part in the work of this as in other great museums. The fourteenth edition of the guide to the minerals is excellently adapted to serve this purpose. It is not so detailed as to be wearisome, and not too inclusive to be complex, but it contains notes on the various collections which include many of the things teachers of mineralogy know so well. Science should be pursued for pleasure and culture as well as for information, and to that end there remains a place for such pamphlets as this modest guide.

Merely reading this guide makes one want to visit the museum, which is probably what it was expected to do, and to wander down the aisles between the cases guide in hand would indeed be pleasant as well as educative.—H. F. B.

High-Speed Diesel Engines. A Practical Text on High-Speed Diesels, Including Instruction on Fuel-Injection and Combustion Systems, Frames and Cylinders, Running Gear, and Construction Details of the Different Models of the Diesel Engines and Their Applications to Industry and Transportation. By L. H. Morrison. Chicago, American Technical Society, 1937. 243 pp., illus. Price, $2.50.

This is a clearly written and well illustrated practical book. The instructions on the fuel injection and combustion system, and construction details of different makes of engines, are especially commended. It is a valuable book for anyone interested in the operation of diesel engines.—F. D. M.

Machinery and Equipment of the Cane Sugar Factory. By L. A. Tromp. London, Norman Rodger, 1936. 644 pp., illus. Price, $8.

This book is an exhaustive textbook on the machinery and equipment used in the sugar factories. It provides comprehensible and valuable information step by step about machinery and equipment from the selection of the sugar factory site to the transportation of the finished product. It combines theory with the practical experience of the author during nearly twenty years of consulting, designing, and operation of cane sugar factories. There are 616 drawings prepared by the author, effectively conveying the technical ideas explained in the text. This book is valuable to engineers designing the machinery as well as those operating them.—F. D. M.

Odyssey of the Islands. By Carl N. Taylor. New York, Charles Scribner's sons, 1936. 284 pp., photographs. Price, $3.

Carl N. Taylor's Odyssey of the Islands makes very interesting and entertaining reading. Unlike other American writers, who came to the Philippines with preconceived ideas for or against independence, Mr. Taylor is unbiased.

The author tells us about his trip to Mindanao, and describes his vivid impressions of primitive life in the Manobo region. He admits that head-hunting, as an institution, still exists among the Manobos; but a Manobo warrior has only one object in chopping off a head—to prove his manhood to the woman he wishes to marry. Head-hunting is also practiced by the Ifugaos of northern Luzon, but to a very limited extent.

There seems to be an established tradition among the Negritos that once a man has ceased to be useful to his tribe he becomes a liability. If food is plentiful, he may be tolerated; if not, he is banished to die in the forest.

In conclusion, the reviewer believes that the book, on the whole, is a fair treatment of the subject. The author has really attempted to give a true picture of native life as he saw it in his wanderings "away from the tourist path." The book would make a valuable reference for any one who desires to know more about the unexplored tribes of the Philippines.—M. J.

An Outline of General Forestry. By Joseph S. Illick. New York, Barnes & Noble, c1935. 259 pp. illus. Price, $1.50.

This outline is designed primarily as a general introduction to forestry and closely related branches of conservation. It consists of thirty chapters, illustrated with text figures, and provided with questions and references. It thus becomes a very handy and highly desirable reference book for students in forestry, teachers, and forest users.

The book is neither a textbook nor a research contribution. It serves as a guide to a general understanding of what forestry is, how it is developing, where it is heading, and what benefits it is bringing to mankind. It is a valuable addition to private and public libraries, primarily for the youth of the land, upon whom, in the words of Professor Illick, the future of forestry rests.

The outline is eminently fitted for extension and public relations work. In discussing "What Forestry Is," lantern slides, photographs, charts, and maps could be used to advantage. A one-reel motion picture—the A B C of Forestry—is available for distribution through the office of Motion Pictures, U. S. Department of Agriculture. This reel contains excellent pictures and text material to supplement the discussion. A similar procedure could be followed in this country to educate the Filipino youth and the people in the barrios. "The trends in forestry," says the author, "are ever-changing. More and more is the wise forester guiding the whole forestry movement in the direction of sustained yields in health, recreation, work opportunities, and other human benefits."—E. de la C.

Philippine Independence; Motives, Problems, and Prospects. By Grayson L. Kirk. New York, Farrar & Rinehart, Inc., 1936. 278 pp. Price, $2.50.

In a rather scholarly way, Professor Kirk starts his analysis of the Philippine question from the time when the United States, imbued with the spirit of "Manifest Destiny," decided to retain the Philippines against the desire of the inhabitants to remain independent. He feels that while the persistent Filipino agitation is in principle noteworthy, "it was in reality a demonstration of marked ingratitude which was to be regretted, but which was not to be regarded with any great gravity." Unfortunately, there were groups of economic interests in the United States which allied with the friends of Philippine independence to undo the American accomplishments in the Islands. The efforts of this unholy alliance, which comprised the old American leaders who were politically rather than economically minded, the Filipino leaders who desired independence at a great price, and these groups of economic interests, brought about the enactment of the Hare-Hawes-Cutting Act and later the Tydings-McDuffie Act. According to the author, the Independence Act was primarily a triumph of selfish interests.

The book is divided into nine chapters: Assuming the white man's burden, the old independence movement, trade follows the flag, the farm groups, the triumph in Congress, the economic outlook, the new Constitution and the political outlook, the Japanese problem, and Filipino-American relations with a suggested program. The appendix includes President Hoover's veto message, the Tydings-McDuffie Act, and the Constitution of the Philippines.—G. P.

Termite City. By Alfred E. Emerson and Eleanor Fish. With a Foreword by William Beebe. Chicago, Rand McNally & Company, c1937. 127 pp., illus. Price, $1.50.

Although intended for young people, this book is equally instructive to adult readers who will find an admirable description in nontechnical language of the life of termites, with emphasis on natural history. The authors have written a very entertaining account of the social life of termites who live in a community with a government which seems to be more efficient than ours, because every member of their community does his job so well, and members who won't work are eaten up by those who do.—P. S. S.

The Tropical Subsistence Homestead. Diversified Crops in Forest Formation for the Antillean Area. By John C. Gifford. New York, Books, Inc., c1934. 158 pp. Price, $0.50.

Dedicated to Senator Duncan U. Fletcher because of his long efforts in behalf of national parks, forest conservation, and conservation in general, this little volume contains valuable and highly constructive ideas and forest policies which should be highly interesting to Filipino leaders and students. Professor Gifford has ably discussed the furtherance of the tropical forest subsistence homestead for the Negroes, the Seminoles, and Tropical Indians living in the tradewind area of the American Tropics.

Large proportions of small holdings covered with diversified tree crops in forest formation—a kind of mixed husbandry with the tree in forest formation—is advocated. The subsistence homestead in the opinion of the author is the only permanent and most essential thing that can give life and comfort to the majority of the American people. To him, the best nations of the world are those with the largest number of small, self-supportive, free-of-debt homesites. Sample subsistence homesteads in cities for parks and exhibition purposes are likewise advocated.

The concluding aphorisms bring to light what we should do or not do with regard to the forest of the future. Importance is attached to the profession of forestry and to the forester. In the opinion of Professor Gifford, "a triangle in the future consists of foresters and other producers of raw materials, chemists who convert these products into many other useful products, and the mechanical engineers who can build machines for these purposes."—E. de la C.

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DETERMINATION OF THE PISCINE INTERMEDIATE HOSTS OF PHILIPPINE HETEROPHYID TREMATODES BY FEEDING EXPERIMENTS.[1]

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The recent works of Africa et al., associating the eggs of various species of heterophyid trematodes with fatal heart lesions in man (3, 4, 6, 8) as well as definite lesions in the cerebro-spinal system (5, 7) of the same host, have attracted considerable interest to this group of worms. As part of a general program to obtain information that may be of value in the prophylactic control of these trematodes in the future, the Department of parasitology, School of Hygiene and Public Health, University of the Philippines, has undertaken a series of feeding experiments to determine the piscine hosts of Philippine heterophyids. The present paper has been prepared in partial fulfillment of this project.

MATERIALS AND METHODS

In order to determine beforehand the species of fish that would be most likely to infect experimental animals to which they are fed with heterophyids, a systematic search for metacercariæ was made in fishes that to our knowledge are eaten raw or semiraw by a large number of Filipinos. To our surprise, most if not all of the species of fish we have so far found in-

[1] Aided by a special research grant from the Board of Regents, University of the Philippines.

fested with metacercariæ which upon feeding to experimental animals yielded adult heterophyid flukes turned out to be marine forms; yet it seems to be the general impression that heterophyids infesting man usually utilize fresh-water fishes as second intermediate hosts. However, Ciurea(10) has found in the parasitic fauna of Roumania seven species of heterophyids derived from marine fishes.

The species of fish we have used in our feeding experiments are: *Hepsetia balabacensis* (locally known as *guno*), *Hemiramphus georgi*[2] (*cansusuit*), *Ambassis buruensis* (*lañgaray*), *Mugil* sp. (*talilong*), *Arius manillensis* (*kanduli*), and *Clarias batrachus* Bloch, all of which are marine forms, according to Doctor Villadolid, ichthyologist of the Bureau of Science, Manila, who identified them. However, the two last-named forms are known to spend a considerable period of their life in fresh waters. As our supply of fish was obtained regularly throughout our experiments from the different public markets of Manila, we are not in a position to state the localities from which they were caught.

Before examination the fish were washed in tap water and rinsed in physiological salt solution. The whole fish when small, or a portion of it when too large, was placed in a small petri dish and physiological salt solution added. Under a dissecting microscope the tissues were searched for metacercariæ by teasing them out bit by bit with teasing needles. Each fish was searched out in its entirety for metacercariæ—fins, scales, skin, flesh, cavities, and internal organs were scrutinized. Thus it was possible at the end of some time to determine for each species of fish the sites usually infected by metacercariæ.

By means of a fine pipette provided with a rubber nipple the metacercariæ were picked out from the dissecting dish and placed in a small quantity of physiological salt solution contained in a staining dish for subsequent feeding, or placed directly in the mouth of the experimental animal selected for the purpose. This method of feeding by pipette was used in feeding rats and mice. In the case of cats and dogs the fish was simply served to them entire or chopped.

[2] January 19, 1937. Eleven specimens of *Hemiramphus georgi* examined for metacercariæ showed in their intestines a characteristic human-fæces-like material rich in *Ascaris* and *Trichuris* eggs. This fish is well-known among the natives as a great scavenger, particularly on human fæces.

By previous tests we have found that albino rats and mice allow full development of heterophyid flukes in their intestines. Since these animals are naturally free from heterophyid infection and can be reared in the laboratory, they are quite satisfactory for feeding experiments. Young pups and kittens were also utilized for the purpose with appropriate parallel controls. Only metacercariæ obtained from one species of fish were fed to one animal. The animals were fed on metacercariæ every day or at irregular intervals, depending on circumstances, over longer or shorter periods. All the animals were kept separately in metal cages set far apart, and precautions taken against all possible contamination of their rations. Their fæces were regularly examined before the start of the experiment to insure freedom from previous heterophyid infection as well as during the progress of the experiment, to ascertain its ultimate supervention in the animals concerned. Then the animals were sacrificed, and the gastro-intestinal tract and all other organs examined for flukes.

RESULTS

The results of our feeding experiments are given separately for each species of fish used in Tables 1 to 6.

REMARKS

All the heterophyids recovered in our experiments, with the exception of *P. genata* and an immature, still unidentified, probably new heterophyid (*Microlistrum*), have already been reported from the Philippines in their final hosts. In one of the species of fish (*Ambassis buruensis*) utilized in these experiments we have frequently found two apparently different species of *Stamnosoma* (one big and having a long intestine, and the other very tiny and having a short intestine), and one *Parascocotyle* (*Phagicola*) in their metacercarial stage. The larger of the two *Stamnosoma* metacercariæ also parasitizes *Hepsetia balabacensis*, another fish used in these experiments. Up to this time, however, we have consistently failed to recover these Centrocestinæ by experimental feeding to albino rats and mice, kittens, and puppies. One of us (C. M. A.) recovered an apparently new species of *Stamnosoma* from the intestine of a pelican (*Pyrreroides manilensis*) and from the cattle egret.

It will be of interest to mention here that *Diorchitrema pseudocirrata* figured among the flukes whose eggs have been

TABLE 1.—*Feeding experiments with metacercariæ from Hespetia balabacensis (guno).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Rat 1	January 8–February 11	10	February 12	*Stictodora guerreroi* *Stictodora manilensis* *Monorchotrema calderoni*	14
Rat 2	March 25–April 23	22	April 27		0
Mouse 1	February 18–February 26	4	March 2		0
Mouse 2	February 18–February 24	4	February 28	*Stictodora guerreroi*	8
Mouse 3	April 26	1	April 30	*Stictodora guerreroi*	1
Mouse 4	April 29	1	May 2	*Stictodora guerreroi*	5
Mouse 5	May 3–July 15	19	July 15	*Stictodora manilensis*	2
Puppy 1	May 26–May 28	3	May 29	*Stictodora guerreroi* *Stictodora manilensis*	20
Puppy 2	May 29–June 5	6	June 7	*Stictodora guerreroi* *Stictodora manilensis*	94
Puppy 3	June 7- June 22	11	June 24	*Stictodora guerreroi* *Stictodora manilensis*	214
Puppy 4	June 24–September 7	41	September 10	*Monorchotrema calderoni* *Heterophyes expectans* *Stictodora guerreroi* *Stictodora manilensis*	([a])
Control Puppy 1		0	June 17		0
Control Puppy 2		0	June 22		0
Control Puppy 3		0	July 4		0
Control Puppy 4		0	September 10		0

[a] Heavy infection.

TABLE 2.—*Feeding experiments with metacercariæ from Hemiramphus georgi (cansusuit).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Rat 1	January 9–February 12	12	February 13	*Stictodora guerreroi*	92
Rat 2	March 22–April 23	20	April 24		0
Mouse 1	February 17–February 18	2	February 26		0
Mouse 2	March 2–March 4	3	March 5	*Stictodora guerreroi*	32
Mouse 3	March 4	1	March 12		0
Mouse 4	March 8–March 12	2	March 15	*Stictodora guerreroi*	3
Mouse 5	April 26	1	April 27	*Stictodora guerreroi*	7
Mouse 6	May 18–May 24	3	May 25		0
Cat 1	May 14–May 17	2	May 18	*Stictodora guerreroi*	384
Cat 2	May 26–June 5	9	June 9	*Stictodora guerreroi* *Heterophyes expectans.* *Monorchotrema yokogawai.*	100
Cat 3	May 28–June 14	13	June 19	*Stictodora guerreroi* *Heterophyes expectans.*	482
Puppy 1	June 9–June 19	6	June 22	*Stictodora guerreroi* *Heterophyes expectans.* *Monorchotrema yokogawai.* *Monorchotrema calderoni.*	1,680
Puppy 2	June 25–August 17	27	August 19	*Stictodora guerreroi* *Heterophyes expectans.* *Monorchotrema calderoni.*	([a])
Control Puppy 1		0	June 24		0
Control Puppy 2		0	July 4		0
Control Puppy 3		0	September 10		0
Control Cat		0	June 7		0

[a] Heavy infection.

TABLE 3.—*Feeding experiments with metacercariæ from Ambassis buruensis (lan͠garay).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Mouse 1	January 25–February 11	10	February 15	*Stictodora guerreroi*	33
				Stictodora manilensis	
				Monorchotrema yokogawai	
Mouse 2	March 1	1	March 4		0
Mouse 3	March 1	1	March 2	*Stictodora manilensis*	2
Mouse 4	March 4–March 10	4	March 11	*Stictodora manilensis*	3
Mouse 5	March 11–March 15	4	March 16		0
Mouse 6	April 26	1	April 28	*Stictodora guerreroi*	7
				Stictodora manilensis	
Mouse 7	April 28	1	May 1		0
Mouse 8	April 28	1	May 2		0
Mouse 9	May 3–May 4	2	May 6		0
Mouse 10	May 6–May 24	13	May 25	*Stictodora manilensis*	1
Mouse 11	May 12	1	May 14		0
Mouse 12	May 25–July 17	15	July 22	*Stictodora manilensis*	1
Rat 1	March 23–April 23	27	April 26		0
Rat 2	April 26–April 27	2	April 29		0
Puppy 1	May 26–June 16	16	June 17	*Stictodora guerreroi*	(a)
				Stictodora manilensis	
				Monorchotrema calderoni	
				Monorchotrema yokogawai	
				Heterophyes expectans	
Puppy 2	June 17–June 23	3	June 24	*Stictodora guerreroi*	7
				Stictodora manilensis	

Cat 1	June 8–September 7	58	September 8	*Stictodora manilensis* *Monorchotrema yokogawai* *Stictodora guerreroi* *Monorchotrema calderoni* *Heterophyes expectans* *Microlistrum* (?) (immature)	228
Control Puppy 1		0	May 29		0
Control Puppy 2		0	July 4		0
Control Puppy 3		0	September 10		0
Control Cat		0	September 17		0

[a] Heavy infection.

TABLE 4.—*Feeding experiments with metacercariæ from Mugil sp. (talilong).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Puppy	July 10–July 27	14	July 28	*Stictodora guerreroi* *Stictodora manilensis* *Monorchotrema yokogawai* *Monorchotrema calderoni* *Diorchitrema pseudocirrata* *Heterophyes expectans* *Pygidiopsis genata* *Pygidiopsis marivillai*	3,949
Control Puppy		0	July 18		0

TABLE 5.—*Feeding experiments with metacerca riæ from Clarias batrachus (hito).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Puppy	July 17–August 17	22	August 18	*Monorchotrema yokogawai*	1,815
Control puppy		0	July 18		0

TABLE 6.—*Feeding experiments with metacercariæ from Arius manillensis (kanduli).*

Experimental animal.	Dates of feeding.	No. of feedings.	Date of dissection.	Species of heterophyids identified.	No. of flukes recovered.
	1937		1937		
Puppy	August 18–September 4	11	September 13	*Monorchotrema yokogawai*	246
Control puppy			September 10		0

found by Africa et al. (3, 4, 6) in the myocardium and valves of persons dying of heart failure; and that *Monorchotrema yokogawai* has been lately found by the same authors infecting man (8) under identical conditions.

SUMMARY

1. Piscine intermediate hosts have been determined for *Stictodora guerreroi, S. manilensis, Monorchotrema calderoni, M. yokogawai, Diorchitrema pseudocirrata, Heterophyes expectans, Pygidiopsis marivillai, P. genata,* and a *Microlistrum* sp., as shown in Table 7.

TABLE 7.—*Piscine hosts of some species of heterophyids.*

Heterophyid.	*Hepsetia balabacensis.*	*Hemiramphus georgi.*	*Ambassis buruensis.*	*Mugil* sp.	*Clarias batrachus.*	*Arius manillensis.*
Stictodora guerreroi	+	+	+	+	—	—
Stictodora manilensis	+	—	+	+	—	—
Monorchotrema calderoni	+	+	+	+	—	—
Monorchotrema yokogawai [a]	—	+	+	+	+	+
Diorchitrema pseudocirrata	—	—	—	+	—	—
Heterophyes expectans	+	+	+	+	—	—
Fygidiopsis genata	—	—	—	+	—	—
Pygidiopsis marivillai	—	—	—	+	—	—
Microlistrum sp.	—	—	+	—	—	—

[a] After a critical review of the various members of the subfamily Haplorchinæ, Chen (1936) agreed with the views of Witenberg (1929, 1930) that the subfamily Monorchotreminæ and the genus *Monorchotrema* should fall into synonymy with the subfamily Haplorchinæ and the genus *Haplorchis*, respectively. According to Chen's reclassification of the members of the subfamily, *Monorchotrema yokogawai* Katsuta, 1932, should now be called *Haplorchis yokogawai* (Katsuta, 1932). Likewise *Monorchotrema calderoni* Africa and Garcia, 1935, would become *Haplorchis calderoni* (Africa and Garcia, 1935).

2. Cats, and especially dogs, are more satisfactory experimental hosts than albino rats and mice for the rearing of heterophyids.

3. The experiments give an idea of the richness of Philippine marine fishes in heterophyid metacercariæ.

ACKNOWLEDGMENTS

The authors wish to express their thanks to Dr. Deogracias Villadolid, ichthyologist of the Bureau of Science, Manila, for identifying fishes used in this investigation. We appreciate the helpful coöperation rendered by Drs. Eusebio Y. Garcia and Pedro G. Refuerzo during this investigation.

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OYSTER FARMING

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THREE PLATES AND ONE TEXT FIGURE

The average yearly importation of fish and fish products into the Philippines is 2,007,409 pesos. Of this amount nearly 300,000 pesos is paid for imported oysters and shell fish. To cut down this importation, and to furnish the people with adequate information on proper and effective methods of oyster propagation, experimental plots for oyster culture by modern methods were put up in May, 1935, by Mr. Florencio Talavera, then of the Bureau of Science, at Binacayan, Kawit, Cavite Province.

Oyster farming is the most important occupation of the people of this region. Natural oyster beds are located in Bacoor Bay, so that oyster shell as well as oyster spats are readily available. The results reported in this paper of the work carried on there are very encouraging.

There are twenty-three known species of oysters in the Philippines. Those of economic importance are: *Ostrea iredalei* Faustino, *Ostrea malabonensis* Faustino, *Ostrea palmipes* Sowerby, *Ostrea cucullata* Born, *Ostrea crista galli* Linnæus, and *Ostrea glomerata* Gould. Among these six species, *Ostrea iredalei* appears to be best for commercial oyster propagation.

HABITAT AND HABITS OF OYSTERS

Oysters thrive best in brackish water. They usually grow in clusters attached to the stumps and fallen branches of trees, rocks, stakes, walls of fishponds, foundations of bridges, landings, and piers. Some are found growing on old shells scattered on or imbedded in very soft muddy bottoms of tide flats, swamps, estuaries, fishponds, and shallow water.

The food of oysters consists of microörganisms suspended in water. The oyster obtains its food by drawing in slow currents of water between the valves to the gills. The minute gill filaments strain the microscopic organisms from the water and pass them by ciliary action to the mouth, which lies between the fleshy palps near the hinge of the valves.

Oysters spawn at water temperatures ranging from 20° to 27°C. Their eggs develop into free-swimming larvæ in less than twenty-four hours after fertilization. The larvæ spend a few days among other organisms of the plankton on the upper surface of the water. This stage in their life is most critical, as many of them are caught for food by bigger aquatic animals, mostly fishes, and many more die due to unfavorable environmental conditions. Those that survive, however, settle down as spats, due to the increasing weight of the developing shell, and attach themselves to any hard object they happen upon. This period is the beginning of the sedentary life of oysters, when they are known to oystermen as "oyster seeds," or simply "seeds."

SITES SUITABLE FOR OYSTER FARMING

The best sites for oyster farming are tidal rivers, narrow creeks, salt marshes, and land-locked bays. The prevailing bottom among them is hard and sticky mud, best fitted for oyster culture. They are protected from the rough sea, and the water is often rich in plankton organisms which constitute the food of oysters.

Oysters also grow in some localities in the sounds, but it would be unwise to cultivate them there on a commercial scale. Sounds with sandy and shifting bottoms are unfit for oyster propagation, because they are exposed to heavy seas, and the salinity of the water is high.

Although oysters grow in the mouths of rivers, these are not suitable sites for oyster cultivation. Oysters growing at the mouths of rivers are exposed to water of low salinity, especially at freshets, and to strong currents, especially during the rainy season, and they are subject to heavy deposition of silt which causes their wholesale destruction.

METHODS OF OYSTER CULTIVATION

Local methods.—Only two methods of oyster cultivation are known to the local oystermen: Spreading of old oyster shells, and the *tulus* method.

Old shells from uncooked oysters are scattered on the places where oysters are found growing. These shells are preferred because of the mistaken notion that spats do not attach themselves to shells taken from cooked oysters. Some oystermen also believe that young oysters develop out of the old oyster shells which are scattered over the oyster ground. This method of oyster culture is extensively practiced by oystermen in Navotas and Malabon, Rizal Province, and Binuañgan, Obando, and Paombong, Bulacan Province.

Oyster propagation through this method usually results in small harvest, if not in complete loss. The planted old oyster shells are often buried under the sand or mud, or carried away by the tides, currents, and waves, so that very few remain for collecting spats. Oyster shells with spats attached and buried into the mud or sand cannot produce oysters for harvest, because spats attached to them die of suffocation. Oysters grown on the surface of mud are generally thin. Oftentimes they become unfit for human consumption because the debris from the mud is taken into their bodies.

Found oftentimes attached to bamboo stakes or *tulus* used for strengthening the *baklad* are clusters of oyster shells. This observation of *baklad* owners led to the use of bamboo stakes for catching and growing oysters. Thus in some localities oyster spats are collected and grown on bamboo branches and trunks implanted in intertidal areas. This method is known as the *tulus* method of oyster culture.

Modern methods.—Oyster cultivation along modern lines consists of two steps: Spat collecting, and growing the seeds into marketable size.

Collecting of spats has been the subject of various experiments in foreign countries. The most common among the types of spat collectors tested were the wire bags filled with oysters, scallop, and clam shells; fascine collectors of twigs and branches of trees; round galvanized wire bushel baskets filled with clam, mussel, and oyster shells; bamboo and wooden screens; tarred cables or ropes; oyster shells threaded on wires; and the partition type of spat collector made from ordinary egg-crate partitions dipped in hot paraffin and coated with a thin layer of sand.

At the Binacayan Oyster Farm, managed by the Fish and Game Administration, Bureau of Science, all the above devices were tried, except the partition type of spat collector. Considering the great expense involved in the use of galvanized-wire bags and baskets which are costly, oyster shells threaded on wire as spat collector were tried with great success and found to suit local needs. Other types of spat collectors were also tried, among them are the following: Shells threaded on cabo-negro rope hung from fences or floats; shells threaded on round rattan of $\frac{1}{4}$ inch diameter, hung from fences or floats; rope (cabo-negro and abacá) wound about frames and lowered in the spawning area; bamboo slats with oyster shells clipped on the edges at regular intervals and planted in the ground between tide levels; and bamboo cone-shaped baskets on poles filled with oyster shells and placed in the spawning ground. The results obtained are not as good as those obtained with the hanging spat collectors made of old oyster shells threaded on wire. At the Binacayan Oyster Farm spat collecting is done during May, June, July, and August.

The spats collected are transplanted as seeds to suitable oyster grounds, where they grow until harvested. The seeds are ready for the growing beds during August and September. In transplanting them either the stake method or the hanging method is used.

In the stake method, old oyster shells with attached seeds are impaled on the sides of bamboo stakes 3 to 4 feet long. The stakes with five to ten shells arranged on each at intervals are planted on the tideflats. Oyster seeds attached to the impaled shells are left to grow until harvested.

In the hanging method, six or seven oyster shells with attached seeds are threaded on a wire 70 cm long. The shells are separated from each other by bamboo or *usiw* tubes 10 cm long. Several of these wires strung with shells are then suspended on bamboo railings supported by bamboo trunks or *puno,* which are grouped into plots. Hanging collectors with seeds may also be suspended on floats or rafts of bamboo.

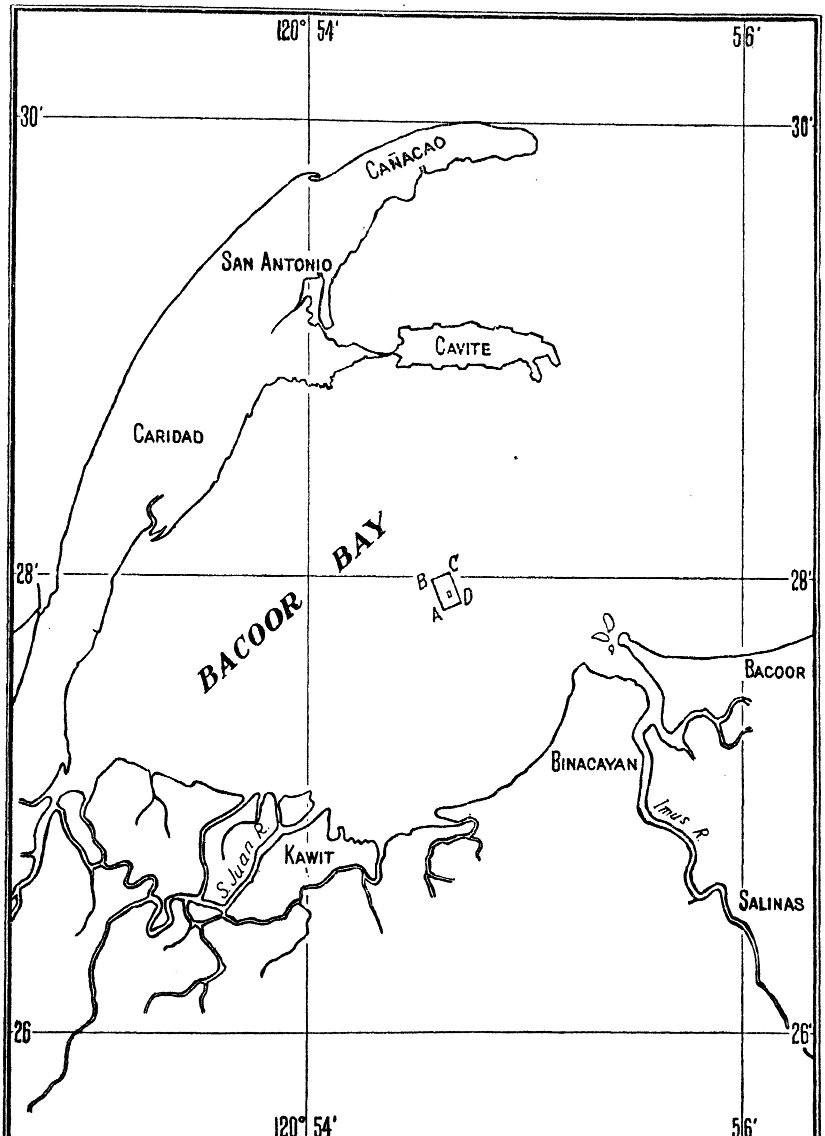
According to the oystermen of Binacayan, Kawit, Cavite Province, who are practicing the modern method of oyster cultivation, their harvest of oysters has more than doubled since they abandoned the old methods of oyster culture. With the modern method oyster seeds grow fast, for they have free access to food on all sides, besides being free from the harmful effects of mud and grains of sand.

Oysters grown by means of the hanging method are clean and fat because they are free from dirt and are constantly supplied with food by the water currents passing through the oyster beds.

HARVESTING

With the old method of oyster culture harvesting is very difficult. A man dives for the oysters and takes them from the surface of the mud. He carries a wire basket for holding the catch which is transferred into a boat from time to time.

Usually a whole day is spent in collecting enough oysters to fill a banca with a capacity of five *kaings*.



Sketch of Bacoor Bay, showing the position of the Bureau of Science Oyster Farm.

Oysters are ready for harvest seven months after the time the spats are collected up to the time the seeds are transplanted to the oyster beds for growing. At the Binacayan Oyster Farm the spats collected and planted during May, June, July, and August are harvested during December, January, February, and March, respectively.

Harvesting of oysters raised by the hanging method is very easy. A man rows his boat between the oyster plots, and with the help of a pair of pliers he unfastens the clusters of oysters hanging from the bamboo railings. A boat with a capacity of five kaings can easily be loaded within thirty minutes.

A MODEL OYSTER FARM

A one-hectare farm may be taken as a model to demonstrate the practicability of the hanging method of oyster culture. According to the Bureau of Science plan there are 220 units of platforms or fences. Each unit, 1.20 meters wide and 24 meters long, has 5 long rows 30 cm apart, supported on 63 bamboo trunks. These rows are set in three parallel lines 60 cm apart with 21 posts to the line and 21 crosspieces. Each of these pieces is 1.50 meters long. There are two side alleys 50 cm wide and two 60 cm wide.

The number of bamboo posts 3 to 5 meters long needed for the 220 units is 13,860. The collectors that can be hung at 30 cm intervals number 89,100 and require 446 rolls of 35-lb G. I. wire No. 8, cut into lengths of 70 cm, so that no less than 200 short pieces can be cut from each roll. For railings and crosspieces 2,400 bamboos 12 feet long will be sufficient. For the hanging of the collectors 360 kilos of ordinary 2½-inch nails are required, and for the crosspieces 100 kilos of ordinary 3-inch nails. About 600 kaings of dead oyster shells and about 300,000 bamboo or usiw tubes, 10 to 15 cm long and 3 to 5 cm in diameter, are needed.

DATA ON THE COMMERCIAL POSSIBILITIES IN AN OYSTER-CULTURE PROJECT IN 1 HECTARE

	Pesos.[a]
I. *Probable initial capitalization:*	
a. Materials and Supplies (list A)	3,347.60
b. Labor (list B)	400.00
c. Working capital	250.00
Total	3,997.60
II. *Probable expenses (annual):*	
a. Maintenance:	
1. Wages (1 laborer at 30 pesos a month)	360.00

[a] One peso equals 50 cents United States currency.

	Pesos.
2. Cost of materials and supplies for repair (list C)	765.10
b. Fixed charges:	
1. Interest on capital, 10 per cent	399.76
c. Sales charges:	
1. Sales tax, 1.5 per cent of sales	45.00
2. Harvesting, advertising, and marketing, 12 per cent of selling price	356.40
Total	1,926.26
III. *Probable income (annual)*:	
a. Sale of 5,940 kaings of oysters (harvest from 89,100 collectors, calculating on 1 kaing from 15 collectors) at 50 centavos	2,970.00 [b]
b. Operating expenses (Item II)	1,926.26
	1,043.74

IV. *Probable net income (deducting b from a in III)*: 1,043.74 pesos, or 26.1 per cent of the total capitalization.

COST OF CONSTRUCTING A 1-HECTARE FARM

	Pesos.
A. *Materials and supplies (list A)*:	
1 nipa house	150.00
13,860 bamboo trunks (puno for posts, 8 centavos each)	1,108.80
2,400 bamboos 12 ft. long, 30 centavos each	720.00
446 rolls 35-lb No. 8 G. I. wire, 1.70 pesos each	728.20
360 kilos ordinary 2½-inch nails, 11 centavos per kilo	39.60
100 kilos ordinary 3-inch nails, 11 centavos per kilo	11.00
600 kaing old oyster shells, 15 centavos a kaing	90.00
300,000 usiw tubes (bungbong)	60.00
2 hammers	2.40
1 saw	3.40
2 pairs of pliers	2.20
40 kaings	12.00
2 bancas	120.00
1 outboard motor	300.00
Total	3,347.60
B. *Labor (list B)*:	
20 men to finish 220 plots in 25 days, 80 centavos per man per day	400.00

[a] One peso equals 50 cents United States currency.
[b] The current price for 1 kaing of oysters is 80 centavos to 1.20 pesos.

C. *Materials and supplies for repairs* (*list C*):	Pesos.
1,000 bamboo trunks (puno), 8 centavos each	80.00
500 bamboos 12 ft. long, 30 centavos each	150.00
200 rolls 35-lb. No. 8 G. I. wire, 1.70 pesos each	340.00
360 kilos ordinary $2\frac{1}{2}$-inch nails, 11 centavos a kilo	39.60
600 kaings old oyster shells, 15 centavos a kaing	90.00
300,000 usiw tubes (bungbong)	60.00
50 kilos ordinary 3-inch nails, 11 centavos a kilo	5.50
Total	765.10

ILLUSTRATIONS

PLATE 1

FIG. 1. Bureau of Science Oyster Farm, Binacayan, Kawit, Cavite Province.
2. Clusters of oysters 7 months old, from Bureau of Science Oyster Farm.

PLATE 2

FIG. 1. Fascine and tulus spat collectors, Bacoor Bay.
2. Plots for growing oysters in the Bureau of Science Oyster Farm.

PLATE 3

FIG. 1. Bamboo stake impaled with old oyster shells with attached seeds.
FIGS. 2 and 3. Methods of hanging oyster shells with attached seeds for growing.
FIG. 4. A railing of wood destroyed by shipworms after 7 months at the Bureau of Science Oyster Farm.

TEXT FIGURE

Sketch of Bacoor Bay, showing the position of the Bureau of Science Oyster Farm.

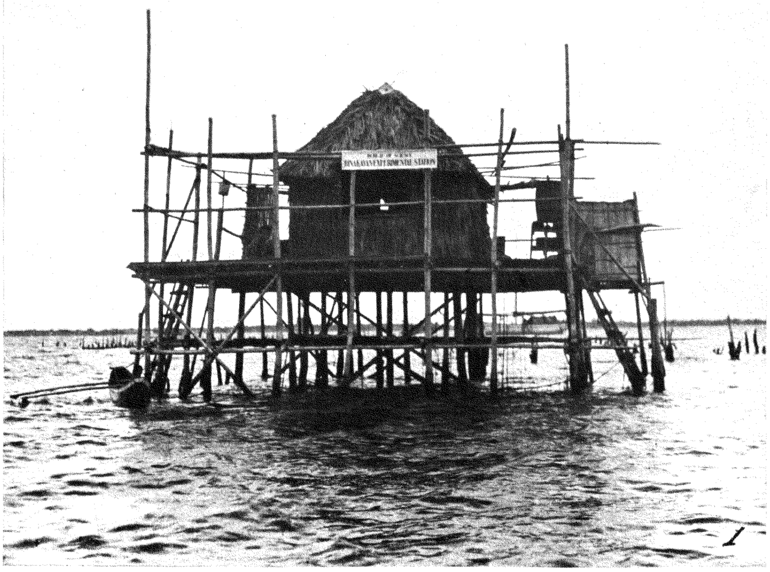


PLATE 1.

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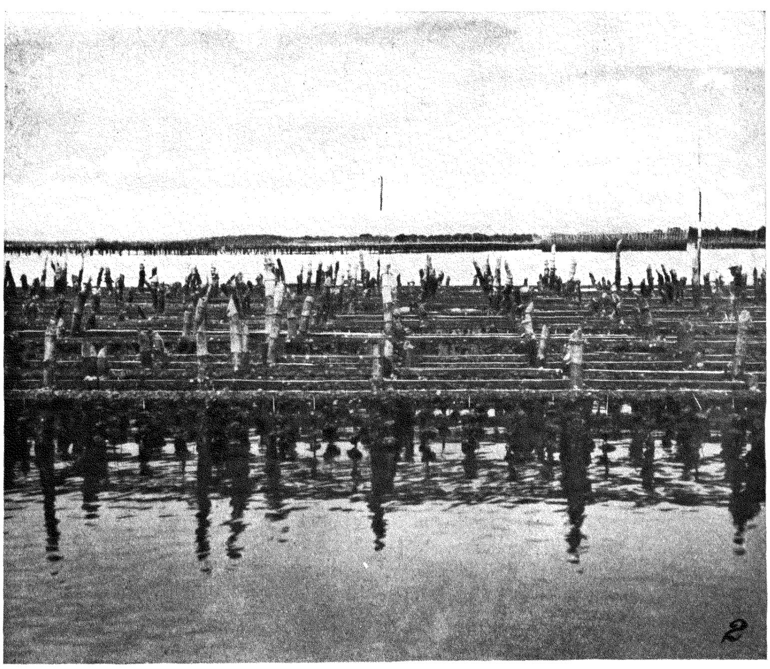

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PLATE 2.

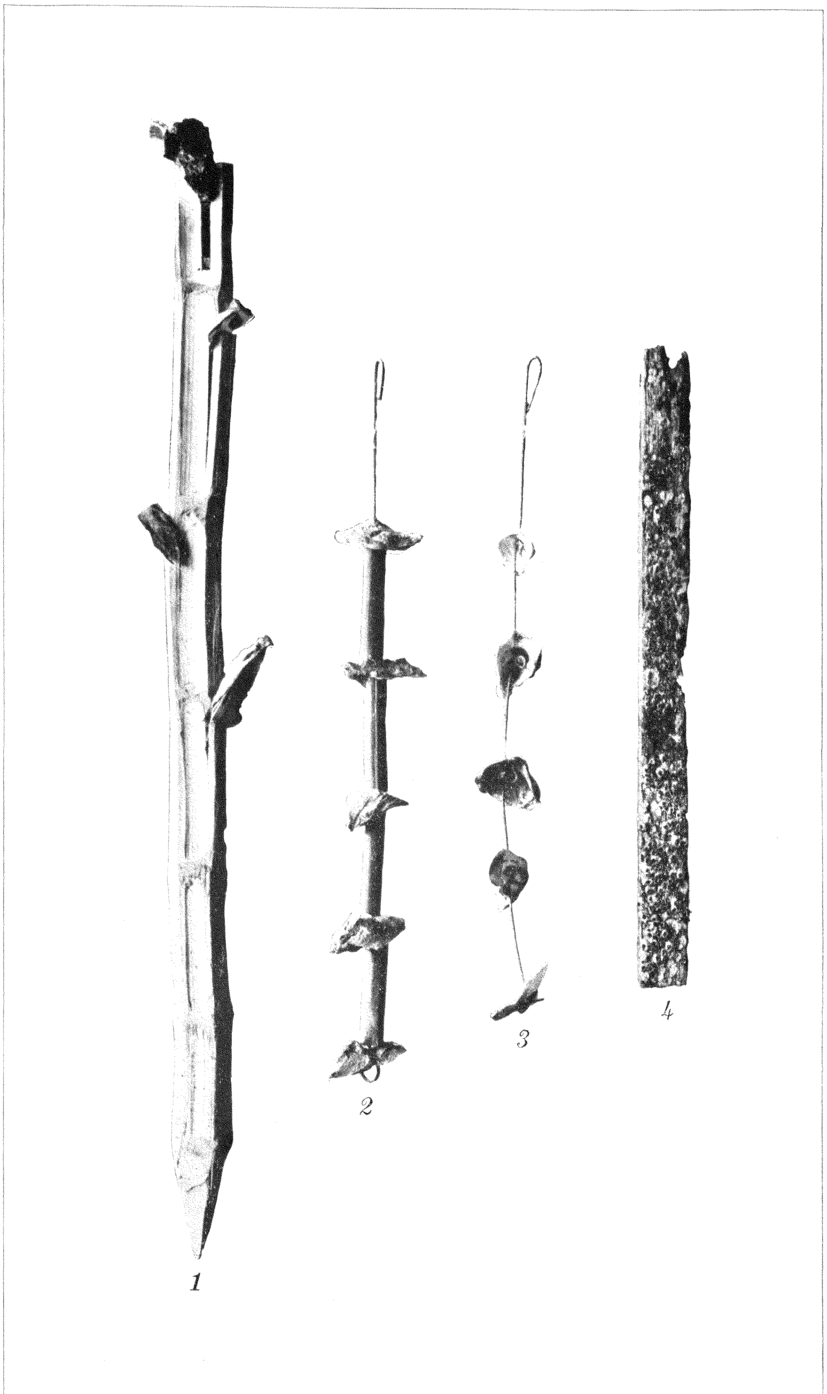

PLATE 3.

CHIRONOMIDÆ FROM JAPAN (DIPTERA), X

NEW OF LITTLE-KNOWN MIDGES, WITH DESCRIPTIONS OF THE METAMORPHOSES OF SEVERAL SPECIES [1]

By MASAAKI TOKUNAGA

Of the Entomological Laboratory, Kyoto Imperial University, Japan

FORTY-FOUR TEXT FIGURES

The midges of the Chironomidæ discussed herein were collected chiefly by myself in Honshu and Kyushu. A second important series was collected in Formosa by Dr. Ryoichi Takahashi. A few additional species were collected elsewhere by Drs. Hachiro Yuasa and Yaichiro Okada, and Messrs. Yasuji Yamada, Tokichi Kani, Tadao Masuda, and Kazuo Shibuya. My sincere thanks are extended to the above-mentioned zoölogists who have thus contributed to the further study of the Japanese Chironomidæ.

Of the midges dealt with in the text, the following three species are peculiar in habitat, being found in hot springs of mineral water in their immature stages: *Pentaneura okadai, Chironomus lugubris,* and *Tanytarsus uraiensis.* Another interesting midge is *Clunio takahashii,* the first marine midge from Formosa, found in the tidal zone of a rocky shore, and representing the sixth species of the genus. Another important species is *Spaniotoma akamusi.* The blood-red larvæ of this species are well-known bait for anglers, being known as *akamusi,* especially for the following fresh-water fishes in Kyoto and Osaka: *Gnathopogon cærulescens, Zacco platypus,* and *Carassius auratus.*

The morphological terminology used in the text is based on previous papers of this series. The antennal ratio is the ratio between the length of the ultimate segment and the combined length of the remaining segments, except the scape, and, in the case of the male of the Tanypodinæ, between the length of the ultimate two segments and the combined length of the remaining segments, except the scape. The leg ratio is the ratio of the length of the first tarsal segment of the leg to that of the tibia.

[1] Contribution from the Entomological Laboratory, Kyoto Imperial University, No. 64.

The abbreviations of the wing venation used in the present paper are those used in text figures 3 and 4.

CLUNIONINÆ

CLUNIO TAKAHASHII sp. nov.

This marine midge is quite peculiar in the highly reduced male antennal segments. The female and immature stages are still unknown.

Male.—Body length 1.3 to 1.5 millimeters; ground color brown.

Head uniformly brown, with antennæ mainly white, maxillary palpi yellowish brown. Antenna (text fig. 1, *a*) 7-segmented (20 : 38 : 14 : 13 : 13 : 14 : 100), with antennaria and scape somewhat brownish, intermediate flagellar segments brownish

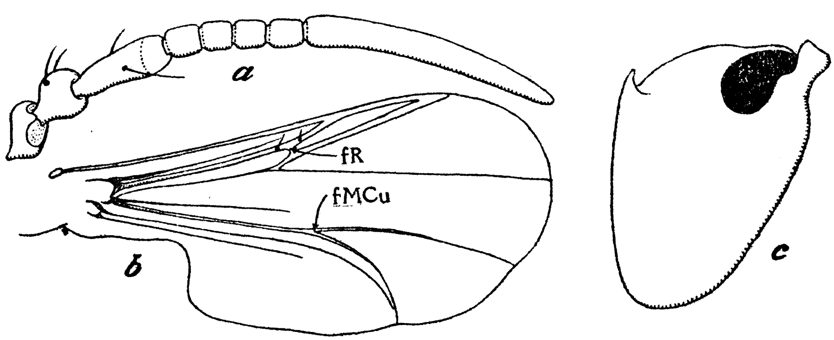

FIG. 1. *Clunio takahashii* sp. nov. (male). *a*, Antenna; *b*, wing; *c*, style.

at each distal end, ultimate segment slender; antennal ratio about 1.1 (16 : 14). Thorax brown in ground color; scutum with dark-brown middorsal line or pale-brown median vitta; caudoscutal area with paired short yellow stripes; humeral parts dark brown; pseudo-sutural foveæ each with four or five small setæ; supra-alar setæ three; scutellum yellowish brown. Legs mainly white; coxæ, trochanters, bases of femora, knee joints, and distal ends of tarsal segments of all legs brown; tibial spur only one on each leg, almost straight; claws distinctly curved; empodium very large. Proportional lengths of segments of legs, excepting coxæ and trochanters 19 : 26.5 : 6 : 2 : 2 : 2 : 3 in foreleg, 24 : 23 : 3 : 2 : 1.8 : 1.4 : 3 in middle leg, and 26 : 26 : 4 : 1.7 : 3 : 1.5 : 3 in hind leg. Wing (text fig. 1, *b*) milky white by reflected light and pale brown by transmitted light, with narrow base; macrotrichia very sparse even on the veins. Venation: R_1 ending at middle of costal margin; Rs straight, about thrice as long as R_1, subequal to radial stem; M_{1+2} straight, reaching wing margin; base of fork between M_{4+5} and Cu_1 just beyond base of radial fork; M_{4+5} and Cu_1 gently curved, reaching wing margin; Cu_2 complete, ending on Cu_1; 1st A hardly reaching under fork between M_{3+4} and Cu_1. Halteres white. Abdomen brown; hypopygium very large, turned through about 180°; style (text fig. 1, *c*) large, triangular, nonsetigerous, with a sharp spine at ventral corner, without apical spines.

Habitat.—Seashore, Formosa.

Holotype.—Male; Tansui, near Taihoku; January 1, 1935.

Paratopotypes.—Two males; January 3, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

This species is named in honor of the collector, Dr. Ryoichi Takahashi. The present midge is quite specific in the 7-segmented antennæ, distinctly petiolate wings, and characteristic wing venation. It may be noteworthy that all other known species of the genus *Clunio* are provided with 10-segmented antennæ in the male.

TANYPODINÆ

PENTANEURA OKADAI sp. nov.

The present species is white in ground color, with four distinct reddish brown vittæ on the scutum; the wings are thickly covered with macrotrichia; there are no colored markings on the wing.

Male.—Body about 2.7 millimeters long, very extensively white. Head almost entirely pale brown; vertex with a brown triangular marking; eyes bare, widely separated above from each other. Antennæ uniformly pale brown; antennal ratio about 0.9, always less than 1; maxillary palpus pale brown, 5-segmented (2 : 4 : 8 : 8 : 5 : 12). Thorax yellowish white; pronotum pale brown; scutum with four very distinct reddish brown vittæ; stripes between vittæ brown; shoulder parts yellowish white; caudoscutal area white; scutellum white; postscutellum brown, with a median yellowish line; pleural and sternal sclerites uniformly yellowish white. Legs entirely pale brown, without beards; claws simple; empodium vestigial, pulvilli wanting. Relative lengths of segments, except coxæ and trochanters, as follows: 37 : 43 : 31 : 16 : 12.5 : 8.5 : 6 in foreleg, 41 : 36 : 27 : 11 : 8 : 6 : 5 in middle leg, and 37 : 48 : 37 : 19 : 14 : 9 : 6 in hind leg. Wing (text fig. 2, *a*) with macrotrichia thickly spread over entire surface, without colored markings. Venation: Costa produced beyond end of R_{4+5}; R_{4+5} ending on costa on the level of end of M_{3+4}; relative lengths of R_1 and R_{4+5} 22 : 39; R_{2+3} simple, extending closely along R_{4+5}, atrophied on distal part; m-cu very short. Halteres whitish yellow. Abdomen very extensively white; terga from second to seventh segment each with a T-shaped whitish pale-brown marking on cephalic part; hypopygium (text fig. 2, *b*) pale brown; coxite with a blunt swelling on mesal side; style straight, about three-fourths as long as coxite, pubescent on basal half, tapering on distal half, with a strong brown spine.

Female.—Body about 1.5 millimeters long; coloration as in male. Antenna (text fig. 2, *c*) 12-segmented, with a slender

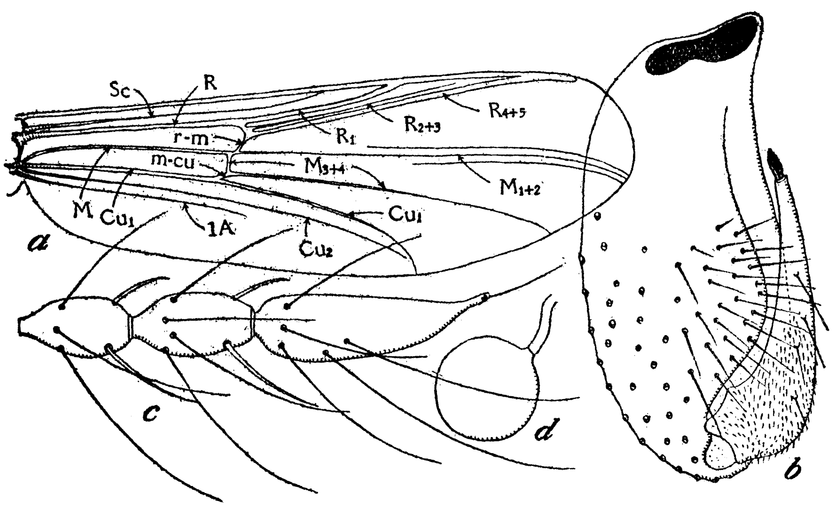

FIG. 2. *Pentaneura okadai* sp. nov. *a*, Male wing (macrotrichia omitted); *b*, male hypopygium; *c*, distal segments of female antenna; *d*, spermatheca.

terminal projection and an apical seta; proportional lengths of distal four segments 14 : 14.3 : 15.7 : 30.7; antennal ratio 0.2. Palpus 5-segmented (2 : 4 : 7 : 8 : 12). Proportional lengths of segments of middle leg 41 : 38 : 24 : 10 : 7.5 : 5.5 : 4.5. Wing with costa less produced than in male; relative lengths of R_1 and R_{4+5} 21 : 45. Abdomen entirely white; spermathecæ (text fig. 2, *d*) three, spherical, yellow; cercus triangular.

Habitat.—Hot spring of mineral water; Honshu, Japan.

Holotype.—Male; Yuno-Mine-Onsen, Wakayama Prefecture. March 24, 1937.

Allotopotype.—Female; March 24, 1937.

Paratopotypes.—Many males and females; March 24, 1937.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. Yaichiro Okada.

The present species is named in honor of the collector, Dr. Y. Okada. This fly is closely allied to *P. cigulata* Walker and *P. kyotoensis* Tokunaga. In the former species, however, the abdomen is extensively brown, with a paler narrow band on the caudal margin of each tergum, and the antennal ratio is about 1.25. In the latter species the pleural side of the thorax carries dark spots, the antennal ratio is greater than 1, and the costa is not produced beyond the end of R_{4+5}.

ORTHOCLADIINÆ

SPANIOTOMA (ORTHOCLADIUS) AKAMUSI sp. nov.

This species is a famous bait for minnow angling in Osaka and Kyoto, as I reported in 1935. The emergence of imagines occurs once a year, during September and October.

Male.—Body about 8 to 9.5 millimeters long, black in ground color. Head entirely black; antennæ black, with dark plumose hairs, 14-segmented; antennal ratio about 2.7 to 3; palpus black, 5-segmented (2 : 5 : 10 : 10 : 13); eyes bare. Thoracic ground color black, highly pruinose in brown along foveæ, slightly pruinose on vittæ, with a pair of black shining humeral thickenings; thoracic setæ brown, slender. Legs with coxæ dark brown; trochanters brown; femora brown, broadly black on distal part; tibiæ black, broadly brownish at middle; tarsus black; empodium minute; no pulvilli; first and second tarsal segments of middle and hind legs with apical spurs; foreleg without beards. Relative lengths of segments of foreleg 94 : 115 : 86 : 51 : 37 : 25 : 19, those of middle leg 106 : 111 : 55 : 34 : 26 : 18 : 18, and those of hind leg 114 : 129 : 68 : 43 : 34 : 20 : 18. Wing (text fig. 3, *a*) gray by transmitted light, squama brown; radial stem, and basal half of R_1 and R_{2+3} yellowish brown; costa, M, R_{4+5}, base of R_{2+3} and r-m black; costa produced beyond end of R_{4+5}; R_{4+5} straight; R_{2+3} ending just beyond middle between ends of R_1 and R_{4+5}. Halteres dark brown, with stems brown. Abdomen black; hypopygium (text fig. 3, *b*) dark brown, without thickened anal point; dorsoproximal appendage dark brown, chitinized, bare on apical half; ventral appendage pale brown, pubescent; styles characteristic in structure, each with a large flattened lobe.

Female.—Size and coloration as in male. Antenna with scape brown, pedicel yellow, 7-segmented (6 : 6 : 6 : 6.5 : 6 : 6 : 14.5);

palpus with first segment brown, 5-segmented (2 : 5 : 10 : 8 : 12). Relative lengths of segments of legs 95 : 125 : 87 : 51 : 36 : 25 : 20 in foreleg, 109 : 120 : 58 : 33 : 25 : 19 : 18 in middle leg, and 120 : 142 : 78 : 47 : 36 : 20 : 18 in hind leg. Wing comparatively broad, with anal lobe almost right-angled. Cercus (text fig. 3, *c*) black, earlike; spermathecæ (text fig. 3, *d*) three, equal, dark brown, with colorless hyaline neck region.

Habitat.—Stagnant water; Honshu, Japan.

Holotype.—Male; Osaka; October, 1936.

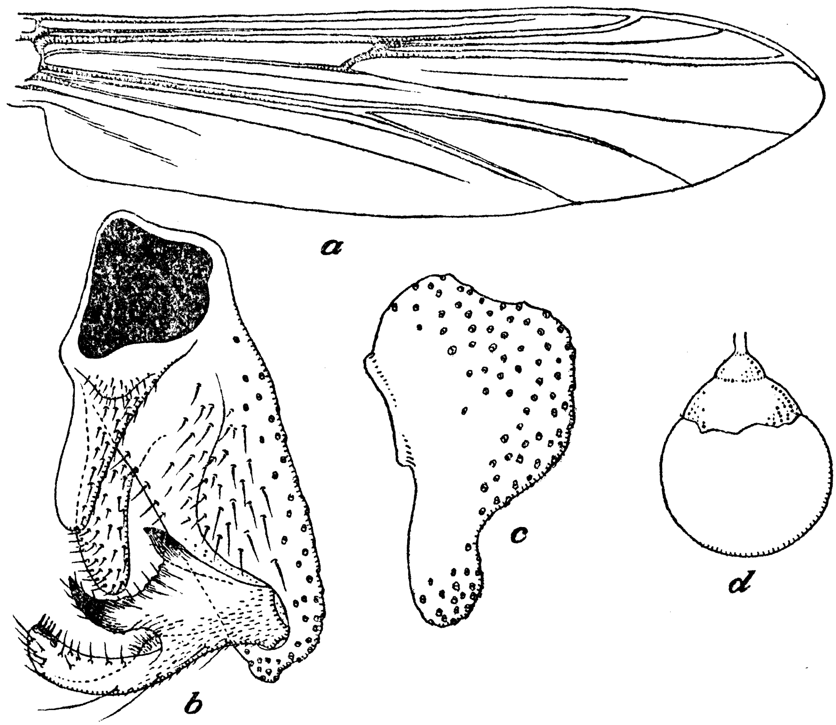

FIG. 3. *Spaniotoma* (*Orthocladius*) *akamusi* sp. nov. *a*, Male wing; *b*, male hypopygium; *c*, female cercus; *d*, spermatheca.

Allotopotype.—Female; October, 1936.

Paratopotypes.—Males and females; October, 1936.

Type specimens.—Alcoholic egg masses, larvæ, pupæ, and imagines; deposited in the entomological laboratory, Kyoto Imperial University; collected and reared by Mr. Atsuo Tanaka and M. Tokunaga.

This species is quite characteristic in the structure of the male styles.

SPANIOTOMA (TRICHOCLADIUS) CHALYBEATA Edwards.

This species is characteristic in thoracic coloration, the scutum being shining black and having a pair of distinct yellow spots on the humeral parts, as stated by Dr. F. W. Edwards. This midge is very abundant in Kyoto along a margin of still water in autumn.

Male.—Body about 2.5 millimeters long; antennal ratio about 1.2 (26 : 22) ; nonplumose apical area of antenna pubescent on distal half; maxillary palpus with four distinct segments (3 : 5 : 8 : 12) ; foreleg with following proportional lengths of segments 37: 45: 27: 17: 13: 9: 6; fore tibial spur as long as diameter of tibial end.

Female.—Body about 2 millimeters long; antenna 6-segmented (17 : 22 : 14 : 15 : 14 : 38) ; intermediate flagellar segments each with a short neck region; ultimate segment without long setæ; maxillary palpus distinctly 4-segmented (3 : 4.5 : 7: 9) ; legs black or dark brown, with trochanters and bases of femora yellowish brown. Proportional lengths of foreleg 35: 42: 24: 14: 11: 8: 6; cercus (text fig. 4, *a*) with a ventral projection; spermathecæ (text fig. 4, *b*), hyaline, large, oval, each with a neck region. Other characters of male and female as stated by Doctor Edwards (1926).

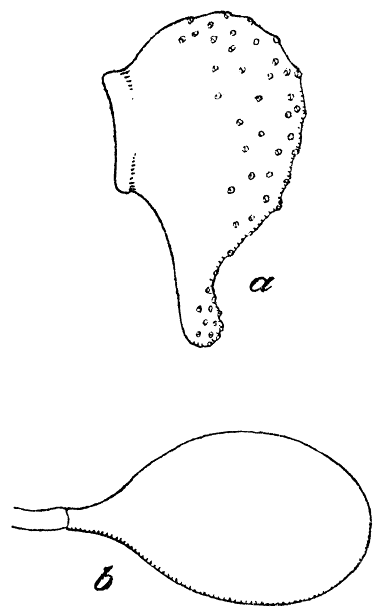

FIG. 4. *Spaniotoma* (*Trichocladius*) *chalybeata* Edwards. *a*, Female cercus; *b*, spermatheca.

Habitat.—Stagnant water.

Specimens.—Alcoholic males and females; Ikeda, Osaka; July 30, 1935; Kitashirakawa, Kyoto; October 19, 1935; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. K. Shibuya from a nest of a hunting wasp, *Crabro wesmäeli* v. d. Linden, and by M. Tokunaga.

SPANIOTOMA (EUKIEFFERIELLA) BICOLOR Zetterstedt.

In this species the sexes are distinguished by color, the male being black and the female extensively yellow.

Male.—Body length about 2 millimeters; ground color black; antennæ with white plumose hairs; wings milky white. Head with eyes widely separated above, distance between them twice their vertical lengths; antenna 14-segmented; nonplumose apical part swollen distally, with small hairs on distal half; antennal ratio less than 1 (21.5 : 23); maxillary palpus distinctly 4-segmented (3 : 4 : 6 : 9). Foreleg entirely dark, proportional lengths of segments 26 : 31 : 20 : 18 : 12 : 7 : 4; middle and hind legs mainly whitish brown, femoral bases dark, tibiæ white at middle, tarsi dark; tibial spur longer than diameter of tibial end; pulvilli small, half as long as claws; empodium slender, as long as claws. Wing (text fig. 5, *a*) milky white, with veins white; squama with a single seta, costa produced beyond end of R_{4+5}; R_1 about half as long as R_{4+5}; R_{2+3} closely extending along R_{4+5}; R_{4+5} almost straight, ending before level of end of

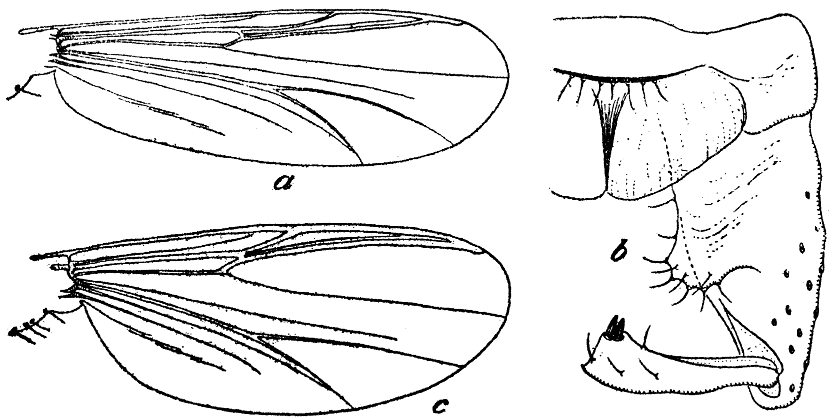

FIG. 5. *Spaniotoma* (*Eukiefferiella*) *bicolor* Zetterstedt. *a*, Male wing; *b*, male hypopygium; *c*, female wing.

M_{4+5}; fMCu beyond the crossvein. Abdomen including hypopygium black; ultimate tergum (text fig. 5, *b*) with a needlelike anal point, slightly setigerous along a transverse thickening; coxite with a small mesal lobe; style truncate with two apical spines.

Female.—Body about 1.7 millimeters long; ground color yellow. Head with vertex black; antenna with ultimate segment dark, 6-segmented (2.5 : 3 : 2 : 2 : 2 : 5.3); maxillary palpus 4-segmented (3 : 4 : 5 : 9 : 5), dark on three proximal segments. Thorax with dark markings; scutum with three distinct black vittæ, postscutellum black; pleural side with a black longitudinal stripe on precoxal region; sternal side with a pair of dark clouds. Forelegs uniformly clouded in brown, proportional lengths of segments 22 : 28 : 16 : 11 : 7 : 5 : 4; ultimate tarsal segments and femoral bases of middle and hind legs black; coxæ of all legs black; halteres yellow. Wing (text fig. 5, *c*) with veins R_1 and R_{4+5} somewhat swollen, brown; R_{4+5} gradually curved, about four times as long as R_1; fMCu under fR. Abdomen with terga and ultimate sternum dark brown; cerci yellow.

Specimens.—Alcoholic males and females; Kitashirakawa, Kyoto; October 23, 1935; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

CHIRONOMINÆ

PENTAPEDILUM SORDENS van der Wulp.

This species is very abundant at Tomioka, Amakusa.

Male.—Body about 3.5 millimeters long, dark brown in ground color. Head dark brown, with eyes bare, frontoclypeus setige-

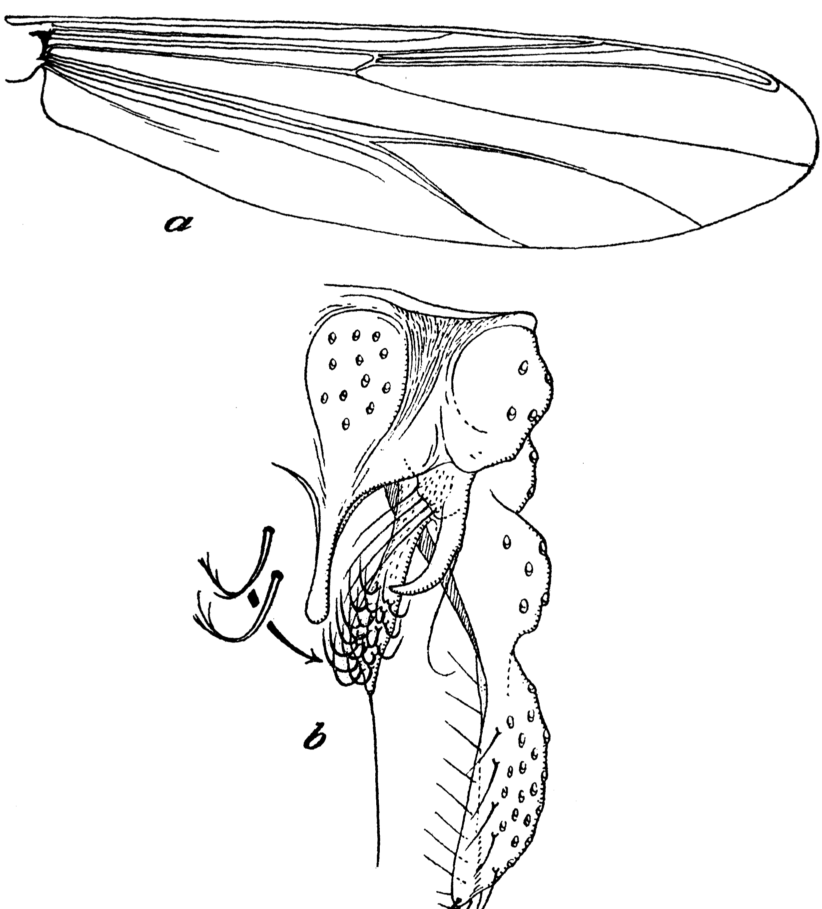

FIG. 6. *Pentapedilum sordens* van der Wulp (male). *a*, Wing; *b*, hypopygium.

rous; no frontal tubercles; antennæ 14-segmented, black; antennal ratio 1.9; maxillary palpus entirely black, 5-segmented (3 : 4 : 11 : 11 : 16.5). Thorax largely black; scutum with three distinct black vittæ which are separated by two yellowish brown pseudosutural foveæ; shoulder parts yellowish; caudoscutal area brown; scutellum yellowish brown; pleural membranes yellow. Legs almost entirely dark brown, with coxæ black; no tarsal beards; pulvilli as large as claws; fore tibia with a sharp fixed spine; middle and hind tibiæ each with two combs and one spur. Relative lengths of segments of legs 63 : 53 : 65 : 40 : 34 : 24 : 12 in foreleg, 72 : 62 : 32 : 23 : 17 : 11 : 7 in middle leg, and 75 : 70 : 44 : 26 : 24 : 15 : 8 in hind leg; foreleg ratio about 1.2. Halteres dark brown. Wing (text fig. 6, *a*) densely hairy, with minute dots spread over entire surface, membrane dark by transmitted light; veins brown; fMCu under base of Rs. Abdomen almost entirely black; each tergum narrowly pale brown along caudal margin; hypopygium (text fig. 6, *b*) with a long anal point; dorsal appendage with a bare long projection, a long isolated and several basal long setæ; ventral appendage pointed caudad, with a long apical seta and many curved setæ on apical part.

Specimens.—Alcoholic males; Tomioka, Amakusa, Kyushu; October 27, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

CHIRONOMUS (CHIRONOMUS) LUGUBRIS Zetterstedt.

Many larvæ and pupæ of the present species were found in hot springs of mineral water, about 17° to 28° C., at Mount Unzen, Kyushu.

Male.—Body about 3.5 millimeters long, black in ground color. Head black, with small frontal tubercles; eyes, frontoclypeus with many dark setæ. Antenna 12-segmented, mainly dark brown, with scape black; antennal ratio about 2.5 to 2.6; maxillary palpus black, 5-segmented (2.5 : 2.5 : 9 : 10 : 13.5). Thorax slightly shining, with brown setæ; supra-alar setæ about five or six; scutum black, with shoulder parts and caudoscutal area dark brown; scutellum black. Legs with coxæ black, trochanters and basal half of femora brownish, other parts entirely black; tarsal segments of middle leg with strong apical setæ; those of hind leg with less strong apical setæ; empodium hyaline; pulvilli dark brown; no beards. Relative lengths of segments of foreleg 66 : 54 : 77 : 39 : 32 : 25 : 15; those of middle leg 68 : 39 : 28 : 17 : 13 : 10 : 8; those of hind leg 73 : 67 : 40 : 24 : 19 : 12 : 9. Wing (text fig. 7, *a*) with veins pale brown; r-m and base of Rs brown. Halteres pale brown. Abdomen with terga brownish black; hypopygium (text fig. 7, *b*) curved dorsad, with anal point long; dorsal appendage nonpubescent, broad, with several small basal setæ.

Female.—Body about 3 to 4 millimeters long. Antenna 6-segmented (4 : 8 : 5 : 6 : 5.2 : 12.8), with scape and ultimate segment black; second segment deeply constricted at middle;

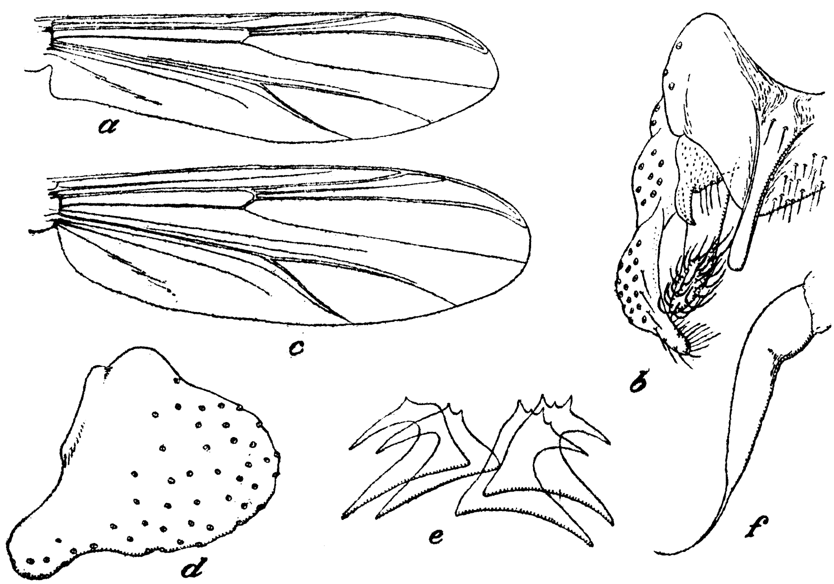

FIG. 7. *Chironomus* (*Chironomus*) *lugubris* Zetterstedt. *a*, Male wing; *b*, male hypopygium; *c*, female wing; *d*, female cercus; *e*, hooklets of second abdominal tergum of pupa; *f*, caudolateral spine of eighth abdominal segment of pupa.

intermediate flagellar segments dark brown on basal half, pale brown on neck region; ultimate segment without basal setæ; antennal ratio about 0.5; palpus dark brown, 5-segmented (2.5 : 2.5 : 8.5 : 9.5 : 14). Legs almost entirely dark brown; trochanters, basal half of femora, and middle part of tibiæ brown. Relative lengths of segments 70 : 54 : 80 : 39 : 33 : 27 : 16 in foreleg, 70 : 65 : 29 : 17 : 13 : 10 : 8.5 in middle leg, and 76 : 73 : 43 : 24 : 21 : 13 : 10 in hind leg. Wing (text fig. 7, *c*) with veins brown, r-m and base of Rs black. Abdomen dark brown, with cerci (text fig. 7, *d*) subtriangular; spermathecæ two, oval, hyaline, colorless, with very short neck region.

Pupa.—Body about 6.5 millimeters long. Exuviæ hyaline, mainly colorless; head, thorax, and terminal end pale brown; abdominal lateral thickenings black. Head with frontal tubercles distinct, each carrying a single apical seta. Thoracic respiratory organs white, consisting of numerous filaments, as in *C. dorsalis;* thorax with a small median tubercle on dorsal side. Abdomen with lateral swimming lamellæ and long hairs on caudal segments from fifth to eighth; these long lateral swimming hairs four pairs on segments five, six, and seven, five pairs on segment eight; terga of second to fifth segments almost entirely spinulose; sixth tergum with three spinulose areas: one on anterior part and one pair on posterior part; seventh tergum without posterior spinulose areas; eighth tergum with a pair of large spinulose areas; second tergum with a caudal line of hooklets which are distinctly serrate on convex side (text fig. 7, *e*); this transverse line of hooklets distinctly interrupted at middle; caudolateral spines of eighth segment black, simple, elongated, and filamentous on apical part (text fig. 7, *f*); ultimate segment fringed with numerous lateral swimming hairs on flattened lamellæ, and a pair of long lateral isolate setæ, caudal lamellæ of male longer than basal width but in female shorter than basal width; genital sheaths of both sexes not extending caudad beyond the caudal end of ultimate segment.

Habitat.—Hot spring of mineral water; Kyushu, Japan.

Specimens.—Alcoholic egg masses, larvæ, pupæ, and male and female imagines; Mount Unzen, Nagasaki Prefecture; October 25 and 26, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

CHIRONOMUS (GLYPTOTENDIPES) GLAUCUS Meigen.

This species is very abundant in a fresh-water pond at Tomioka, Kyushu.

Male.—Body length about 5.5 to 6.5 millimeters. Head yellowish brown; frontoclypeus brown, setigerous; frontal tubercles very minute. Antennæ 12-segmented, dark brown; antennal ratio about 3.7 to 3.9; maxillary palpus black, 5-segmented (4 : 4 : 14 : 12 : 15). Dorsal side of thorax almost entirely black; prothorax yellow, highly reduced; scutum highly pruinose along foveæ, its shoulder parts obscurely yellowish; pleural membranes yellowish brown; pleural and sternal sclerites black. Legs with coxæ and trochanters brown; femora bicolored: Distal fourth of fore femur, distal half or one-third of middle femur, and entire length or distal two-thirds of hind femur black, other parts brown; tibiæ black; tarsal segments mainly black; pulvilli large; two combs of tibia each with a spur; no beards. Relative lengths of segments of foreleg 95 : 86 : 125 : 70 : 58 : 50 : 22, those of middle leg 105 : 106 : 52 : 37 : 30 : 21 : 13, and those of hind leg 103 : 120 : 77 : 50 : 43 : 28 : 14. Wing (text fig. 8, *a*) obscurely yellowish at base, slightly clouded darkly on entire surface, with veins black; R_{4+5} straight; M_{3+4} and Cu_1 undulated. Halteres pale brown. Abdominal terga entirely black; terga from second to sixth each with a distinct median impression, which is about one-third as long as tergal length in second to fourth terga, and about half as long as tergal length in fifth and sixth terga; hypopygium (text fig. 8, *b*) dark brown, with styles broad; dorsal appendages large, nonpubescent, slightly setigerous at basal part.

Female.—Body about 7 to 9 millimeters long, coloration almost as in male. Antenna with scape yellowish brown; intermediate flagellar segments fusiform, yellowish brown on basal half and black on distal half, with neck region short; ultimate segment black; relative lengths of segments, 5 : 8 : 7 : 7.8 : 8 : 8.5 : 17; palpus 5-segmented (4 : 4 : 13 : 12 : 18). Relative lengths of segments of legs 97 : 90 : 144 : 66 : 57 : 49 : 24 in foreleg, 109 : 110 : 54 : 35 : 28 : 20 : 14 in middle leg, and 108 : 126 : 84 : 54 : 45 : 27 : 15 in hind leg. Halteres dark brown. Wing broad; R_{4+5} slightly curved along costal margin; M_{3+4} and Cu_1 not sinuous. Abdominal tergal impressions as in male, but that of fifth tergum comparatively shorter, about one-third as long as tergal length; cerci (text fig. 8, *c*) pale brown; spermathecæ (text fig. 8, *d*) two, spherical, colorless, hyaline.

Pupa.—Male about 8 to 10 millimeters long, female about 11 to 12, dark red in life, exuviæ brown; thoracic regions dark brown. Head with a pair of distinct tubercles each with an apical seta. Thoracic respiratory organ 5-branched at base, consisting of ordinary white numerous filaments. Abdominal terga from second to sixth each with a median raquetlike impression (text fig. 8, *f*); typical chætotaxy of abdominal segments as follows: On tergal side one pair of simple setæ on anterior part, three pairs of simple setæ on posterior parts, and a pair of simple or branched setæ on the lateral part; on sternal side, one pair on anterior part and three pairs on posterior part; lateral sides from segment one to segment four each with three isolated setæ, those from fifth to seventh each with four long swimming hairs on either lateral lamella, that of eighth with five swimming hairs on lamella; tergal side with characteristic spinulose areas: First tergum with a pair of lateral spinulose areas, second almost entirely spinulose except middorsal area, spinules of caudomesal area of this segment comparatively strong, third to sixth terga uniformly spinulose, seventh and eighth with spinulose areas more or less reduced, each provided with a pair of lateral spinulose areas; second tergum with a complete caudal transverse line of hooklets (text fig. 8, *e*); caudolateral corner of eighth segment with a variable number of solid

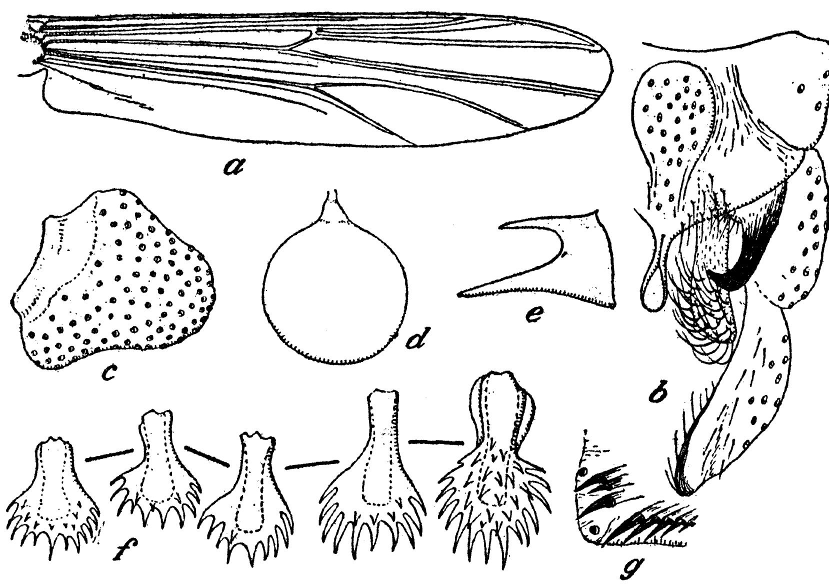

FIG. 8. *Chironomus* (*Glyptotendipes*) *glaucus* Meigen. *a*, Male wing; *b*, male hypopygium; *c*, female cercus; *d*, spermatheca; *e*, hooklet of second abdominal tergum of pupa; *f*, dorsal impressions of terga from second to sixth abdominal segments of pupa; *g*, caudolateral spines of eighth segment of pupa.

spines (text fig. 8, *g*). Ultimate segment almost circular, genital sheaths hardly beyond caudal margin of swimming lamellæ even in male.

Habitat.—Stagnant water; Tomioka, Kyushu, Japan.

Specimens.—Alcoholic egg masses, larvæ, pupæ, and male and female imagines; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

CHIRONOMUS (STENOCHIRONOMUS) TAKAHASHII sp. nov.

There have been known only three species of the subgenus *Stenochironomus* Kieffer from Japan; namely, *C. bitensis* Kieffer, *C. nelumbus* Tokunaga and Kuroda, and *C. satorui* Tokunaga and Kuroda. The present species, therefore, is the fourth of this subgenus. The male and the immature stages are still unknown.

Female.—Body about 3.5 millimeters long, yellowish white in ground color. Legs with characteristic markings. Wings very closely allied to those of *C. satorui* in markings but without apical markings. Setæ of body yellow. Head yellowish brown, with vertex brown, frontoclypeus brown. Maxillary palpus black, 5-segmented (4 : 5 : 17 : 14 : 22); antenna yellow, with ultimate segment yellowish brown, with two long apical setæ; intermediate flagellar segments each with a long neck region; second segment double; relative lengths of antennal segments, 5 : 12.5 : 9.5 : 8.5 : 8 : 11. Thorax yellow in ground color; scutum with paired dark-brown lateral vittæ, without median vittæ; scutellum yellowish brown; postscutellum black, with a yellow median line; pleural sclerites yellowish brown; epimeron

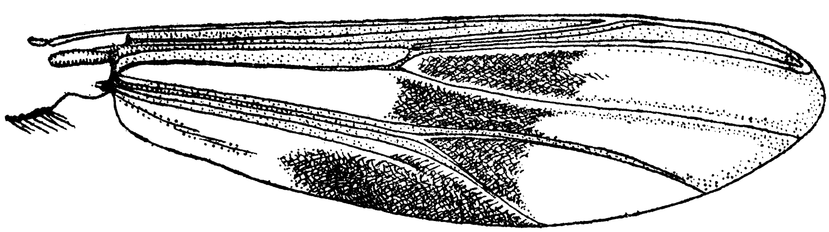

FIG. 9. *Chironomus (Stenochironomus) takahashii* sp. nov. Female wing.

dark brown; other parts yellow. Legs yellow in ground color; fore coxa yellow, middle and hind coxæ brown; fore femur mainly black, brown at both ends; middle and hind femora black on basal half, yellow on apical half, broadly brown at both ends; tibiæ of all legs black on basal half, yellow on apical half, brown or dark brown at base; other segments uniformly yellowish white. Tibial combs each with a spur; pulvilli large, as long as claws; empodium slender. Proportional lengths of segments of legs as follows: 97 : 81 : 92 : 52 : 41.5 : 31 : 15 in foreleg, 95 : 80 : 49 : 27 : 19.5 : 13 : 9 in middle leg, and 115 : 100 : 69 : 41 : 31 : 20 : 10 in hind leg. Wing (text fig. 9) with a median large dark band, which extends proximad along anal margin; veins yellow, marginal areas along M_{1+2}, M_{3+4}, and Cu_1 yellow; apical margin of wing also yellowish; wing cells along costal margin C, Sc, R, R_1, and R_3 entirely yellow. Venation as in *C. satorui*. Halteres white.

Abdomen yellowish white; posterior segments somewhat brownish.

Habitat.—Northern Formosa.

Holotype.—Alcoholic female; Koyo, Taito-cho, Taihoku, Formosa; June, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

CHIRONOMUS (POLYPEDILUM) KYOTOENSIS sp. nov.

This midge was reared in the laboratory from the larva collected at the botanical garden of the Kyoto Imperial University.

Male.—Body about 3.6 millimeters long, dark brown in ground color. Thorax dark brown with three black lines along middorsal and pseudosutural lines. Wings without colored markings. Legs uniformly pale brown. Head without frontal tubercles; eyes narrowly separated above; antenna black, with scape brown on basal half, 14-segmented, with two apical setæ, plumose hairs black; antennal ratio about 1.9; maxillary palpus brown, with four distinct segments (3 : 6 : 7 : 10). Thorax pruinose; scutum dark brown, with black middorsal and pseudosutural lines; scutellum brown; postscutellum black; pleura and sternum shiny, black. Foreleg with a distinct apical spine of tibia; leg ratio of foreleg about 1.7; pulvilli slender, bifurcate; empodium slender. Wing (text fig. 10, *a*) very slightly clouded entirely, with veins pale brown; R_{2+3} extending closely along R_1; R_{4+5} ending very near wing tip, gradually curved caudad on apical part; fMCu just under fR; 1st A atrophied under fMCu. Halteres yellow. Abdomen black; terga from second to sixth with paired pale brown spots on caudal corners; ultimate tergum (text fig. 10, *b*) broadly pale brown on cephalic margin, with several long setæ on meson; anal point slender, long, beyond distal end of coxite; style straight, as long as coxite, not sharply narrowed distad; dorsal appendage with basal portion swollen, pubescent, with a long isolated seta, distal portion slender, long, nonpubescent; ventral appendage very slender, long, extending beyond distal end of coxite, with several (4 or 5) curved apical bristles and a very long apical seta.

Female.—Body about 2.5 millimeters long; coloration as in male. Antenna brown, 6-segmented (4 : 7 : 5 : 5.5 : 3 : 9), with three apical setæ; maxillary palpus with four distinct segments (3 : 6 : 7 : 11). Foreleg ratio about 1.8. Wing (text fig. 10, *c*) broader and shorter than in male; anal angle obtuse. Abdomen uniformly dark brown; ultimate sternum with a shallow caudal incision, setigerous only on laterocaudal areas; spermathecæ (text fig. 10, *d*) two, oval, yellow, with short neck region; cercus (text fig. 10, *e*) with a short ventrocephalic projection.

Pupa.—Body about 3.5 millimeters long; head with a small tubercle on each scape; thoracic respiratory organ (text fig. 10, *f*) branched into seven subequal filaments; abdomen with characteristic cuticular processes. First abdominal segment with a pair of large anterior and small posterior lateral swellings, without dorsal spinous area; second tergum with a transverse

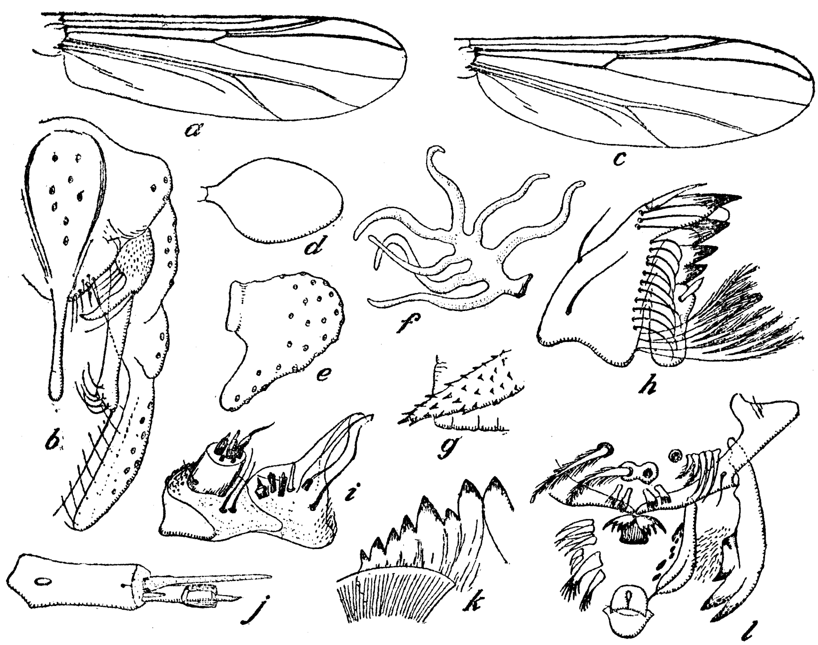

FIG. 10. *Chironomus* (*Polypedilum*) *kyotoensis* sp. nov. *a*, Male wing; *b*, male hypopygium; *c*, female wing; *d*, spermatheca; *e*, female cercus; *f*, thoracic respiratory organ of pupa; *g*, caudolateral spine of abdominal segment eight of pupa; *h*, larval mandible; *i*, larval maxilla; *j*, larval antenna; *k*, larval mentum; *l*, larval labrum-epipharynx.

spinulous area on anterior region and a line of recurved thorn-like spines on posterior margin; third tergum with a transverse spinulous area on anterior region; fourth terga with an X-shaped spinulous area on anterior half, a pair of oval spinulous areas on caudal region, and a pair of small spinous patches on caudolateral sides; fifth tergum with a large median X-shaped spinulous area, lateral swimming lamellæ and three pairs of long lateral setæ; sixth tergum similar to fifth, but with X-shaped spinulous area narrow; seventh with a pair of small spinulous areas on anterior region and four pairs of long lateral setæ on lateral swimming lamellæ; eighth similar to seventh, but without spinulous areas, with a pair of imbricate caudolateral large spines (text fig. 10, *g*); ninth segment with a pair of large lateral swimming lamellæ, each of which is provided with about thirty-seven long marginal setæ, with a U-shaped caudal incision; genital sheaths long, pointed, far beyond caudal margin of ultimate segment in both sexes.

Larva.—Body about 6 millimeters long. Head with three unpaired sclerites of clypeus, of which the preclypeal plate is thinly membranous on mesal oval area; labrum-epipharynx (text fig. 10, *l*) with three paired sclerites; namely, clypealiæ, tormæ, and labraliæ, on lateral sides; labral membrane with following cuticular appendages: One pair of plumose projections which arise from basal rings, paired lateral groups of three simple and two serrulate trichoid projections, and a group of distomesal appendages which are composed of two plumose projections arising from a common basal plate, and two pairs of small comblike projections; epipharynx with following cuticular appendages: A median appendage composed of two strongly serrate thornlike projections which are partially fused with each other on their basal parts, paired groups of thornlike projections which are composed of two large serrulate, and five larger and two smaller simple projections, along each arm of V-shaped thickening; two small plates located at caudal angle of V-shaped thickening; premandible with two strong and a small basal tooth; mandible (text fig. 10, *h*) with four cutting teeth, an apical spinelike projection, a small trichoid projection on molar edge, four slender setæ on apical part, a line of slender setæ along molar edge, several plumose hyaline projections at mesal base, and two isolated setæ on lateral surface; maxilla (text fig. 10, *i*) with two apical lobes; mesal lobe with two strong projections, two slender setæ, a trichoid sensilla, and three peglike sensillæ; lateral lobe with two small setæ and a palpus; palpus 3-segmented, consisting of a large basal segment, two small distal segments, and several small sensory projections on the distal end of first segment; labium without apical membranous projections; mentum (text fig. 10, *k*) with seven pairs of teeth, median tooth large, second small, third as large as median, fourth and fifth teeth small as in second, sixth somewhat larger than adjacent, seventh smallest; submentum fanlike, finely striated; paired setæ of mentum simple; hypopharynx with a pair of scalelike or comblike mesal projections, four pairs of peglike sensillæ, and spinous area on dorsal side, without common salivary duct. Antenna (text fig. 10, *j*) 5-segmented, first segment with a very long trichoid projection which extends beyond antennal tip. Anterior pseudopod with numerous simple claws; posterior pseudopod with sixteen simple claws; caudal tuft of setæ consisting of eight long setæ arised from a small basal projection; anal gills conical, dorsal pair of them large, slightly constricted preapically; ventral pair small, not constricted.

Habitat.—Fresh water; Honshu, Japan.

Holotype.—Male; Kitashirakawa, Kyoto; October 3, 1935.

Allotopotype.—Female; October 3, 1935.

Paratopotypes.—Males and females; October 3, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is closely allied to *P. integrum* Kieffer and *P. albicornis* Meigen. In the first allied species, however, the dorsal appendage of the male hypopygium is curved and the foreleg ratio is 1.3, and in the second species the male antennæ are provided with yellow plumose hairs and the foreleg ratio is 1.4, both differing from the present species.

CHIRONOMUS (POLYPEDILUM) MASUDAI sp. nov.

Collected at light screen at Yamashina, Kyoto.

Male.—Body about 2.5 millimeters long, brown in ground color. Antenna with several apical setæ; antennal ratio about

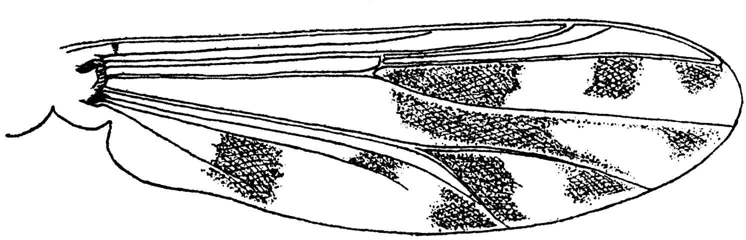

FIG. 11. *Chironomus (Polypedilum) masudai* sp. nov. Male wing.

1.5. Thorax brown in ground color; vittæ three, separated, dark brown; caudoscutal area dark brown; scutellum pale brown; postscutellum and sternal side black; pronotum dark brown. Legs with coxæ and trochanters dark brown; femora mainly dark brown, pale brown on apical third; tibiæ entirely pale brown; tarsal segments extensively pale brown; first segment with a distinct black preapical ring; other segments each with a distinct black ring at middle; ultimate tarsal segments indistinctly dark brown uniformly. Relative lengths of segments of foreleg, 41 : 28 : 52 : 35 : 27 : 20 : 10. Wing (text fig. 11) with nine dark markings, veins yellow. Halteres black, with stems pale brown. Hypopygium (text fig. 12) with anal point slender, simple; style very slender, pointed; dorsal appendage broad, flat, with three long and several small setæ; ventral appendage with a terminal hair only moderately long.

FIG. 12. *Chironomus (Polypedilum) masudai* sp. nov. Male hypopygium.

Habitat.—Honshu, Japan.

Holotype.—Male; Yamashina, Kyoto; October 11, 1935.

Paratopotypes.—Males; October 11, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Masuda.

This species is named in honor of the collector, Mr. Tadao Masuda. The present fly is somewhat related to *C. heptasticum* Kieffer and *C. lætus* Meigen, but in the former allied species the dorsal appendages of the male hypopygium are bare and the legs are white, and the latter differs greatly from *C. masudai* in having the wing cell R_1 provided with a dark streak along the vein M, and in being without two distal spots.

CHIRONOMUS (POLYPEDILUM) JAPONICUS sp. nov.

Very common in Kyoto in spring and autumn and often found at light screen.

Male.—Body about 2.7 millimeters long; thorax dark brown in ground color; wing with four distinct dark markings. Femora black on proximal two-thirds, yellow on distal third; knee joints narrowly black. Antennæ and plumose hairs brown, with scapes black, each with two apical setæ; antennal ratio about 1.4 to 1.5. Maxillary palpi brown, distinctly 4-segmented (2 :

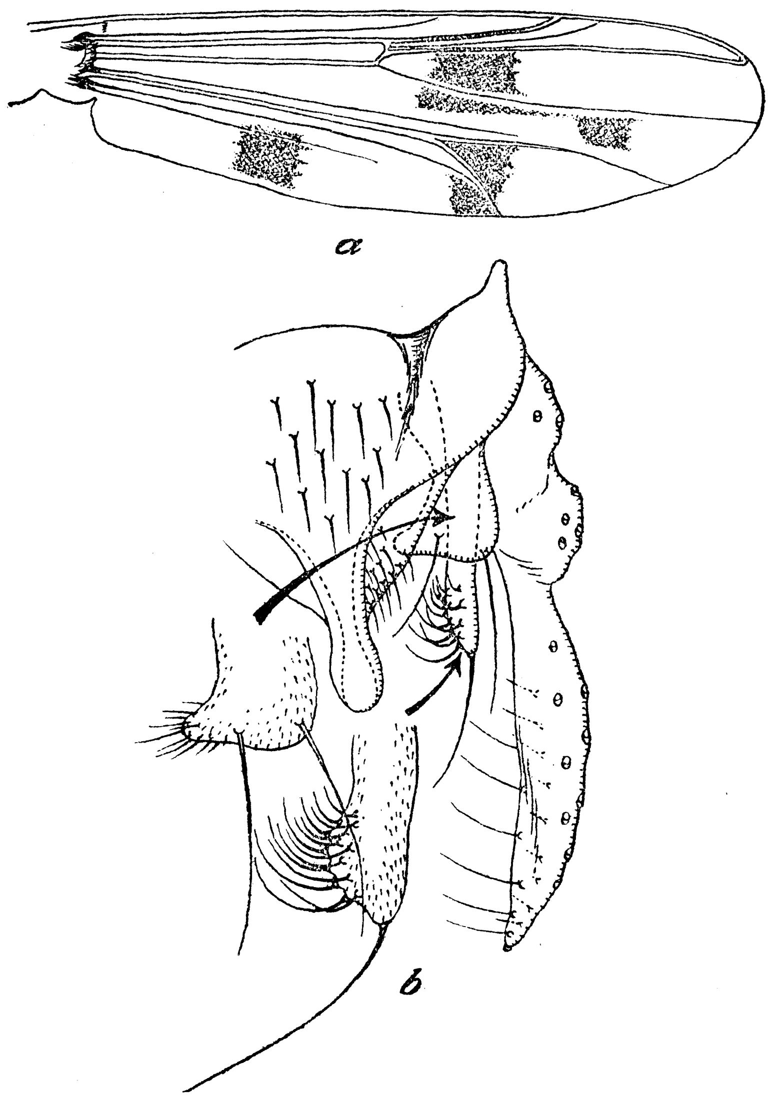

FIG. 13. *Chironomus* (*Polypedilum*) *japonicus* sp. nov. *a*, Male wing; *b*, male hypopygium.

5 : 6 : 10). Scutum with three indistinct black vittæ, pseudosutural foveæ brown, caudoscutal area dark brown; scutellum brown; postscutellum black, with a brown median stripe; pleural and sternal sclerites black. Legs with coxæ and trochanters

black; femora distinctly bicolored; tibiæ and tarsus yellowish brown; pulvilli comparatively large. Relative lengths of segments of foreleg, 44.7 : 26.7 : 55.3 : 34 : 25.7 : 19 : 9.5. Halteres yellow. Wing (text fig. 13, *a*) with three large markings and a small dark marking, all square; a distinct linear marking along caudal margin of vein M_{1+2}; veins mainly yellow; R_1 and R_{4+5} black in the area of dark marking. Abdomen mainly yellow; posterior segments brown or black; hypopygium (text fig. 13, *b*) black; ultimate tergum setigerous on mesal area, finely setigerous apical area, with anal point broad and thickened; dorsal appendage distinctly swollen, with two long isolated setæ on dorsal side, many small setæ on mesal corner; ventral appendage with a comparatively short apical seta.

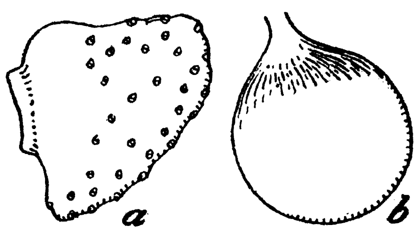

FIG. 14. *Chironomus (Polypedilum) japonicus* sp. nov. *a*, Female cercus; *b*, spermatheca.

Female.—Body length about 2 millimeters, coloration largely as in male. Antennæ 6-segmented (4 : 8 : 6 : 6.2 : 3.7 : 9), with several apical setæ; segment two distinctly constricted before middle; segments two to four each with an elongated neck region; penultimate short, fusiform; ultimate slender, without ordinary setæ, not swollen basally. Relative lengths of segments of foreleg, 54 : 31 : 66 : 40 : 30 : 23 : 11. Abdomen with anterior two or three segments yellow, other posterior segments brown; spermathecæ (text fig. 14, *b*) two, spherical, mainly pale brown, brown on basal part, with hyaline neck region; cerci (text fig. 14, *a*) subtriangular, with ventral corner prominent.

Habitat.—Honshu, Japan.

Holotype.—Male; Shimogamo, Kyoto; May 18, 1930.

Allotopotype.—Female; May 18, 1930.

Paratopotypes.—Males and females, Shimogamo and Kitashirakawa, Kyoto, May 18, 1930, and October 30, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is closely related to the European *C. (P.) scalænus* Schrank var. *quadriguttatus* Kieffer, from which it differs, however, in the wing cell M_2 not being provided with a dark linear stripe along M_{1+2}.

CHIRONOMUS (POLYPEDILUM) UNIFASCIA sp. nov.

This fly was collected at light at Yamashina, Kyoto.

Female.—Body length about 1.7 millimeters; thorax mainly dark brown; abdomen largely pale brown. Wing (text fig. 15, *a*) with a transverse dark band at distal third, and a square marking at middle of anal cell. Antennæ pale brown, with several apical setæ, 6-segmented (3 : 5 : 3.5 : 4 : 3 : 6.7). Thorax almost entirely dark brown; scutal vittæ indistinct; scutellum pale brown; pleural and sternal sclerites black. Legs with coxæ dark brown,. trochanters brown; femora dark brown on proximal half and pale brown on distal half; tibiæ and tarsi uniformly pale brown; relative lengths of fore femur and tibiæ about 28 : 20. Halteres yellow. Wings as in the figure; dark marking of cell M_2 large, extending distad along veins M_{1+2} and M_{3+4}, branching

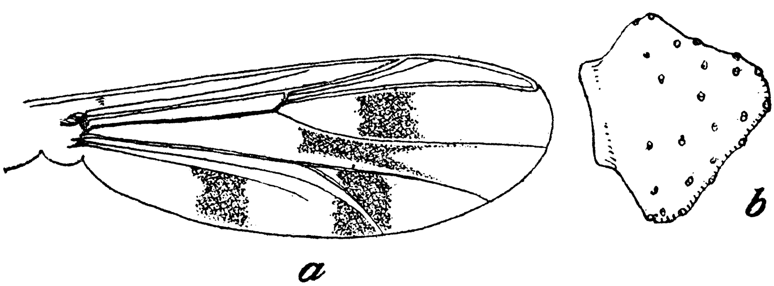

FIG. 15. *Chironomus* (*Polypedilum*) *unifascia* sp. nov. *a*, Female wing; *b*, female cercus.

into two distal stripes. Abdomen pale brown, eighth segment black; cerci (text fig. 15, *b*) somewhat pentagonal, with ventral angle prominent.

Habitat.—Honshu, Japan.

Holotype.—Female; Yamashina, Kyoto, Otcober 11, 1935.

Paratopotypes.—Females; October 11, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. Tadao Masuda.

This species is very closely allied to *C.* (*P.*) *scalænus* Schrank, from which it is easily distinguished by the dark marking in wing cell M_2.

CHIRONOMUS (POLYPEDILUM) SAGITTIFERUS sp. nov.

Collected at light at Yamashina, Kyoto.

Male.—Body 2 to 3 millimeters long; coloration closely similar to that of *C.* (*P.*) *masudai.* Antenna with about five apical

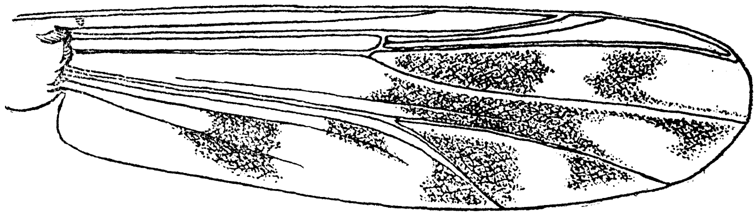

FIG. 16. *Chironomus (Polypedilum) sagittiferus* sp. nov. Male wing.

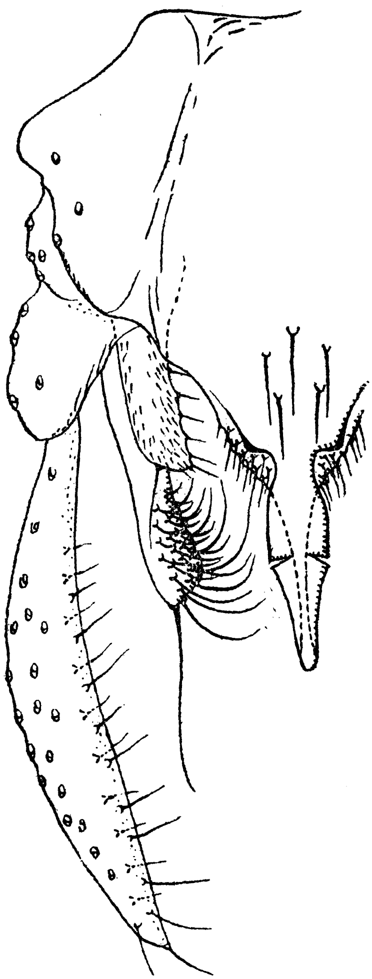

FIG. 17. *Chironomus (Polypedilum) sagittiferus* sp. nov. Male hypopygium.

setæ; antennal ratio about 1.8. Legs with coxæ black, trochanters dark brown; fore femur dark brown or black on proximal two-thirds, pale brown on distal third; fore tibia pale brown or yellow; fore tarsus yellowish on proximal two segments, brown on distal three segments; middle and hind femora black on proximal half or more, pale brown on distal half; tibiæ uniformly pale brown or yellow; tarsus dark brown, each segment with an obscure apical pale-brown ring. Relative lengths of segments of foreleg 57 : 37 : 73 : 45 : 34 : 26 : 13. Wing (text fig. 16) with eight distinct dark markings; veins yellow. Haltere with pale-brown stem and dark knob. Hypopygium (text fig. 17) with style very slender; anal point trilobate, with a pair of basal thickenings and a pair of preapical incisions; ventral appendage with an apical seta very long, extending directly caudad.

Habitat.—Honshu, Japan.

Holotype.—Male; Yamashina, Kyoto; October 11, 1935.

Paratopotypes.—Males; October 11, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Masuda.

This species is somewhat related to *C.* (*P.*) *apfelbecki* Strobl, in which, however, the dark cloud between M_{1+2} and M_{3+4} is small and very obscure, the basal half of the wing shows a transverse dark band before r-m, and the male hypopygium carries a needle-like anal point.

CHIRONOMUS (POLYPEDILUM) DECEMATOGUTTATUS sp. nov.

Found at light.

Male.—Body about 4.6 millimeters long; thorax dark brown in ground color, with four distinct black vittæ on scutum; halteres with knobs black, stems pale brown; wings with many dark markings. Antennæ brown, with scape black, with about five apical setæ; antennal ratio about 2; maxillary palpus pale brown. Thoracic pleural and sternal sclerites and postscutellum black; scutellum pale brown; scutum with four distinct black vittæ, caudoscutal area brown. Legs with coxæ and trochanters dark brown, all femora dark brown on proximal two-thirds and pale brown on distal third; tibiæ of all legs largely pale brown, with proximal ends brown; fore tarsus mainly yellow, with second segment dark brown on proximal fourth, third also dark brown on proximal third, fourth and fifth segments dark brown on proximal half; middle tarsus also mainly yellow, with second to fourth segment dark brown on proximal half; hind tarsus with each segment dark brown on basal third or half. Proportional lengths of segments of foreleg as follows: 73 : 51 : 90 : 60 : 47 : 35 : 17. Wing (text fig. 18, *a*) with ten distinct dark markings: Three in cell R_5, three in cell M_2, one covering distal section of Cu_1, one at distal corner of cell M_4, and two in anal cell. Abdomen entirely brown. Hypopygium (text fig. 18, *b*) with peculiar anal point; dorsal appendage swollen apically, with a long isolated seta; ventral appendage with a very long apical seta.

Female.—Body about 4 millimeters long, coloration as in male. Antenna 6-segmented (4 : 9 : 7 : 7.5 : 4.4 : 12), with three apical setæ; intermediate flagellar segments two to four each with a distinct neck region. Legs with tibiæ entirely pale brown, differing from male; proportional lengths of segments of foreleg 69 : 50 : 88 : 56 : 45 : 35 : 17. Abdomen with cerci (text fig.

18, *c*) pale brown, earlike; spermathecæ short-oval, colorless, hyaline, each with a neck region brown.

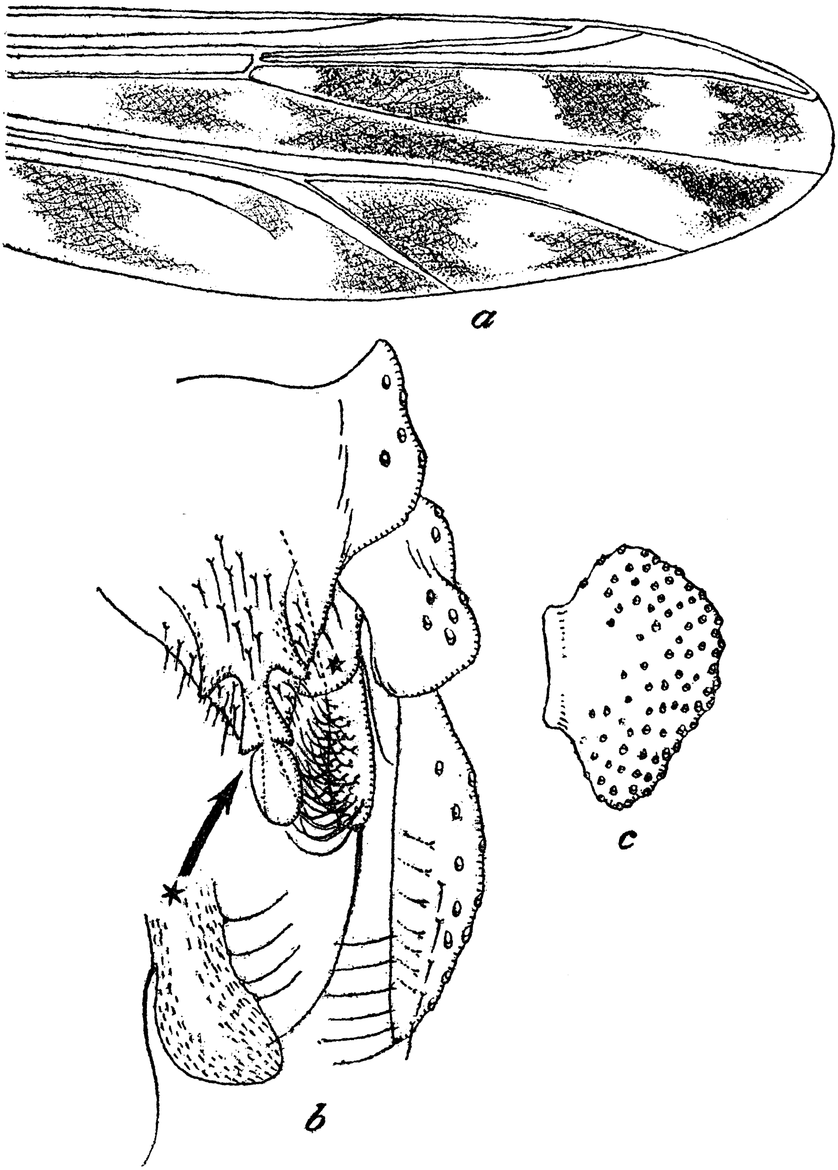

FIG. 18. *Chironomus* (*Polypedilum*) *decematoguttatus* sp. nov. *a*, Male wing; *b*, male hypopygium; *c*, female cercus.

Habitat.—Honshu, Japan.

Holotype.—Male; Shimogamo, Kyoto; May 18, 1930.

Allotopotype.—Female; May 18, 1930.

Paratopotypes.—Males; May 18, 1930.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is quite different from the other species of this subgenus in the characteristic structures of the male hypopygium. The wing markings are somewhat similar to those of an American *C.* (*P.*) *octopunctatus* Loew and a Japanese *C.* (*P.*) *octoguttatus* Tokunaga, but the wings of these are provided with only two markings in cell M_2 and lack the apical markings in cell M_4.

CHIRONOMUS (POLYPEDILUM) MULTANNULATUS sp. nov.

Collected at light from Kyushu and Honshu, but not abundant. The male is still unknown.

Female.—Body length about 4 millimeters; thoracic ground color dark brown, distinctly pruinose, with three black scutal vittæ. Legs with numerous colored rings. Halteres yellow, Wing with distal area, distad of r-m, mainly black, with a number of hyaline spots. Head entirely brown, including mouth parts and antennæ; antennæ with two apical setæ, 6-segmented (4: 8.5: 5.5: 7: 6: 11); intermediate flagellar segments each with a distinct neck region. Thoracic scutum with a median black vitta which is narrowly extended caudad, reaching to scutellum, and indistinctly separated by a paler middorsal stripe; on this stripe a very narrow black middorsal line; caudoscutal area between two caudal extensions of a median vitta triangular; pale brown; two stripes along foveæ pale brown; postscutellum and pleural and sternal sclerites black. Legs mainly brown with many pale rings; coxæ and trochanters entirely brown; femora mainly brown, each with two broad pale rings, and often fore femur yellow on basal third, basal yellow ring very broad extending to the proximal end; tibiæ of fore and hind legs each with two broad pale rings, often without basal pale brown ring; middle tibia with three broad pale rings, including a very broad apical ring, and often uniformly dark brown on basal three-fourths, two basal yellow rings absent; tarsi of legs mainly yellow, with two proximal segments narrowly brown or black on distal end, segments three and four also pale brown or brown on distal half or more, ultimate segment entirely pale brown. Relative lengths of segments of foreleg 82 : 68 : 97 : 66 : 50: 43 : 18. Wing (text fig. 19, *a*) dark on apical half or more, with distinct but subconfluent clear spots on marginal and apical part; cell R_5 with an isolated distinct circular clear spot before middle; anal cell with a dark cloud before middle. Abdomen comparatively slender, brown, distal end curved upwards in life; cerci (text fig. 19, *b*) earlike, yellow, with ventral projection prominent; spermathecæ (text fig. 19, *c*) oval, clear, with duct on side.

Habitat.—Honshu and Kyushu, Japan.

Holotype.—Female; Shimogamo, Kyoto; May 18, 1930.

Paratypes.—Females; Hita, Oita Prefecture; April 12, 1936; and Hachijo, Kyoto; June 8, 1937.

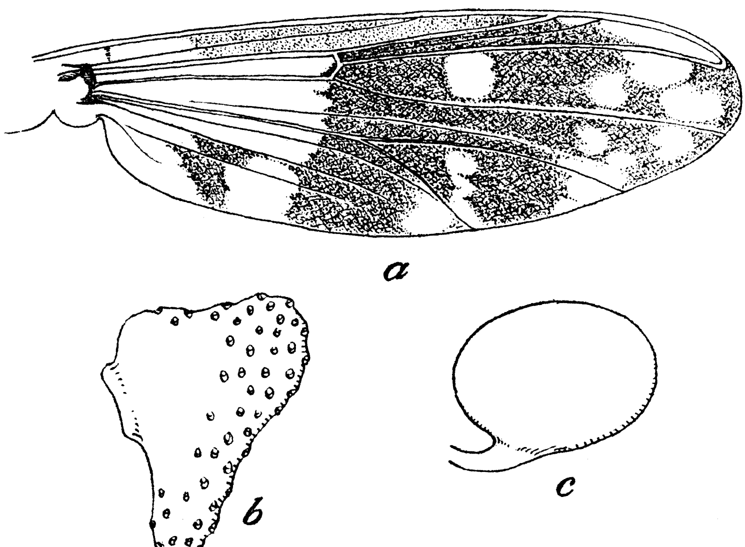

FIG. 19. *Chironomus* (*Polypedilum*) *multannulatus* sp. nov. *a*, Female wing; *b*, female cercus; *c*, female spermatheca.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. Y. Yamada and M. Tokunaga.

This species is somewhat allied to the American *C.* (*P.*) *perpulcher* Mitchell, in which, however, the dark wing area extends more proximad far beyond r-m, thus being completely fused with the anal cloud; moreover, the latter differs from the Japanese species in having an incomplete transverse clear band at the position of the circular clear spot of cell R_5.

TANYTARSUS (TANYTARSUS) STAGNARIUS sp. nov.

This species is very common along stagnant water in Kyoto.

Male.—Body 2.8 to 2.9 millimeters long, not highly setigerous, brown, without distinct dorsal vittæ; scapes of antennæ pale brown, flagella brown; legs, halteres, and abdomen yellowish pale brown. Wings hyaline under transmitted light. Frontal tubercles present, minute, papilliform; eyes bare, reniform, narrow; distance between them narrow and about half as wide as vertical length of eye; antennæ 14-segmented; ultimate segment with two short apical setæ; antennal ratio about 1.3 (4 : 3); maxillary palpi slender, 4-segmented (15 : 52 : 59 : 90). Scutellum with a pair of long median setæ closely situated to each other, two pairs of short lateral setæ arranged in a transverse line on cephalic part; only one on supra-alar seta. Abdomen slender; coxite with four slender setæ on chitinized ventral margin; style slender, extending dorsocaudad, with many slender setæ on mesal side; dorsal appendage somewhat hemispherical, thinly membranous, with several small setæ on dorsomesal part; its accessory lobe relatively large, clawlike, extending mesad beyond dorsal lobe; intermediate appendage short, not extending to middle of style, with many strong curved setæ on dorsomesal side of distal part, a few long setæ on ventrolateral part; ventroproximal appendage slender, long, reaching end of intermediate appendage, with many clavate hairs on dorsal side of distal part; ultimate tergum with a large V-shaped thickening, a pair of small tubercles on lateral side, several small setæ very closely situated to each other on caudomesal part, several minute setæ on caudal margin near anal point; anal point small, extending dorsad, then curved caudad (text fig. 20, *e*). Foreleg with a small fixed tibial spur not longer than half of diameter of tibial end; foreleg ratio about 2; tibial combs distinctly separated from each other, occupying at most half of circumference of tibial end, each with a spur; empodium slender, as long as claws; pulvilli wanting. Wings (text fig. 20, *a*) about 1.8 millimeters long, thickly haired; anal angle atrophied; fringe of anal margin long; vein R_{4+5} ending a little beyond level of tip of M_{3+4}, shorter than twice R_1 (13 : 8); fMCu a little beyond r-m, narrow; M_{3+4} very lightly bent caudad at tip; 1st A slightly beyond base of fMCu.

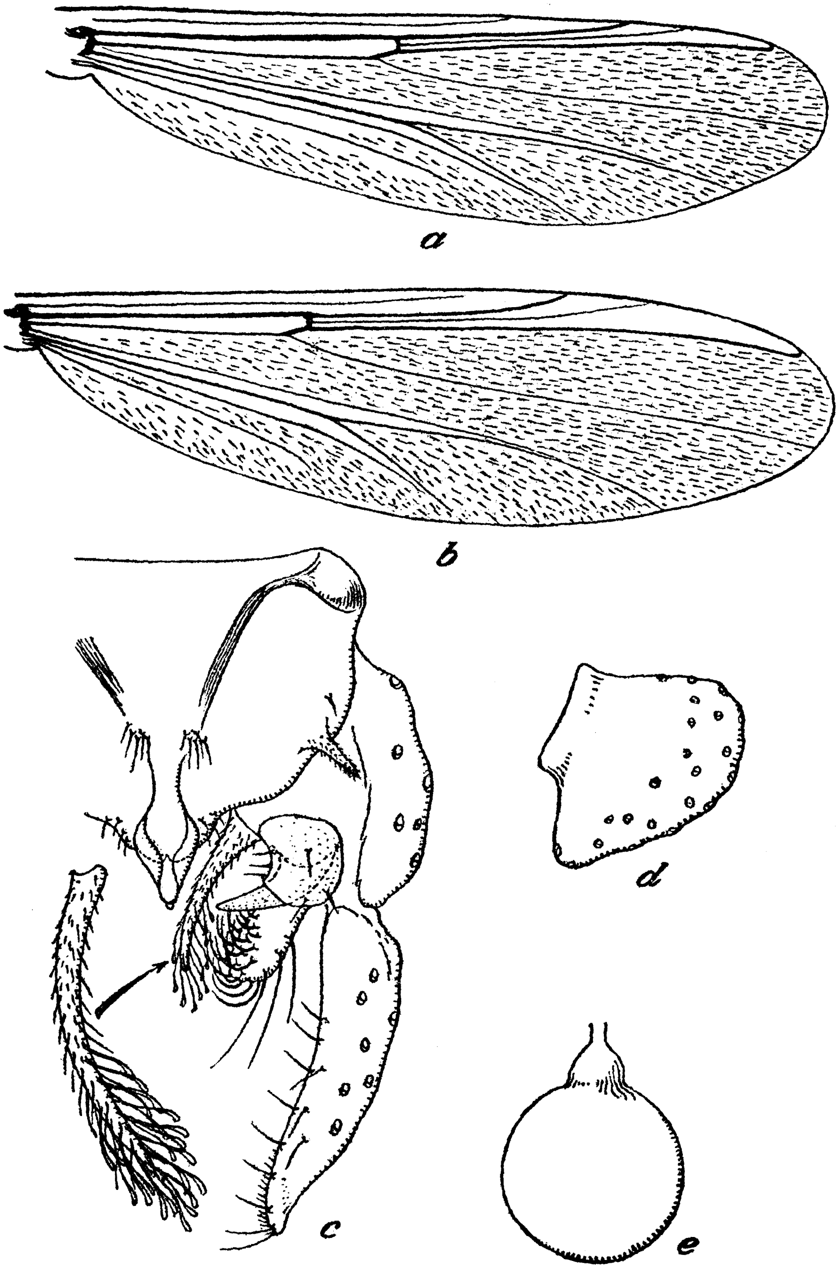

FIG. 20. *Tanytarsus* (*Tanytarsus*) *stagnarius* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus; *e*, spermatheca.

Female.—Body 2.1 to 2.2 millimeters long; coloration as in male, but antennæ uniformly pale brown; frontal tubercles more distinct than in male, cylindrical; eyes reniform, broader than in male; distance between them far wider than in male, a little narrower than vertical length of eye (10 : 13); antennæ 5-segmented; ultimate segment subequal to two preceding segments taken together (59 : 26+24), without apical setæ; second segment constricted shallowly; maxillary palpi slender; distal joint longer than two preceding segments taken together (14 : 35 : 47 : 87). Ultimate sternum setigerous, with a very shallow caudal incision and a deep V-shaped ental thickening. Cerci (text fig. 20, *d*) setigerous, with small setæ on lateral side, with ventral area slightly extending ventrocephalad and angulated; spermathecæ (text fig. 20, *e*) spherical, hyaline, with neck region. Foreleg ratio larger than in male, rather variable, about 2.6 to 3; tibial combs smaller and more separated than in male occupying about two-thirds of circumference of tibial end. Wings (text fig. 20, *b*) about 1.9 to 2 millimeters, relatively broader than in male; R_{4+5} ending far distad beyond level of tip of M_{3+4}, shorter than twice R_1 (66 : 37); M_{3+4} distinctly curved caudad at distal part. Other structures of head, thorax. wings, and legs essentially similar to those of male.

Habitat.—Stagnant water; Honshu, Japan.

Holotype.—Male; Kitashirakawa, Kyoto; May 25, 1930.

Allotopotype.—Female; May 25, 1930.

Paratopotypes.—Males and females; May 25, 1930.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is allied to *T. tenuis* Meigen, in which, however, the foreleg ratio is 1.5, the tibial combs are scarcely separated, the thorax is provided with reddish black vittæ, and the female antennæ is 6-segmented.

TANYTARSUS (TANYTARSUS) PARVICRINIS sp. nov.

This midge was found along a stream in a hilly district of Kyoto.

Male.—Body about 2.6 millimeters long, greenish white in ground color; head, antennæ, scutal vittæ, postscutellum, and sternal sides of thorax greenish brown. Frontal tubercles obsolete; eyes bare, distance between them half their vertical length; maxillary palpi distinctly 4-segmented (2 : 6 : 7 : 13); antennal ratio 0.4 to 0.5; antennæ 14-segmented, ultimate segment with a small apical seta. Supra-alar seta only one; scutellum with one median and two lateral pairs of setæ. Hypopygium (text fig. 21, *c*) with anal point very long, V-shaped thickening of ultimate tergum almost atrophied, represented only by short arms; dorsal appendage somewhat triangular in dorsal aspect, with a few minute setæ on dorsal surface and one or two setæ on mesal margin; accessory lobe absent; intermediate appendage constricted preapically, up-curved, with many strong curved setæ on dorsal side of swollen tip; ventro-proximal appendage very small, with stem very short and slightly pubescent; its terminal tuft consisting of many flat hairs

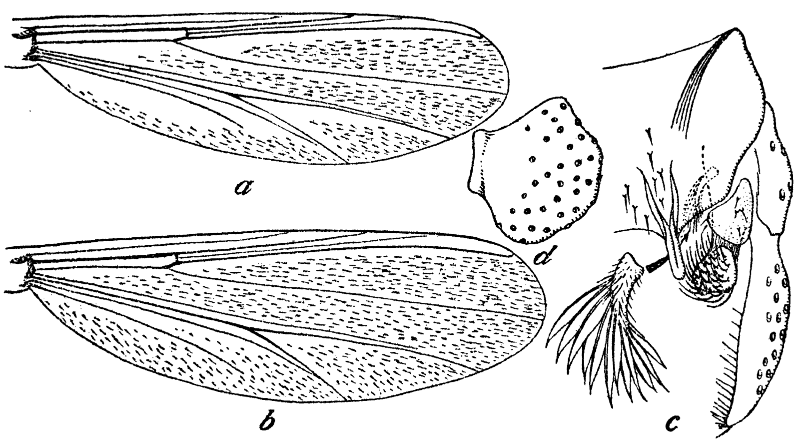

FIG. 21. *Tanytarsus* (*Tanytarsus*) *parvicrinis* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus.

which are about twice as long as stem. Legs without beards; foreleg ratio about 2 (50 : 27); fixed tibial spine of foreleg about half as long as diameter of tibia; four posterior legs each with two large combs which are widely separated from each other and occupy about one-third of circumference of end of tibia; combs each provided with a spur which is fully twice as long as comb; no pulvilli. Wings (text fig. 21, *a*) about 2 millimeters long, comparatively broad, with macrotrichia spread over almost entire surface; anal angle almost atrophied; vein R_{4+5} hardly twice as long as R_1 (21 : 12), ending slightly beyond level of tip of M_{3+4}; M_{1+2} long, about $2\frac{1}{2}$ the length of medial stem (70 : 29); fMCu far beyond base of Rs; r-m short, slightly longer than basal section of Rs, slightly oblique in position.

Female.—Body length about 2.1 millimeters; ground color far paler than in male; head, scutal vittæ, and postscutellum yellowish brown. Antennæ 6-segmented (21 : 35 : 22 : 24 : 25 : 35) ; ultimate segment with two apical setæ, one long and the other short. Ultimate abdominal sternum broad; spermathecæ two, hyaline, oval; cerci (text fig. 21, *d*) small, very short, angulated. Wings (text fig. 21, *b*) slightly larger and broader than in male, about 2.1 millimeters long; relative lengths of veins R_{4+5} and R_1 73 : 43; M_{1+2} long, fully thrice as long as median stem. Other structures of head, thorax, wings, and legs closely similar to those of male.

Habitat.—Running water; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; April 10, 1932.

Allotopotype.—Female; April 10, 1932.

Paratopotypes.—Males and females; April 10, 1932.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species differs highly from the other Japanese species of subgenus *Tanytarsus* in the possession of the very short terminal segment of the antenna in the male, which is only half as long as the twelve preceding segments taken together.

TANYTARSUS (TANYTARSUS) KYOTOENSIS sp. nov.

Very abundant along slow stream in Kyoto.

Male.—Body 1.9 to 2.8 millimeters long, highly setigerous, with long setæ; thorax reddish brown; dorsal vittæ and sternal side dark brown; postscutellum also dark brown but sometimes pale brown; abdomen yellowish semihyaline. Some individuals darker than in above description. Eyes bare, narrowly projected dorsad, not widely separated from each other on dorsal side; distance between them about half as wide as vertical length of eyes; antennæ 14-segmented; ultimate segment usually with an apical seta, subequal in length to ten preceding segments taken together; antennal ratio 0.8 to 0.9; maxillary palpi long, slender; ultimate maxillary segment subequal in length to two preceding segments taken together; clypeus highly setigerous, with long setæ. Pronotum greatly reduced; scutum with median vittæ short, ending at middle of scutum; supra-alar seta only one; scutellum with two very long median and four long and two short lateral setæ. Abdomen very slender. Hypopygium (text fig. 22, *a*) also setigerous; ultimate tergum with a long thickened anal point, setigerous with small setæ on median part; ultimate sternum without macrotrichia; coxite setigerous, with very long, strong setæ, with five slender hairs on ventromesal margin; style prominently extending caudodorsad, with many slender hairs on mesal side; dorsal appendage thinly membranous, with several short setæ, expanded dorsad; its accessory lobe very small; intermediate appendage large, broad, curved at tip, crowned with many curved strong setæ, not extending caudad beyond anal point; ventroproximal appendage hardly as large as intermediate appendage, uniformly chitinized,

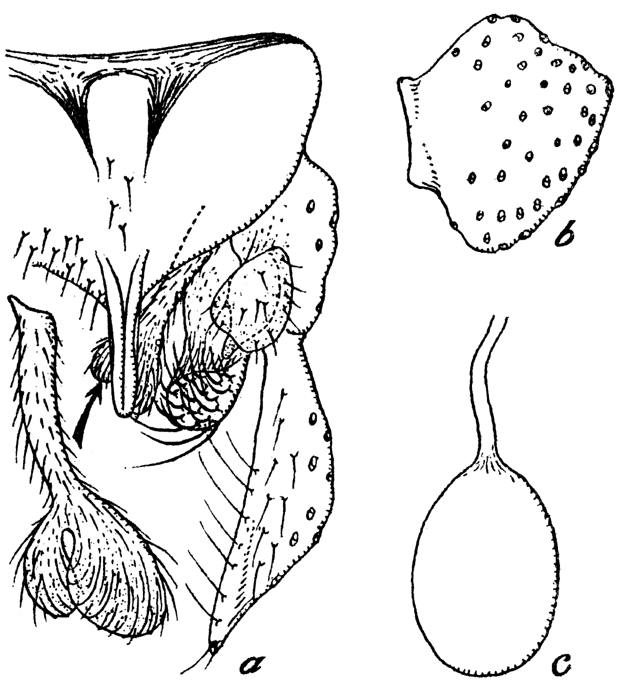

FIG. 22. *Tanytarsus* (*Tanytarsus*) *kyotoensis* sp. nov. *a*, Male hypopygium; *b*, female cercus; *c*, spermatheca.

setigerous on stem, bilobate distally; lateral arm forming a large membranous distal knob; mesal arm forming a small knob; these knobs hyaline, finely striated. Legs hairy, beards wanting; foreleg ratio 2 to 2.2; fore tibia with a fixed distal spine; two tibial combs distinct from each other, occupying about two-fifths of circumference of tibial end, each with a similar spur about twice as long as comb; claws each with two basal hairlike projections; pulvilli very small; empodium large, but shorter than claws. Wings (text fig. 23, *a*) 1.7 to 2.2 millimeters long, very slightly brown under transmitted light, densely hairy on entire surface; anal angle completely atrophied; fringe of posterior margin long; vein R_{4+5} twice as long as radial stem, 1.7 times as long as R_1, ending just beyond level of tip of M_{3+4}; fMCu far beyond r-m; 1st A almost reaching base of fMCu.

Female.—Body about 1.7 to 2.3 millimeters long; coloration paler than in male. Eyes not projected dorsad, reniform; antennæ 6-segmented; ultimate segment subequal in length to preceding segment, other flagellar segments fusiform, each with six very long setæ and two sensory setæ. Hypopygium setigerous; ultimate tergum not pointed caudad; ultimate sternum very broad, setigerous on caudal half, with caudal incision very

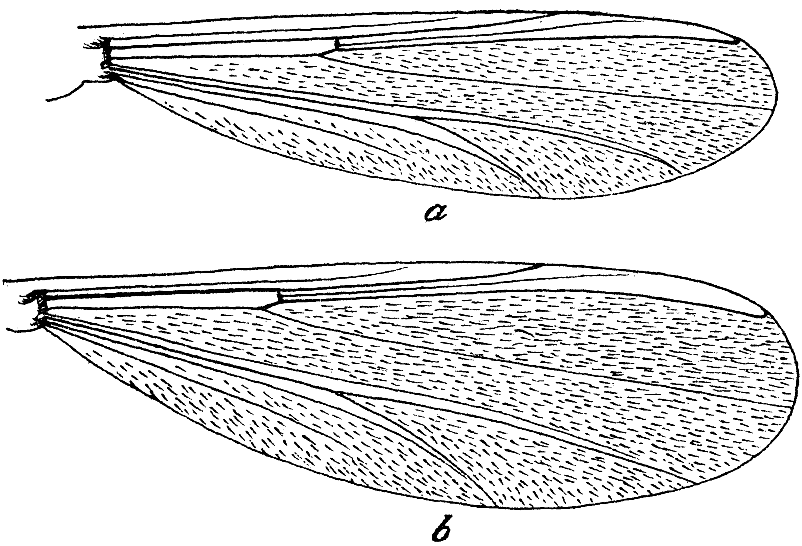

FIG. 23. *Tanytarsus (Tanytarsus) kyotoensis* sp. nov. *a*, Male wing; *b*, female wing.

small; cerci (text fig. 22, *b*) very small, somewhat rhombic; spermathecæ (text fig. 22, *c*) two, hyaline, oval. Wings (text fig. 23, *b*) 1.8 to 2.1 millimeters long, macrotrichia thicker than in male; anal angle atrophied. Other structures of head, thorax, wings, and legs as in male.

Habitat.—Running water; Honshu, Japan.

Holotype.—Male; Shimogamo, Kyoto; April 3, 1930.

Allotopotype.—Female; April 3, 1930.

Paratopotypes.—Males and females; Shimogamo and Kamigamo, Kyoto; April 3 to 14 and May 11 to 19, 1930, and April 10, 1932.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The present species is somewhat related to *T. excavatus* Edwards and *T. glabrescens* Edwards, but highly specific in the structures of the ventroproximal appendages of the male hypopygium.

TANYTARSUS (TANYTARSUS) ATAGOENSIS sp. nov.

This fly was found along a rapid stream in a hilly district.

Male.—Body 1.9 to 2 millimeters long, slender, pale brown in ground color; dorsal vittæ and sternal side of thorax reddish brown; middorsal vittæ distinct, slightly paler than lateral vittæ; pleuron with a brown spot near wing basis; postscutellum reddish brown on caudal part; scapes of antennæ reddish brown. Eyes bare, reniform, widely separated from each other, distance between them on dorsal side wider than vertical length of eye (5 : 4); frontal tubercles present, very small; antennæ 14-segmented; ultimate segment usually with an apical seta, equal in length to five preceding segments taken together; antennal ratio about 0.5 (19 : 39); maxillary palpi slender, distinctly 4-segmented; last segment far shorter than two preceding segments taken together (10 : 7+7); clypeus with only about 12 to 15 setæ. Pronotum greatly reduced; scutum scantily haired; middorsal vittæ short, somewhat paler than lateral vittæ; supra-alar seta only one; scutellum with only four setæ. Abdomen scantily haired, very slender in general appearance; ultimate tergum (text fig. 24, *b*) also very scantily setigerous, with a few long setæ on each lateral corner, several minute setæ on caudomeson near anal point, a large brown V-shaped band on surface; anal point highly chitinized, with many small but distinct dots; coxite large, scantily setigerous, with three slender hairs on ventromesal margin; style rather slender, not sharply pointed, with ten or more setæ on lateral side, many slender short hairs on mesal side; dorsal appendage large, prominent, walnutlike, with several minute setæ on dorsal side and a few similar setæ on mesal side; its accessory lobe small, clawlike, not extending beyond dorsal lobe; intermediate appendage as large as style, crowned with many curved setæ, extending at middle of style; ventroproximal appendages very small, entirely setigerous with simple hairs. Legs without beards; foreleg ratio about 1.5; fore tibia with a small fixed spine which is shorter than diameter of tibia; four posterior legs each with two small tibial combs; combs widely separated from each other, each with a spur; spurs of one leg unequal in length; shorter spur twice as long as comb, longer one 2.5 times as long as comb; empodium as long as claws, slender; pulvilli present, very small,

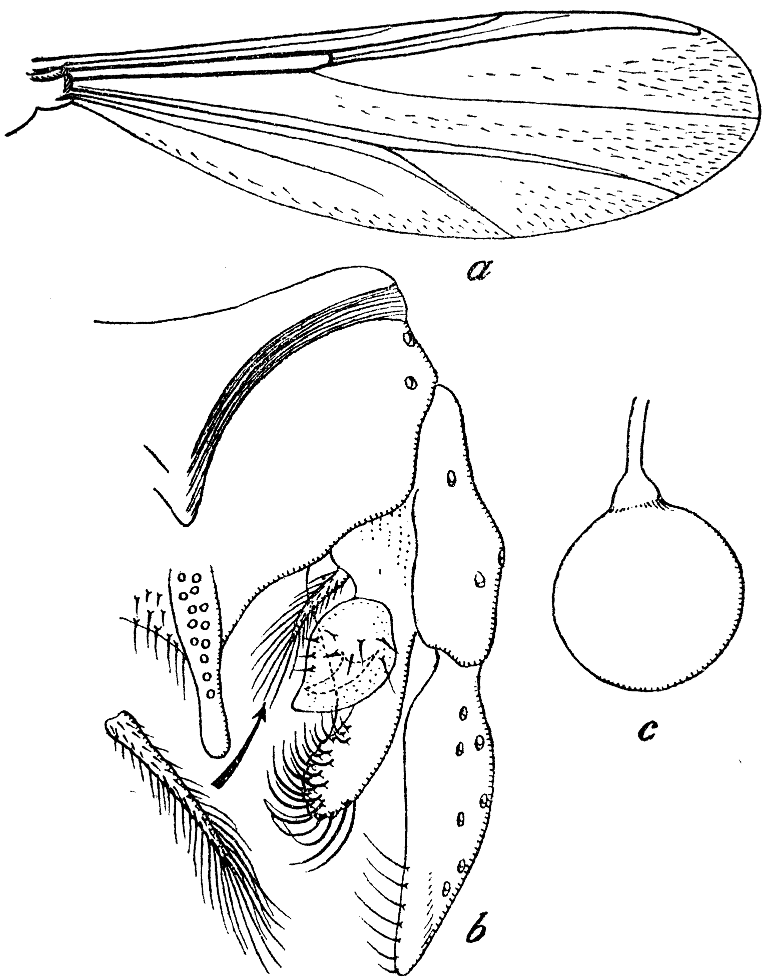

FIG. 24. *Tanytarsus* (*Tanytarsus*) *atagoensis* sp. nov. *a*, Female wing; *b*, male hypopygium; *c*, spermatheca.

with minute hairs. Wings (text fig. 25) very narrow, 1.5 to 1.6 millimeters long, with macrotrichia comparatively scarce; fringe of anal margin long; anal angle completely atrophied; R_{4+5} ending beyond level of tip of M_{3+4}, about twice as long as R_1; fMCu far beyond r-m; 1st A reaching fMCu.

Female.—Body 1.5 to 1.6 millimeters long, far paler than in male, yellowish white in general appearance; thoracic vittæ, sternum, and postscutellum pale brown. Eyes widely separated from each other; distance between them about $1\frac{1}{2}$ times vertical length of eye; frontal tubercles very minute and papilliform. Antennæ 5-segmented; ultimate segment slightly shorter than two preceding segments taken together (7 : 4+4), usually with an apical seta; segment two shallowly constricted, slightly longer than following segment (5 : 4). Thorax with one supra-alar seta. Hypopygium scantily haired; ultimate sternum with a shallow V-shaped incision; cerci very small, sometimes almost completely atrophied, represented only by a blunt elevation of integument; spermathecæ (text fig. 24, *c*) spherical, hyaline. Wings (text fig. 24, *a*) about 1.4 to 1.5 millimeters long, comparatively broader and more hairy than in male; vein R_{4+5} ending on level of tip of M_{3+4}. Other structures of head, wings, and legs as in male.

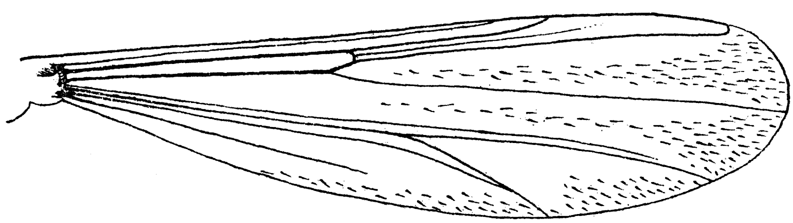

FIG. 25. *Tanytarsus* (*Tanytarsus*) *atagoensis* sp. nov. Male wing.

Habitat.—Mountainous region; Honshu, Japan.

Holotype.—Male; Mount Atago, Kyoto; May 31, 1931.

Allotopotype.—Female; May 31, 1931.

Paratopotypes.—Males and females; May 31, 1931.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

T. curticornis Kieffer is closely allied to the present species, which, however, has the antennal ratio of the male 0.8, and the foreleg ratio 2.

TANYTARSUS (TANYTARSUS) URAIENSIS sp. nov.

This species is peculiar in habitat, being found in hot springs of mineral water.

Male.—Body about 2.7 millimeters long, uniformly yellow or pale brown. Antennæ 14-segmented; antennal ratio about 1.2 (32 : 27) maxillary palpus with four distinct segments (2 : 5 : 6 : 9.5). Thorax with a line of setæ along pseudosutural foveæ and two short lines of setæ on cephaloscutal area, supra-alar setæ one, rarely two; scutellum with a pair of median and two pairs of lateral setæ. Fore tibia with a distinct immovable apical spine; relative lengths of fore femur and tibia 43 : 27; hind tibial combs very narrowly separated, each with a spur; empodium slender, as long as claws; pulvilli minute, setigerous. Wing (text fig. 27, *a*) hyaline, with macrotrichia on middle part of cell R_5 and on apical part of M_2; R_{2+3} ending on costa just before the middle between ends of R_1 and R_{4+5}. Abdomen slender; hypopygium (text fig. 26) with ultimate tergum very sparsely setigerous, with a V-shaped chitinization; anal point with a dotlike impression, with apical lamella; dorsal appendage thinly membranous, setigerous, with a very indistinct accessory lobe; ventral projection slender, with a tuft of slender setæ on apical end.

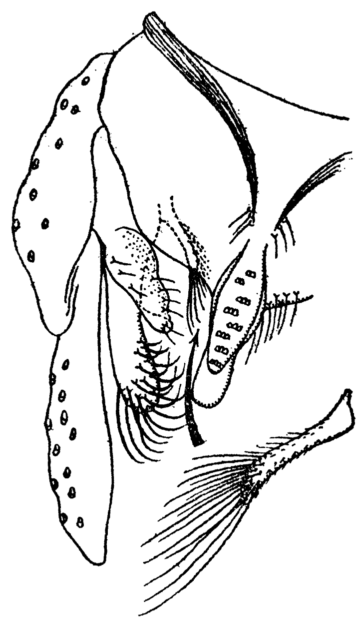

FIG. 26. *Tanytarsus* (*Tanytarsus*) *uraiensis* sp. nov. Male hypopygium.

Female.—Body length 2 millimeters; in coloration similar to male. Head with eyes bare, reniform, widely separated on vertex, the distance between eyes slightly wider than half of vertical length of eyes (8 : 14); frontoclypeus highly setigerous; antenna 5-segmented (4 : 6 : 4 : 4.5 : 9.5); intermediate segments each with a neck region very short; maxillary palpus with four distinct segments (2: 4.8: 6: 10). Wing (text fig. 27, *b*) with macrotrichia uniformly spread over wing cells R_5, M_2, M_4, and anal cell. Foreleg with proportional lengths of seven distal segments 35: 24: 54: 25: 20: 17: 8. Abdomen with ultimate sternum highly setigerous, with a deep U-shaped incision, cercus (text fig. 27, *c*) somewhat rectangular; spermathecæ (text fig. 27, *d*) two, pale brown, short-oval.

Pupa.—Body about 5 millimeters long; exuviæ almost colorless, hyaline. Head with two pairs of pointed tubercles larger on frontal region, and smaller on scape of antenna. Thoracic respiratory organ (text fig. 27, *e*) slender, with small hairs on one side. Abdomen hyaline; first tergum without cuticular processes; second tergum with a broad median dark area, a spinous welt on anterior part, minutely spinous small area on posterior

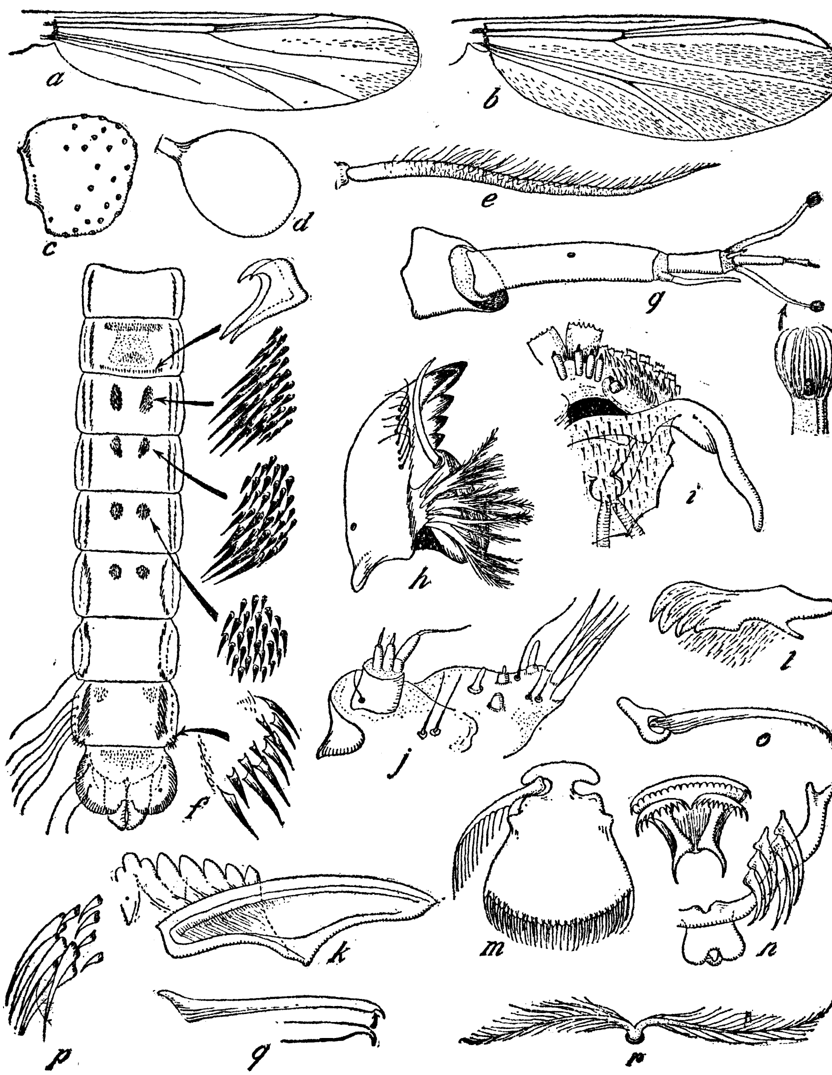

FIG. 27. *Tanytarsus* (*Tanytarsus*) *uraiensis* sp. nov. *a*, Male wing; *b*, female wing; *c*, female cercus; *d*, spermatheca; *e*, thoracic respiratory organ of pupa; *f*, dorsal side of pupal abdomen; *g*, larval antenna; *h*, larval mandible; *i*, larval hypopharynx; *j*, larval maxilla; *k*, larval mentum; *l*, larval premandible; *m*, distomesal appendage of larval epipharynx; *n*, median and midproximal appendages of larval epipharynx; *o*, distal appendage of larval labrum; *p*, laterodistal appendages of larval labrum; *q*, hooklet of anterior pseudopod of larva; *r*, plumose hair of larval abdomen.

part, and a line of thornlike spines (text fig. 27, *f*) on caudal margin; terga from third to sixth each with a pair of spinous patches on anterior part; these spinous patches larger on anterior segments; seventh tergum with a long lateral swimming hair on either caudal corner; eighth tergum with a pair of dark linear areas on lateral sides, a pair of minutely spinous small areas on anterior part, about eleven strong isolated spines on either laterocaudal corner, five slender swimming hairs on either lateral side; ultimate segment with a pair of hemicircular swimming paddles fringed with about thirty-seven slender swimming hairs on either margin, and two pairs of long isolated setæ on lateral sides; dorsal side of ultimate segment with a minutely spinous area on anterior part.

Larva.—Body about 7 millimeters long, without special strong setæ. Head with three chitinized plates of clypeus, three pairs of distinct setæ on these plates, paired chitinized clypealiæ, tormæ, and labraliæ; premandible (text fig. 27, *l*), with four apical teeth; distal labral appendage (text fig. 27, *o*) slender, very minutely serrulate at apex, with a basal ring; laterodistal labral appendages (text fig. 27, *p*) consisting of six strong and five small simple thorns; epipharynx with following cuticular appendages: Distomesal appendage (text fig. 27, *m*) consisting of a pair of plumose projections and a broad scalelike plate; median appendage consisting of a pair of strong hooklike projections and a broad minutely serrulate plate; midproximal appendage (text fig. 27, *n*) consisting of a V-shaped thickening, a small median trapezoid plate, and six spinelike solid projections along each arm of V-shaped thickening. Antenna (text fig. 27, *g*) slender, 5-segmented, basal antennal projection bluntly ended, segment one longest, longer than four following segments taken together, with a distinct sensory projection at end; segment two with two long and a short sensory projection at end; segment three simple, slightly shorter than preceding; segment four simple, about half as long as preceding; segment five very minute, conical. Mandible (text fig. 27, *h*) with two apical and three cutting teeth, a strong hyaline setalike projection on cutting edge, distal brustia of several simple setæ, proximal brustia of three plumose hairs and a group of hyaline setalike projections. Maxilla (text fig. 27, *j*) consisting of an inner lobe which carries five hyaline apical spines, three sensory setæ, and four peglike sensillæ, and an outer lobe which carries two setæ and a palpus; maxillary palpus 4-segmented, with two sensory projection on distal end of first segment. Labium (text fig. 27, *k*) with a pair of large submenta, a pair of simple setæ near the former; mentum with five pairs of lateral teeth and a triple median tooth; labial appendages atrophied. Hypopharynx (text fig. 27, *i*) supported by a large chitinized pharyngealingula; its anterior membranous lobe with a pair of distinct scalelike median lamellæ, many minute comblike scales on ventral side, four pairs of peglike sensillæ, and a number of minute spines on dorsal side, many spines on posterior dorsal membrane; paired salivary ducts united just before salivos, common duct absent. Anterior pseudopod with numerous simple hooklets of similar size and shape (text fig. 27, *q*); typically abdominal segments each with a pair of lateral bifurcate plumose hairs (text fig. 27, *r*) on caudal part; caudal tuft of setæ composed of a small basal tubercle, eight long apical setæ and two preapical minute setæ; apical setæ arising from a common basal ring-shaped thickening; posterior pseudopod with sixteen simple hooklets; anal gills two pairs of ordinary lobes.

Habitat.—Hot spring water; Formosa.

Holotype.—Male; Urai-Onsen, Formosa; September 14, 1924.

Allotopotype.—Female; September 14, 1924.

Paratopotypes.—Males and females; September 14, 1924.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

This species is somewhat similar to a Formosan species, *Rheotanytarsus formosæ* Kieffer, in which, however, the antennal ratio of the male is about 1, the wing of the female is less hairy, and the foreleg ratio is about 2.

TANYTARSUS (TANYTARSUS) PELAGICUS **Tokunaga.**

This marine midge has been reported from Seto, Wakayama.[2] In 1936 I collected a male pupa at Ebisu, Tomioka, Amakusa Islands, Kyushu.

Pupa.—Closely related to pupa of *T. boodleæ* Tokunaga. Body about 2.5 millimeters; head, thorax, and genital sheaths pale brown; other parts colorless, hyaline. Thorax without respiratory organs. Abdominal terga from second to sixth each with a pair of spinous patches, patches brown, oval, comparatively large, subequal in size in all segments, consisting of numerous minute spinules; second terga with a caudal straight row of simple hooklets; abdominal segments, except ultimate segment, without both lateral swimming lamellæ and lateral long swimming hairs; penultimate segment with a pair of small caudal hornlike projections (text fig. 28); ultimate segment small, with

[2] Tokunaga, M., Philip. Journ. Sci. **51** (1933) 364–366.

many lateral swimming hairs, two pairs of very long lateral isolated setæ; genital sheaths distinctly projected caudad far beyond caudal margin of ultimate tergum.

Habitat.—Seashore, under low-tide mark; Japan.

Specimens.—An alcoholic male pupa; Ebisu, Tomioka, Amakusa, Kyushu; October 28, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

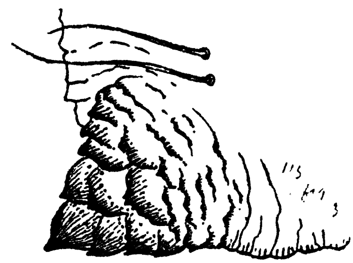

FIG. 28. *Tanytarsus* (*Tanytarsus*) *pelagicus* Tokunaga. Caudolateral spine of eighth abdominal segment of pupa.

TANYTARSUS (RHEOTANYTARSUS) PENTAPODA Kieffer.

This species is very common in running water in Kyoto. The larval nest cases are characteristic, being provided with several tentaclelike filaments.

Male.—Body 2 to 2.2 millimeters long; ground color white; thorax with four yellowish vittæ; wing without anal lobe. Head yellowish brown, with eyes bare, without frontal tubercles; frontoclypeus yellowish brown, setigerous, with about twenty-four yellow setæ. Antenna with scape yellowish white, flagellum and plumose hairs pale brown, 14-segmented; ultimate three or four segments sometimes incompletely segmented; antennal ratio 0.7 (0.68 to 0.72). Maxillary palpus yellowish brown, 5-segmented (1.3 : 2 : 5.5 : 6.1 : 11.3). Thorax extensively white; scutum with two short yellowish white median and two long yellowish brown lateral vittæ; scutellum with two pairs of long lateral and a pair of short median setæ on anterior margin, and two long median setæ on meson; postscutellum with an obscure yellowish brown cloud on caudal part; sternal side pale brown. Legs with coxæ and trochanters white, tibiæ and tarsi yellowish white; fore femur yellowish white on distal half and white on proximal half; middle and hind femora entirely white; tibial combs distinctly separated, each with a spur, pulvilli absent; empodium very slender, hairlike; beards absent; proportional lengths of segments of legs 42 : 19 : 49 : 25 : 19 : 16 : 7 in foreleg, 47 : 23 : 55 : 27 : 21.5 : 17.2 : 7.5 in middle leg, and 42 : 21 : 50 : 25 : 19 : 16 : 7 in hind leg; foreleg ratio about 2.6. Wing (text fig. 29, *a*) with macrotrichia spread over entire surface, fringed with long setæ, without anal lobe; crossvein very short; R_{2+3} indistinct; R_{4+5}

slightly curved along costal margin; fMCu far beyond level of crossvein, but before middle of wing. Abdomen entirely white; hypopygium (text fig. 29, *b*) with anal point long, ultimate ter-

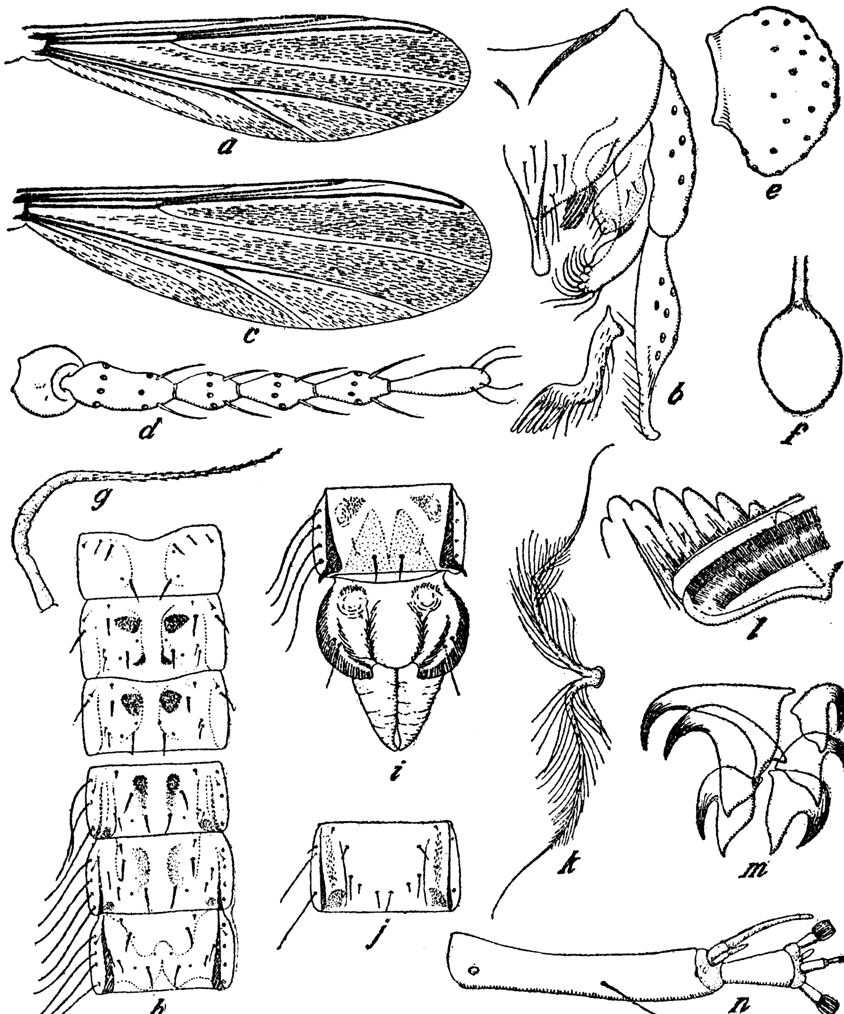

FIG. 29. *Tanytarsus* (*Rheotanytarsus*) *pentapoda* Kieffer. *a*, Male wing; *b*, male hypopygium; *c*, female wing; *d*, female antenna; *e*, female cercus; *f*, spermatheca; *g*, thoracic respiratory organ of pupa; *h*, dorsal side of abdominal segments of pupa (segment four omitted); *i*, caudal end of pupal abdomen; *j*, ventral side of abdominal segment four of pupa; *k*, plumose hair of larval abdomen; *l*, larval mentum; *m*, claws of posterior pseudopod larva; *n*, larval antenna.

gum very scantily setigerous; style very long, with apical half very narrow, distinctly curved ventrad, forming a hook; dorsal appendage swollen, without accessory projections; intermediate appendage strongly curved mesad, with many curved setæ on apex; ventral appendage suddenly angulated distally with many flattened projections on apex and long pubescence on stem.

Female.—Body about 1.5 to 1.8 millimeters long; coloration as in male. Antenna mainly yellowish white, with ultimate segment pale brown, 6-segmented; intermediate flagellar segment short-fusiform; ultimate segment with about four apical hairs, without strong basal setæ; proportional lengths of antennal segments, 3 : 5 : 3 : 3.2 : 3 : 4.5. Maxillary palpus 5-segmented (2 : 2 : 6 : 6.5 : 12). Proportional lengths of segments of legs 44 : 22 : 54 : 26.5 : 20 : 17 : 7.3 in foreleg, 41 : 32 : 18 : 8 : 6 : 4.3 in middle leg, and 45 : 38 : 24 : 15 : 12 : 7 : 4.5 in hind leg. Wing (text fig. 29, *a*) with macrotrichia thicker than in male; R_{2+3} very obscure; venation as in male. Cercus (text fig. 29, *e*) white, setigerous; spermathecæ (text fig. 29, *f*) two, oval, colorless, with long neck regions. Other structures mainly as in male.

Pupa.—Body length about 3 to 3.5 mm; exuviæ mainly colorless and hyaline, head and thoracic regions dark. Head with a pair of long setæ between antennæ; vertexal region finely imbricate; antennal base with a ring of minute spinules; sheath of paraglossa with an apical filamentous projection. Thorax with a pair of filamentous respiratory organs (text fig. 29, *g*) which are finely spinulous on distal half; middorsal area of scutum finely imbricate; pronotal region with two long flattened setæ on either side; scutum with three long setæ near respiratory organ and small setæ on mesal area. Abdomen (text fig. 29, *h* to *j*) with lateral swimming lamellæ on fourth to eighth segments, paired spinous patches on dorsal side of segments two to five. Typical chætotaxy of abdominal tergum: One pair of minute setæ on anterior margin, one pair of small flattened setæ on anterior region, two pairs of small slender setæ on posterior region, one pair of small flattened setæ near posterior margin, one pair of minute sensory pores on middle part and posterior margin; sternum: One pair of minute setæ on anterior margin, one pair of small setæ on anterior or middle region, three pairs of small slender setæ on posterior margin; lateral side with variable number of setæ; in first, eighth, and ninth segments setæ more or less reduced; first tergum without two pairs of caudal small setæ; eighth tergum with only one pair of caudal flattened setæ; first sternum with only two pairs of anterior setæ; eighth sternum without three pairs of posterior setæ; seg-

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ment one without lateral setæ; segments two and three each with a large dorsal, two small ventral setæ on either lateral side; segment four with a large dorsal seta and a small and a long ventral setæ on either side; segment five with three long ventral setæ on either side; segments six to eight each with four long ventral setæ on either lateral lamella. Caudal ridge of spines of second tergum consisting of curved simple hooklike spines arranged in a line; spinous patches of fifth tergum very small; caudal spines of segment eight simple; ultimate segment with shallow caudal incision, a pair of dorsal and ventral setæ on

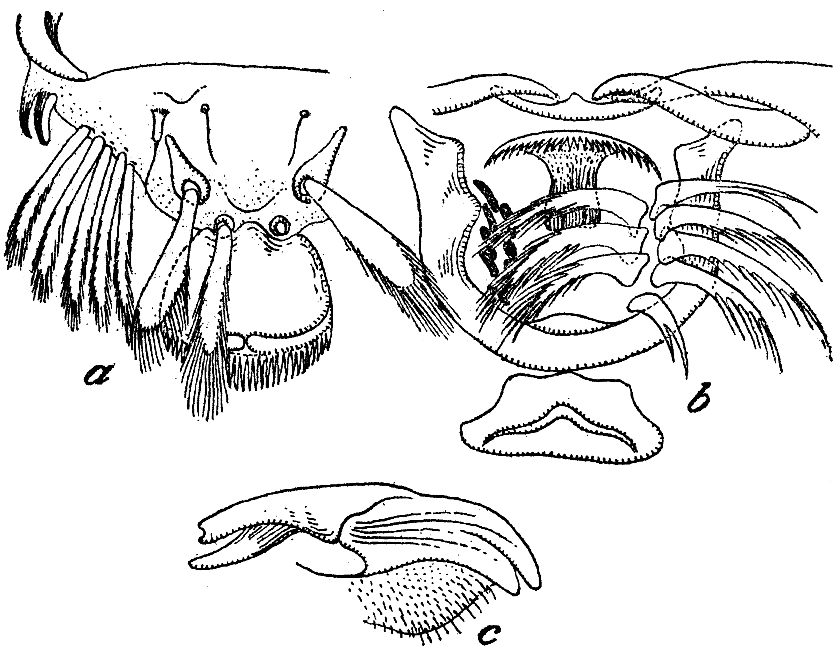

FIG. 30. *Tanytarsus* (*Rheotanytarsus*) *pentapoda* Kieffer. *a*, Larval labrum; *b*, larval epipharynx; *c*, larval premandible.

lateral lamellæ, about twenty-five swimming hairs on either side; genital sheaths extending caudad far beyond ultimate segment in both sexes.

Larva.—Body about 3.2 to 3.7 millimeters long. Head oval, with two clypeal plates; antenna (text fig. 29, *n*) arising from a basal large projection, 5-segmented; segment one long, about twice as long as the remaining segments taken together; segment two with two Lauterborn organs and a small sensory projection on its distal end; trichoid sensilla on distal end of first segment ending far before antennal tip. Labrum (text fig.

30, *a*) with two small scalelike and five large plumose appendages on either lateral side, one pair of slender setæ, one pair of peglike sensillæ, and one pair of large plumose appendages on mesal area, one pair of large plumose appendages and one large comblike plate on distomesal area; epipharynx (text fig. 30, *b*) with a pair of large bidentate premandibles (text fig. 30, *c*) a large fanlike serrulate plate on mesal area, and complex midproximal appendages composed of a large U-shaped thickening, a large subtrapezoid plate, and two groups of eight plumose hooklike appendages. Labium (text fig. 29, *l*), with a pair of large submenta, a thickened dentate mentum, and a pair of single simple setæ; mentum with a large unpaired median tooth which bears small shoulder parts, and five lateral teeth on either side. Mandible with a slender apical tooth, five cutting teeth, a very long trichoid projection on base of cutting edge, many slender hairs on distal brustia, five plumose hairs on mesal side, and two isolated setæ on lateral side. Maxilla with two large trichoid projections on inner lobe, a large palpus, and a large sensory disc on outer lobe. Anterior pseudopod with numerous nonserrulate simple hooklets; posterior pseudopod with sixteen simple yellow claws (text fig. 29, *m*); caudal tuft of setæ consisting of seven long setæ and two minute setæ arising from a small common tubercle; a pair of two-branched plumose hairs (text fig. 29, *k*) on lateral sides of second to sixth abdominal segments; anal gills short-oval.

Nest case.—Polygonal and cylindrical, closely applied on substratum (that is, stones, plants, and other material) with its slender basal part; free larger part of case with five or six, rarely eight, tentaclelike filaments on margin; external surface of case with several longitudinal ridges; pupal nest case with filaments short, an operculum which is very thin, hyaline, with many concentric circular lines and a small central opening; in nest case of young larva both ends often with two or four filaments, and closely applied on substratum with entire lengths of case; number of filaments corresponding to that of external longitudinal ridges.

Habitat.—Running water.

Specimens.—Alcoholic; Kitashirakawa, Kyoto; October 8 to 30, 1935 and 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Kani and M. Tokunaga.

TANYTARSUS (RHEOTANYTARSUS) ÆSTUARIUS sp. nov.

This midge was found at the estuary of a river, Tottori Prefecture.

Male.—Body 2.7 to 2.8 millimeters long, setigerous, brown in general appearance; thorax and legs yellowish brown; antennæ, thoracic dorsal vittæ, sternal side, postscutellum, and tips of femora all reddish or dark brown; abdomen with brown bands on caudal margin of each tergum from first to sixth; thoracic dorsal vittæ and postscutellum distinctly separated by pale longitudinal lines; middorsal vittæ far shorter than lateral vittæ; halteres and abdominal sternal side yellowish white. Frontal tubercles absent; eyes bare, not widely separated from each other; distance between them about half vertical length of eye (18 : 35); maxillary palpi long, distinctly 4-segmented (4 : 7 :

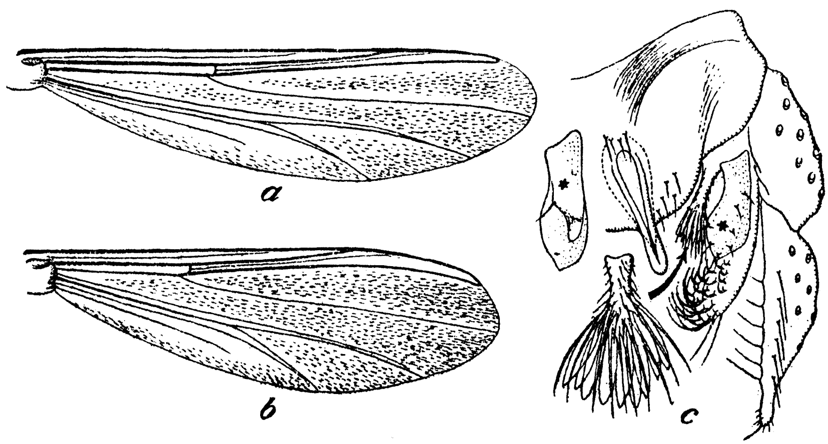

FIG. 31. *Tanytarsus* (*Rheotanytarsus*) *æstuarius* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium.

8 : 14); antennæ 14-segmented, with four distal segments incompletely segmented; antennal ratio about 1; ultimate segment with a short apical seta. Supra-alar seta always only one; scutellum with a pair of median and two pairs of lateral long setæ. Hypopygium (text fig. 31, *c*) setigerous, with anal point long, thickened, with a large cavity between the two dorsal lamellæ; setæ on ultimate tergum very scanty, small, found only on caudal margin and base of anal point; coxite with four stiff setæ on thickened ventromesal margin; style sharply pointed, directly extending caudad, very narrow on caudal part; dorsal appendage thinly membranous, elongated caudad, with several

minute setæ on dorsal surface; accessory lobe of dorsal appendage wanting; intermediate appendage large, with a few setæ extending directly caudad, and many curved setæ on distal end; ventroproximal appendage with short pubescent stem and a long tuft consisting of simple hairs and flat hyaline hairs. Legs without beards; foreleg ratio about 2; fixed tibial spine of foreleg minute; four posterior legs each with two large combs distinctly separated from each other and occupying fully half circumference of tibial end; combs provided with long spurs twice as long as combs; claws simple, slender; empodium also slender, as long claws; pulvilli wanting. Wings (text fig. 31, *a*) narrow, about 2 millimeters long, with macrotrichia spread over entire surface, brown under transmitted light, fringed with long hairs on anal margin; anal angle greatly atrophied; R_{4+5} about one and half times as long as R_1 (70 : 43), ending far beyond level of tip of Cu_1; M_{1+2} long, twice as long as medial stem (80 : 35); fMCu far beyond level of basal section of Rs, very narrow.

Female.—Body distinctly shorter than in male, 1.9 to 2 millimeters long; coloration far paler than in male; head, thorax, and legs pale brown, thoracic dorsal vittæ and postscutellum reddish brown; femoral ends brown; abdomen without brown bands, uniformly yellow. Head with frontal tubercles papilliform; maxillary palpi short (3 : 6 : 7 : 12). Antennæ 6-segmented (18 : 35 : 24 : 25 : 25 : 34); segment two deeply constricted; distal segment subequal in length to segment two, fusiform, without apical setæ, but pubescent on distal half; ultimate sternum of abdomen broad, setigerous on caudal half, with a shallow caudal U-shaped incision; cerci (text fig. 32, *a*) setigerous with small setæ on lateral side, angulated ventrally; spermathecæ (text fig. 32, *b*) two, hyaline, oval, with slightly swollen neck region. Fixed tibial spine of foreleg comparatively long, but not longer than $\frac{1}{3}$ diameter of tibial end. Wings (text fig. 32, *b*) 1.8 to 1.9 millimeters long, broader than in male, somewhat angulated

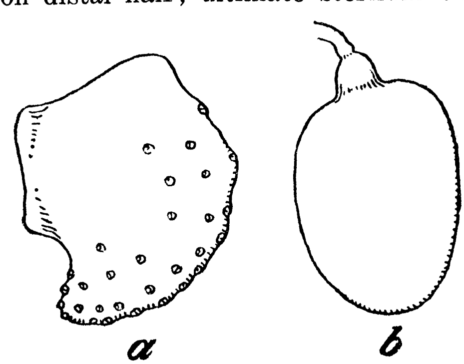

FIG. 32. *Tanytarsus* (*Rheotanytarsus*) *æstuarius* sp. nov. *a*, Female cercus; *b*, spermatheca.

on the anal margin at tip of Cu_1; vein R_{4+5} far longer than $1\frac{1}{2}$ times R_1 (7 : 4), M_{1+2} very long, slightly shorter than thrice medial stem (8 : 3); fMCu broader than in male. Other structures of head, thorax, wings, and legs as in male.

Habitat.—Estuary of river; Honshu, Japan.

Holotype.—Male; Karo, Tottori Prefecture; October 18, 1930.

Allotopotype.—Female; October 18, 1930.

Paratopotypes.—Males and females; October 18, 1930.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. Hachiro Yuasa and M. Tokunaga.

This species is allied to *T. raptorius* Kieffer, in which, however, the middle tibia has only one spur.

TANYTARSUS (MICROPSECTRA) FOSSARUM sp. nov.

This species is very common in the field in Kyoto.

Male.—Body 3.8 to 4.1 millimeters long, slender, uniformly dark; dorsal vittæ not distinct, but separated by lines of pale dots arranged along middorsal suture and pseudosutural foveæ; halteres yellowish white; abdomen uniformly dark brown. Frontal tubercles present, minute, conical; eyes bare, narrow, projected dorsad; distance between them half as wide as the vertical length of eye; clypeus black with many long brown setæ; maxillary palpus slender, long, distinctly 4-segmented (4 : 13 : 12 : 20); antenna 14-segmented; antennal ratio about 1.3; distal segment with two or rarely one small apical seta. Supra-alar setæ three, dark; scutellum with one pair of middle long setæ and four or three pairs of short setæ on its cephalic region. Abdomen with dark setæ; ventral side paler than dorsal side; ultimate tergum with a dark V-shaped thickening, a large anal point, several minute setæ on caudomesal margin, several small tuberculate setæ on its caudomeson, and a pair of small membranous tubercles on lateral sides; ultimate sternum very narrow, without setæ; coxite with three small setæ on ventromesal margin; style long, slender in lateral aspect but broad and truncate obliquely in dorsal aspect; dorsal appendage dark brown, somewhat triangular, expanded dorsad, with minute setæ on distal part; its accessory lobe slender, sinuous, extending mesad beyond tip of dorsal lobe; tip of intermediate appendage with many strong recurved setæ; ventroproximal appendage slender, entirely setigerous, extending caudad as far as intermediate appendage, with many curved spoonlike hairs on dorsal side of distal part (text fig. 33, *c*). Legs without beards; foreleg ratio about 1.6 to 1.7; foreleg with one minute fixed tibial spine; posterior four legs with broad tibial combs which are completely confluent and occupy about three-fourths circumference of tibial end; claws simple; empodium slender, as long as claws; pulvilli wanting. Wings (text fig. 33, *a*) about 3.5 millimeters long, not distinctly narrow, slightly brown under transmitted light, with macrotrichia dark, very thick; anal margin fringed with long setæ; anal angle almost atrophied; R_{4+5} ending far beyond level of tip of M_{3+4}, curved along costal margin, a little shorter than twice R_1 (78: 43); r-m about thrice as long as basal section of Rs; fMCu narrow, a little beyond proximal end of r-m or

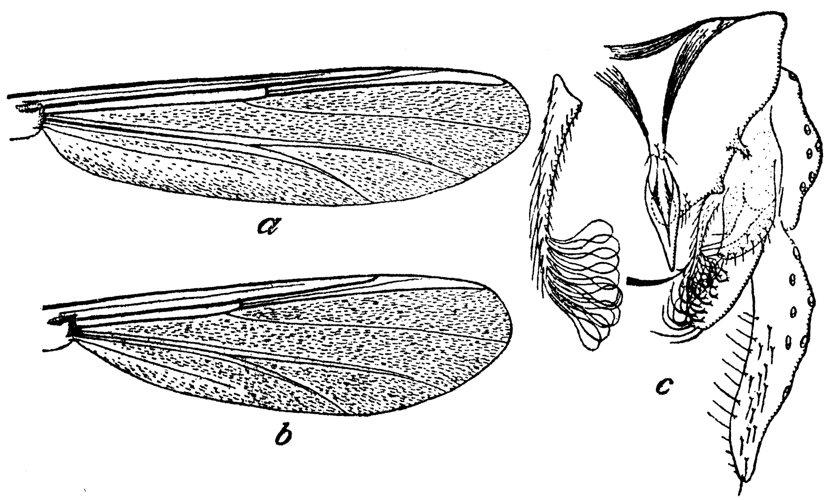

FIG. 33. *Tanytarsus* (*Micropsectra*) *fossarum* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium.

far before basal section of Rs; M_{3+4} gradually bent caudad; Cu_1 slightly sinuous; 1st A a little beyond base of fMCu.

Female.—Body 3.2 to 3.6 millimeters long; dark as in male; abdomen dark brown; halteres yellow; cerci yellowish brown; eyes broader and shorter than in male; distance between them a little narrower than vertical length of eye (11 : 15); maxillary palpi longer than in male, distinctly 4-segmented (4 : 11 : 13 : 23); antennæ 6-segmented; segment two constricted at middle, twice as long as scape; ultimate segment longer than any of remaining fusiform flagellar segments (49 : 40), subequal in length to second, with a small apical seta. Ultimate sternum broad, setigerous on laterocaudal parts, with a U-shaped caudal incision; cerci (text fig. 34, *a*) with many small setæ on lateral side, subrectangular; spermathecæ (text fig. 34, *b*) hyaline, oval, with small neck region. Wing (text fig. 33, *b*) about 2.8 to 2.9 millimeters long, comparatively broader than in male; anal angle obscurer than in male; relative lengths of veins R_1 and R_{4+5} about 16 : 9. Other structures of head, thorax, wings, and legs highly similar to those of male.

Habitat.—Stagnant water; Honshu, Japan.

Holotype.—Male; Kitashirakawa, Kyoto; June 15, 1934.

Allotopotype.—Female; June 15, 1934.

Paratopotypes.—Males and females; June 2 to 15, 1934.

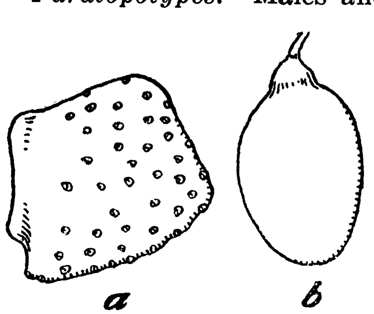

FIG. 34. *Tanytarsus* (*Micropsectra*) *fossarum* sp. nov. *a*, Female cercus; *b*, spermatheca.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This midge is very closely allied to *T. subviridis* Goetghebuer, in which, however, the thorax is yellow or pale brown and equipped with yellow vittæ, and the apical hairs of the ventroproximal appendages of the male hypopygium are pinheadlike, their apical swellings being smaller than in the present species.

TANYTARSUS (MICROPSECTRA) DAISENENSIS sp. nov.

This species was collected at a light screen at Mount Daisen, Hooki.

Male.—Body 3.3 to 3.4 millimeters long, very slightly yellowish white in ground color, with white setæ; flagella of antennæ and spiracles of thorax pale brown; frontal tubercles obscure; eyes narrowly extending dorsad, reniform, bare; distance between them about two-thirds vertical length of eye; clypeus setigerous, with about twenty or twenty-five long setæ; maxillary palpi long, slender; ultimate segment very slightly shorter than preceding two taken together (18 : 10+11); scape white; antennal ratio about 1. Scutum setigerous; dorsal vittæ obsolete. Supra-alar setæ three to five; scutellum with five pairs of setæ, middle pair long and very closely situated to each other on caudal region, other pairs arranged in a transverse line along cephalic margin, most lateral pair very small; rarely cephalic setal line of scutellum represented by only three pairs. Abdomen setigerous, slender; hypopygium (text fig. 35, *b*) setigerous, with brown setæ; ultimate tergum very scantily haired, with a V-shaped thickening, a thickened anal point, several small setæ on caudal area. Coxite with three slender setæ on highly chitinized ventromesal margin; style slender, extending

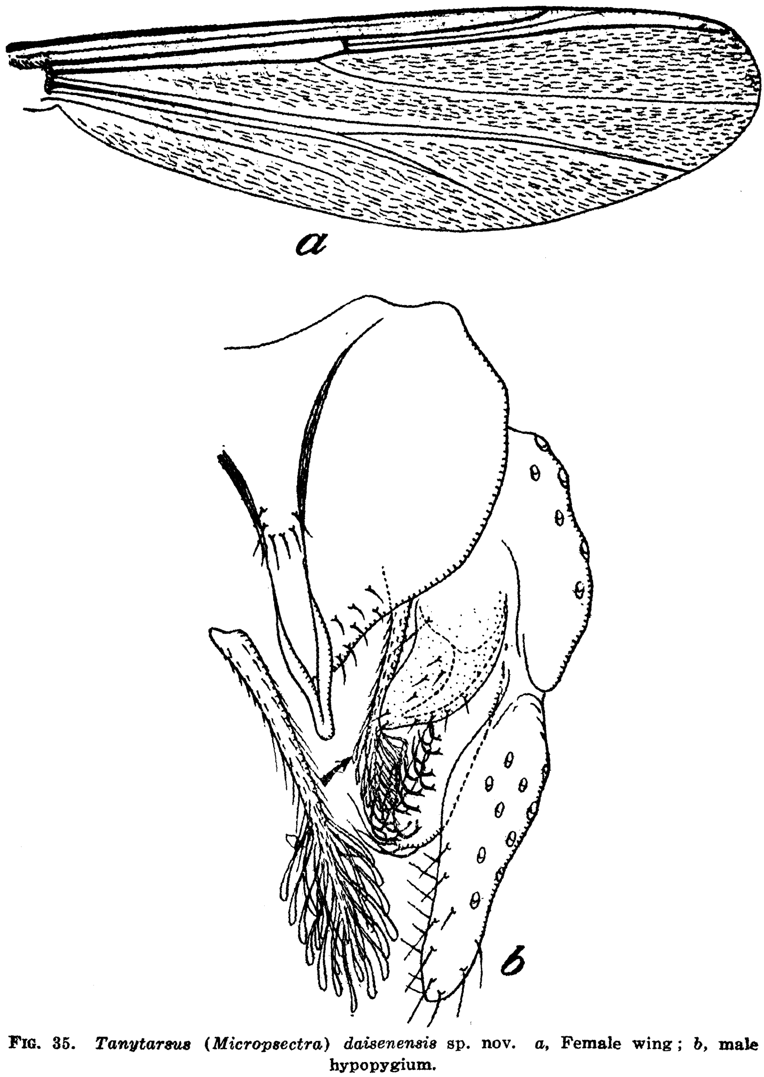

FIG. 35. *Tanytarsus* (*Micropsectra*) *daisenensis* sp. nov. *a*, Female wing; *b*, male hypopygium.

dorsocaudad, with many slender small setæ on mesal and ventral sides; dorsal appendage comparatively large, thinly membranous, expanded dorsomesad, bluntly ending, with several minute setæ on dorsal side and a stiff small seta on mesal side of thickened basis; accessory lobe of dorsal appendage small, claw-like, not extending beyond dorsal appendage; intermediate appendage broad, with a blunt secondary dorsal projection on distal part, setigerous on dorsal and mesal sides and distal part; ventroproximal appendage slender, hardly as long as intermediate appendage, highly setigerous on chitinized stem, with many clavate curved hairs on distal half. Legs without beards; fore-leg ratio about 1.6 to 1.7; fore tibia with a very small fixed spine; posterior four legs with broad tibial combs which are completely confluent, occupying three-fourths of circumference of tibial end, without spurs; claws simple; empodium slender, as long as claws; pulvilli wanting. Wings (text fig. 36) 2.2 to 2.3 millimeters long, narrow, with very dense macrotrichia, slightly brown under transmitted light, with long marginal hairs; anal angle atrophied; vein R_{4+5} ending beyond level of tip of vein M_{3+4}, about twice as long as R_1 (11 : 6); r-m hori-

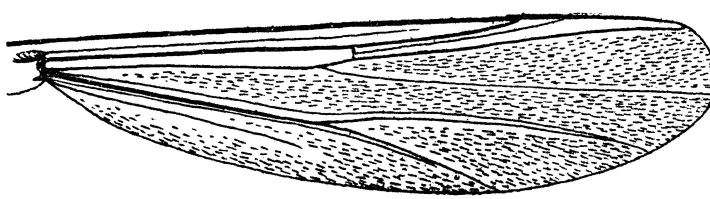

FIG. 36. *Tanytarsus (Micropsectra) daisenensis* sp. nov. Male wing.

zontal, twice as long as Rs; basal section of fMCu just caudad of r-m, very narrow, 1st A ending at base of fMCu.

Female.—Body 2.7 to 2.8 millimeters long; coloration similar to that of male but antennæ uniformly white; eyes broader than in male; maxillary palpi comparatively longer than in male; ultimate segment subequal to two preceding segments taken together (24 : 11 + 12); antennæ 6-segmented; segment two distinctly constricted; ultimate segment long, 1½ times as long as each of three preceding fusiform segments, with a long apical seta. Ultimate abdominal sternum broad, with many long setæ and a U-shaped caudal incision; cerci (text fig. 37) somewhat rectangular, with many small setæ on lateral side and a few setæ on mesal side. Wings (text fig. 35, *a*) larger than in male (2.6 to 2.7 millimeters long), comparatively broad; anal angle atrophied; vein R_{4+5} shorter than twice R_1 (15 : 8). Other structures of head, wings, and legs similar to those of male.

Habitat.—Mountainous region; Honshu, Japan.

Holotype.—Male; Mount Daisen, Tottori Prefecture; July 2, 1931.

Allotopotype.—Female; July 2, 1931.

Paratopotypes.—Males and females; July 2, 1931.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This fly is very closely similar to *T. brunnipes* Zetterstedt in the structures of the male hypopygium and antennæ, but easily distinguished from the allied species by the yellowish milky coloration of the thorax.

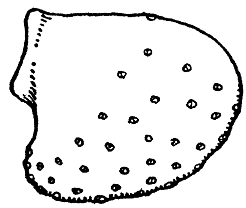

FIG. 37. *Tanytarsus (Micropsectra) daisenensis* sp. nov. Female cercus.

TANYTARSUS (LUNDSTRÖMIA) TELMATOPHILUS sp. nov.

This species is very abundant along marshes at Kyoto.

Male.—Body slender and fairly setigerous, 4 to 4.1 millimeters long; head, thorax, hypopygium, flagella of the antennæ, middle legs, and femora of forelegs and hind legs, uniformly brown; abdomen greenish pale brown; dorsal vittæ of thorax, postscutellum, pleural sclerites, forelegs distad of femora, and scapes on antennæ dark brown; hind legs distad of femora reddish brown; thorax shining. Frontal tubercles cylindrical, minute; eyes bare, narrowly elongated dorsad, not widely separated, distance between them on dorsal side about half vertical length of eye; clypeus with many long brown setæ. Antennæ 14-segmented; distal joint with one, rarely two, short apical setæ; antennal ratio about 1.3; maxillary palpi long and slender, 4-segmented distinctly (17 : 10 : 9 : 4), with distal segment slightly longer than two preceding taken together. Scutum with many brown setæ arranged along middorsal suture and pseudosutural foveæ; supra-alar setæ two, but sometimes one and rarely three; scutellum with variable number of setæ (4 to 8). Ultimate tergum of abdomen very scantily haired, with a few minute setæ on caudomesal margin near base of anal point and about four minute setæ on caudal part, a large V-shaped thickening; coxite with four slender setæ on ventromesal margin; style slender, longer than coxite; dorsal appendage subtriangular, chitinized, dark brown, with several small setæ on dorsal side; accessory lobe clawlike; ventroproximal appendage small, short, but stout, setigerous on stem, with an apical tuft of many bladelike hairs that are almost as long as the stem (text fig. 38, *c*). Legs without beards; fixed tibial spine of foreleg short, about half as long as diameter of tibial end; foreleg ratio about 1.5; posterior four legs with large tibial combs which are completely confluent; each leg provided with usually two spurs which are $1\frac{1}{2}$ times as long as comb (at least one spur remains conspicuously when the other is reduced in various degrees); claws simple; empodium as long as claws and slender; pulvilli wanting. Wings (text fig. 38, *a*) about 3.1 millimeters long, narrow, macrotrichia thick; membrane pale brown under transmitted light; anal angle almost atrophied; vein R_{4+5} ending far beyond level of tip M_{3+4}, shorter than twice R_1 (73 : 43); fMCu slightly beyond r-m, narrowly forked; M_{3+4} slightly sinuous at tip; 1st A reaching the base of fMCu.

Female.—Body 2.9 to 3 millimeters long; paler than in male; head, thorax, antennæ, and posterior four legs brown; abdomen pale brown; forelegs distad of femora reddish brown; dorsal vittæ of thorax, postscutellum, and sternum dark brown; pleural sclerites with two dark spots, one near wing basis and the other beneath basis of halter. Frontal tubercles conical, more pointed than in male. Eyes more broadly separated from each other than in male. Antennæ 6-segmented; distal segment with an apical seta, slightly longer than each of the preceding three segments (28 : 48 : 33 : 35 : 34 : 37). Maxillary palpi also slender, distinctly 4-segmented (20 : 51 : 52 : 96). Ultimate sternum broad, setigerous; caudal incision small, U-shaped, without macrotrichia on its margin but with many microtrichia; cerci (text fig. 38, *d*) small, somewhat rhombic, with short setæ on lateral side; spermathecæ (text fig. 38, *e*) two, hyaline, oval. Legs stouter than in male. Wings (text fig. 38, *b*) about 3.1 millimeters long, larger, comparatively broader, more densely covered with hairs than in male; vein R_{4+5} about 1.7 times as long as R_1 (80 : 47). Other structures of head, thorax, wings, and legs closely similar to those of male.

Habitat.—Stagnant water; Honshu, Japan.

Holotype.—Male; Kitashirakawa, Kyoto; March 14, 1932.

Allotopotype.—Female; March 14, 1932.

Paratopotypes.—Males and females; March 14, 1932, and November 31, 1935.

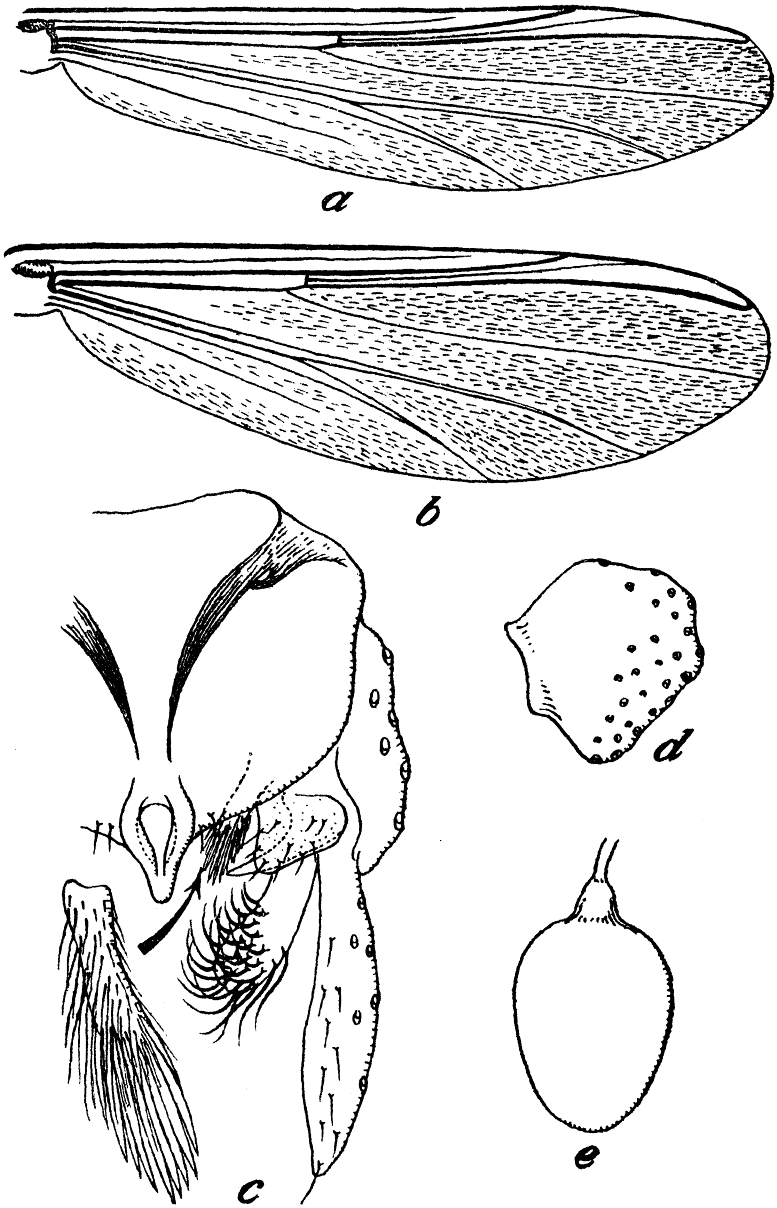

FIG. 38. *Tanytarsus* (*Lundströmia*) *telmatophilus* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus; *e*, female spermatheca.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is somewhat related to *T. lobatus* Kieffer and *T. bituberculatus* Edwards; in the first related species, however, the hypopygium of the male is distinctly different, the dorsal appendage being bare, petiolate, and oval on the distal end. The second species is provided with paired tubercles behind the anal point and very short ventroproximal genital appendages in the male, and the thorax is uniformly yellow or green in the female.

TANYTARSUS (LUNDSTRÖMIA) TREDECEMARTICULUS sp. nov.

This fly was collected along a rapid stream of Kibune, Kyoto.

Male.—Body about 2 millimeters long, slender, pale green in ground color; antennæ, scutal vittæ, sternal side of thorax, and postscutellum brown; pleuron with a brown spot near wing basis; scutal vittæ distinctly separated; supra-alar setæ two or three; scutellum with two pairs of long median and a pair of small lateral setæ. Frontal tubercles very minute, papilliform; eyes bare, reniform, widely separated from each other; distance between them subequal to vertical length; clypeus scantily haired; maxillary palpi long, 4-segmented (10 : 40 : 45 : 77); antenna long, 13-segmented; antennal ratio 0.32 to 0.35; ultimate segment with two or three apical setæ, subequal in length to three preceding segments taken together. Hypopygium (text fig. 39) slender, setigerous; ultimate tergum with several minute setæ on caudal margin and base of anal point; anal point thickened, slender, with a large dorsal cavity between thin lamellæ; coxite with four slender setæ on ventromesal margin; style elongated, triangular in lateral aspect; dorsal appendage hemispherical, with several minute setæ on dorsal surface; its accessory lobe slender, slightly beyond dorsal lobe; intermediate appendage large, broad, with many setæ on dorsal side of distal half, crowned with a strong

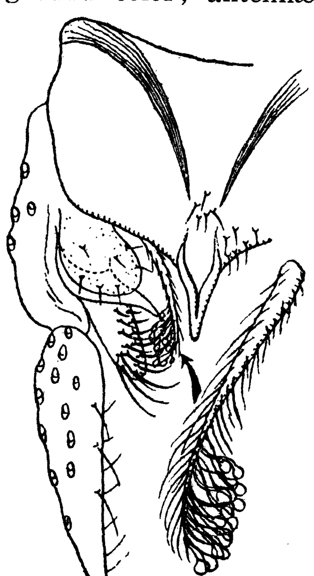

FIG. 39. *Tanytarsus* (*Lundströmia*) *tredecemarticulus* sp. nov. Male hypopygium.

curved seta; ventroproximal appendage with many spoonlike hairs on distal third. Legs without beards; fixed tibial spine of foreleg short, hardly half as long as diameter of tibial end; foreleg ratio about 1.6; four posterior legs each with a single broad comb which occupies about half or a little more than half of circumference of end of tibia; spur of comb about $1\frac{1}{2}$ the length of comb; claws simple, without pulvilli; empodium slender, as long as claws. Wings (text fig. 40) about 1.7 to 1.8 millimeters long, with macrotrichia spread over entire surface; anal angle quite atrophied; R_{4+5} slightly curved along costal margin, shorter than twice R_1 (80: 47), ending a little beyond level of tip of M_{3+4}; r-m long, twice as long as basal section of Rs; M_{1+2} twice as

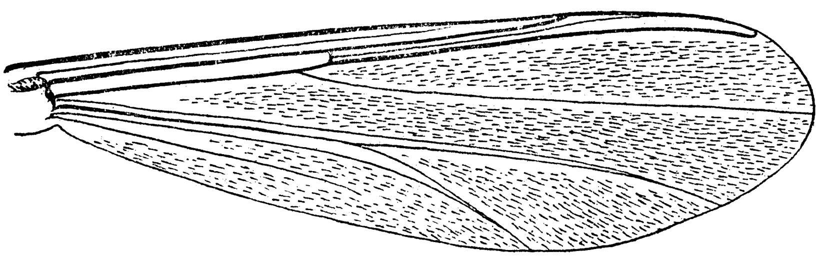

FIG. 40. *Tanytarsus* (*Lundströmia*) *tredecemarticulus* sp. nov. Male wing.

long as medial stem; fMCu very slightly beyond basal section of Rs, narrow; M_{3+4} and Cu_1 very slightly curved caudad at tip; 1st A short, hardly reaching base of fMCu.

Habitat.—Rapid stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; June 22, 1932.

Paratopotypes.—Males; June 22, 1932.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The present species is quite characteristic in the extremely small value of the antennal ratio and the 13-segmented antennæ of the male. Similar characters of the antennæ are unknown among the known members of this subgenus so far as I am aware.

TANYTARSUS (STEMPELLINA) BICOLIOCULUS sp. nov.

This small midge is abundant along running water in Kyoto.

Male.—Body 1.7 to 1.8 millimeters long. Thorax yellowish brown; dorsal vittæ and sternal side reddish brown; middorsal vittæ distinctly separated by a pale line of dots along middorsal suture; lateral vittæ dark at caudal ends; pleuron with a brown spot near wing basis; postscutellum reddish brown on caudal half. Antennæ brown, with scapes reddish brown; eyes black on ventral half and brown on dorsal half. Other appendages of head and thorax uniformly pale brown. Abdomen white; hypopygium pale brown. Eyes bare, reniform, bicolored, widely separated, distance between them on dorsal side far greater than vertical length of eyes (17 : 13); frontal tubercles present, very small, blunt, subtriangular; antennæ 11-segmented; antennal ratio about 0.6 (0.55 to 0.59); ultimate segment with two apical setæ, subequal in length to four or five preceding segments taken together; maxillary palpi slender, 4-segmented; ultimate segment slightly shorter than two preceding segments taken together (10 : 20 : 30 : 46). Clypeus not densely haired, with about fifteen to twenty setæ. Pronotum greatly reduced; scutum very scantily haired; middorsal vittæ short, ending at cephalic ends of lateral vittæ; supra-alar seta one, very rarely two; scutellum with a pair of distinct median setæ and two pairs of small lateral setæ. Abdomen also scantily setigerous, slender in general appearance; hypopygium (text fig. 41, *a*) not highly chitinized; ultimate tergum very scantily haired, with few very small setæ on caudal part; anal point not distinctly thickened, with very thin lateral ridges, and very fine pubescence; ultimate sternum without macrotrichia; coxites large, broad, with five slender setæ on ventromesal margin; style also broad, extending caudodorsad, ending in blunt broad tip in lateral aspect; dorsal appendage very thinly membranous, expanded dorsad, provided with a few minute setæ, extending mesad, ending in a blunt or sometimes more sharp pointed tip on which a few minute setæ are found; accessory lobe of dorsal appendage slender, smooth, somewhat clawlike; intermediate appendage stout, broad, with many small strong setæ at tip and on dorsodistal margin, without macrotrichia on stem; ventroproximal appendage slender, almost smooth at stem, with a tuft of simple hairs at tip. Legs without beards; foreleg ratio 1.8 to 1.9; fore tibia with a fixed apical spine as long as diameter of tibia; posterior four legs each with two small distinctly separate combs, occupying at most about one-third circumference of end of tibia; each comb with a distinct spur twice as long as comb; claws with a few minute setæ on basal part; empodium slender, slightly shorter than claws; pulvilli obscure. Wings (text fig. 42, *a*) 1.2 to 1.3 millimeters long, slightly brown under transmitted light, fringed with long hairs on anal margin, with macrotrichia very scantily spread; anal angle atrophied; R_{4+5} slightly curved along costal margin, ending on level of end of M_{3+4}, slightly shorter than twice R_1 (48:27); fMCu far beyond r-m; 1st A almost reaching fMCu.

Female.—Body 1.6 to 1.7 millimeters long, paler than in male; eyes bicolored as in male, broader than in male; antennæ 5-segmented; ultimate segment shorter than two preceding segments taken together, without apical setæ; second segment

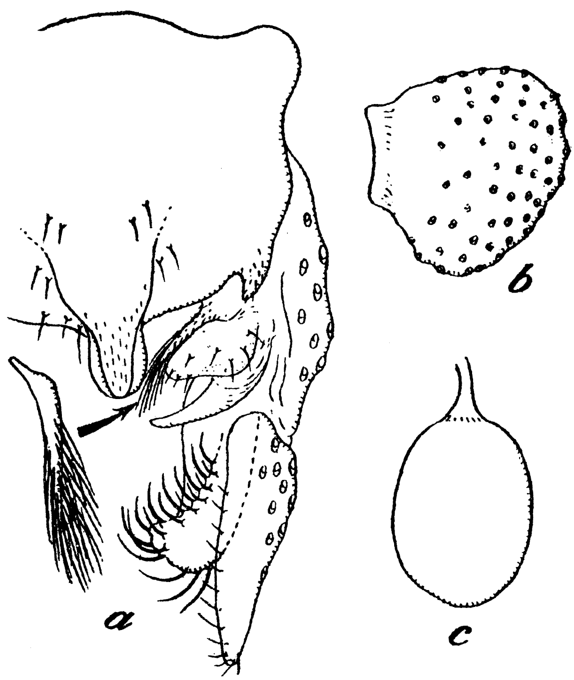

FIG. 41. *Tanytarsus* (*Stempellina*) *bicolioculus* sp. nov. *a*, Male hypopygium; *b*, female cercus; *c*, spermatheca.

shallowly constricted; maxillary palpus with last segment subequal to two preceding segments taken together. Hypopygium with many short setæ; cerci (text fig. 41, *b*) discoidal, small; ultimate sternum somewhat rectangular in outline, with a U-shaped caudal incision, a deeper V-shaped ental caudal thickening; spermathecæ (text fig. 41, *c*) almost spherical. Wings (text fig. 42, *b*) 1.3 to 1.4 millimeters long, comparatively broader, more hairy than in male, vein R_{4+5} far longer than in male, more than twice as long as R_1 (5 : 11). Foreleg ratio subequal to that of male (1.6 to 1.7); spurs of tibial combs of one leg unequal in length; longer spur 2½, shorter twice as long as comb. Other structures of head, thorax, wings, and legs as in male.

Habitat.—Running water; Honshu, Japan.

Holotype.—Male; Kitashirakawa, Kyoto; May 15, 1930.

Allotopotype.—Female; May 15, 1930.

Paratopotypes.—Males and females; April 24, 1931, May 15, 1930, and October 30, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

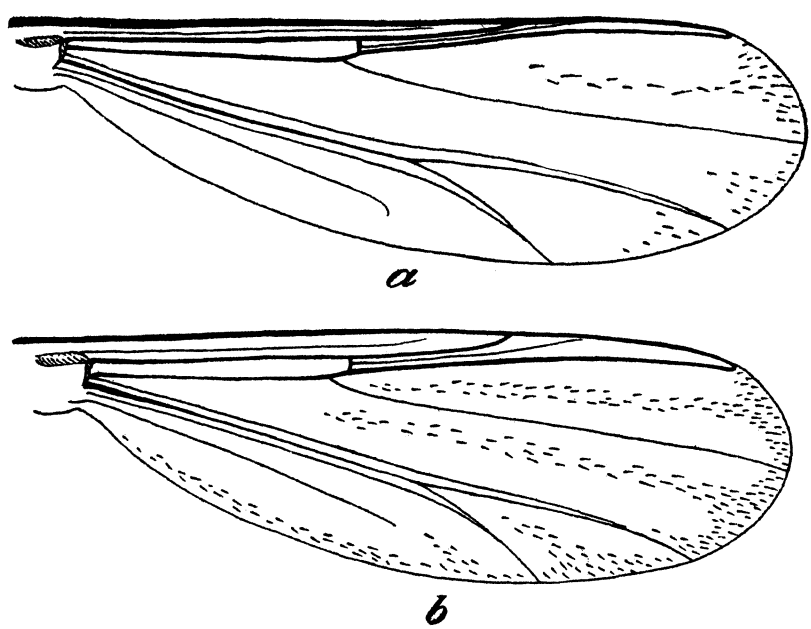

FIG. 42. *Tanytarsus (Stempellina) bicolioculus* sp. nov. *a*, Male wing; *b*, female wing.

The present species is very different from all known members of the subgenus *Stempellina* Bause in the possession of two tibial spurs on the combs of each of the posterior four legs and of the accessory lobes of the dorsal appendages of the male hypopygium, and seems to represent a transitional form to the subgenus *Tanytarsus*. Except for these conspicuous characters, this fly may be related to *T. brevis* Edwards and *T. saltuum* Goetghebuer; but the three species may be easily distinguished by the following diagnoses:

T. brevis.—Foreleg ratio 1.6, male antennal ratio 0.5, wing with macrotrichia moderately spread over, male hypopygium with anal point long and with dots, ventroproximal appendages small.

T. saltuum.—Foreleg ratio 1.2, male antennal ratio 1.3, wing with mocrotrichia thickly spread over, male hypopygium with anal point long and without dots, ventroproximal appendages hardly as long as intermediate appendages.

T. bicolioculus.—Foreleg ratio 1.6 to 1.9, male antennal ratio 0.6, wing with macrotrichia scantily spread over, male hypopygium with anal point short and with very fine pubescence, ventroproximal appendages small.

TANYTARSUS (ZAVRELIA) KIBUNENSIS sp. nov.

This fly was captured along a rapid stream in a hilly district of Kyoto.

Male.—Body small, not slender, about 2 millimeters long, very scantily haired; ground color yellow; antennæ, forelegs,

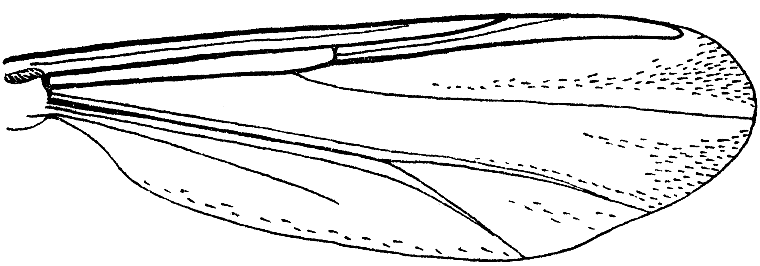

FIG. 43. *Tanytarsus (Zavrelia) kibunensis* sp. nov. Male wing.

and thoracic dorsal vittæ brownish yellow; caudal half of postscutellum brown; pleuron with a brown spot near wing base; halteres white; median scutal vittæ distinctly separated by a pale line; lateral vittæ each with a brown spot on caudal end; pedicel of the antenna white. Frontal tubercles of head obscure, but floor of frontal tubercles large and prominently projected over scapes of antennæ; eyes small, with velutinous hairs spread over entire surface, reniform, widely separate; distance between them on dorsal side $1\frac{1}{2}$ times vertical length of eyes; clypeus very scantily haired; antennæ short, 11-segmented, without trace of more segments; antennal ratio about 0.28 to 0.3; distal segment very short, $1\frac{1}{2}$ times as long as scape of antenna, subequal to two preceding segments taken together, clavate at tip, with two small apical setæ; maxillary palpi short, 4-segmented (11 : 23 : 30 : 52); distal segment subequal to two preceding segments taken together. Scutum shiny; supra-alar seta only one; scutellum with a pair of long setæ besides two pairs of short lateral setæ. Hypopygium (text fig. 41, *d*) yellow, short, upcurved; ultimate tergum not distinctly projected caudad, very scantily haired, with T-shaped thickening, several minute setæ on caudal part; anal point small, broad, with many minute dots; coxite with three slender setæ on thickened ventromesal margin; style small, extending dorsocaudad; dorsal appendage thinly membranous, oval, with many minute setæ; its accessory lobe curved, large; intermediate appendage distinctly curved dorsad, crowned with many strong curved setæ only on distal end; ventroproximal appendage small, with nonpubescent stem and a tuft of several long simple hairs. Legs without beards; fixed tibial spine of foreleg long, fully as long as diameter of tibia; foreleg ratio about 1.4; posterior four legs each with two conspicuous tibial combs which are distinctly separated from each other and occupy about half of circumference of tibial end; tibial combs each provided with a spur which is fully twice as long as comb itself; claws simple; empodium slender, subequal in length to claws; pulvilli wanting. Wings (text fig. 43) about 1.6 millimeters long, comparatively broad, pale brown under transmitted light, with macrotrichia only on wing tip and along anal margin; cell R_5 with a longitudinal row of macrotrichia; cell M_4 with only several macrotrichia; anal margin fringed with long hairs; anal angle atrophied; vein R_{4+5} about twice as long as R_1, ending on level of tip of M_{3+4}; fMCu far beyond base of Rs; 1st A straight, reaching base of fMCu.

Habitat.—Rapid stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; June 22, 1932.

Paratopotypes.—Males; June 22, 1932.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species is highly different from other members of the subgenus *Zavrelia* Kieffer in the following characters: The wing is comparatively broad, the vein R_{4+5} ends on the level of end of M_{3+4}, each of four posterior legs is provided with two combs, each comb with a distinct spur, dorsal appendage of male hypopygium with an accessory ventral lobe. The distinct characters for *Zavrelia* are shown in the structures of the compound eyes and the male antennæ. Judging from these features, the present species seems to be of a transitional form between *Tanytarsus* (s. str.) and *Zavrelia.*

Genus YUASAIELLA novum

This genus is provided the following characters:

Male.—Head with eyes bare, small, and widely separated, with large frontal tuberclelike swellings which are not surmounted by tubercles; antennæ 13-segmented, with normal plumose hairs; maxillary palpi 5-segmented. Thorax with pronotum widely separated; scutum comparatively long, with midcephalic region (region of median vittæ) distinctly swelling dorsad, caudoscutal area flattened, a distinct hump in middle at caudal end of median vittæ. Legs without rigid combs at end of tibiæ; fore tibia without spurs; middle and hind tibiæ each with a very small comblike structure composed of very short free spinules; no spurs; pulvilli present, small; fore tibia long, at least as long as first tarsal segment. Wings milky white by reflected light, with macrotrichia on membrane; squama bare; anal area greatly reduced; venation as in *Stempellina* Bause. Hypopygium as in *Tanytarsus* in general.

Female.—Antennæ 5-segmented; pulvilli larger than in male; other characters mainly as in male.

Genotype.—*Yuasaiella kyotoensis* sp. nov.

This genus is named in honor of Dr. Hachiro Yuasa who directed our entomological laboratory during the past ten years. It is somewhat related to *Graceus* Goetghebuer, *Corynocera* Zetterstedt, and *Dolichopelma* Kieffer in the structure of the tibial end. In the first allied genus, however, all other important generic characters are quite different. In the second allied genus, the male antennæ are 12-segmented and without plumose hairs, the maxillary palpi 3-segmented, and the middle and hind femora swollen. The third genus is most closely related to the present genus, differing, however, in the absence of a middorsal hump of the thorax and a pair of the ventroproximal appendages of the male hypopygium. Another allied genus may be *Pseudochironomus* Malloch, which, however, differs greatly from the present genus in the structure of the tibial combs.

YUASAIELLA KYOTOENSIS sp. nov.

Male.—Body about 3.8 millimeters long. Head brown, with large frontal swellings; eyes bare, small, reniform, very widely separated from each other, the distance between them greater than vertical lengths of eyes (19 : 12); frontoclypeus with about ten setæ; antenna mainly brown, with scape dark brown; ultimate segment slender, distal segments of intermediate flagellar part about twice as long as diameter; antennal ratio about 0.77; maxillary palpus 5-segmented (1 : 3 : 6 : 7.5 : 10.5). Thorax almost entirely dark brown; scutum with vittæ black, confluent; postscutellum black; pleural membranes yellow. Legs uniformly pale brown, without spurs; middle and hind tibiæ with minute spinules arranged comblike at distal end; pulvilli very small, slender; empodium as long as claws; claws simple; fore tibia longer than basitarsus; proportional lengths of segments of legs 42 : 35 : 33 : 20 : 15.5 : 10 : 6 in foreleg,

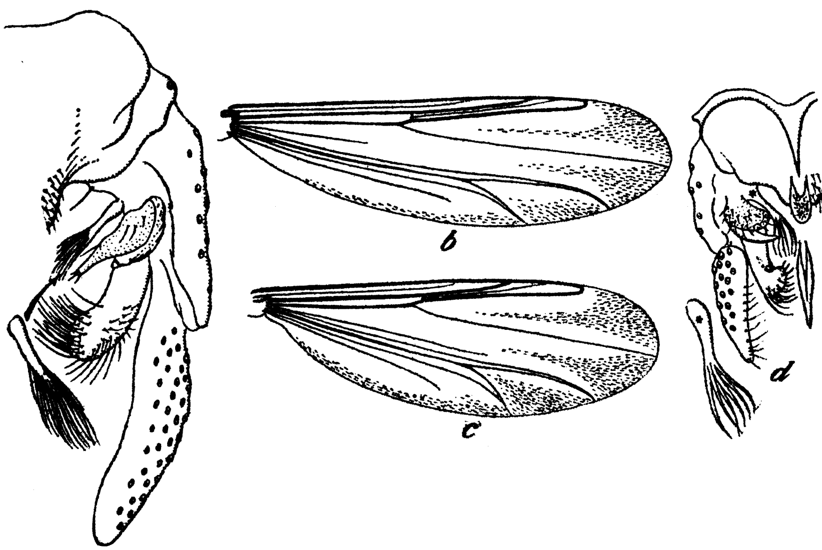

FIG. 44. *Yuasaiella kyotoensis* gen. et sp. nov. *a*, Male hypopygium; *b*, male wing; *c*, female wing; *d*, *Tanytarsus* (*Zavrelia*) *kibunensis* sp. nov. Male hypopygium.

43 : 38 : 16 : 12 : 10 : 7 : 5 in middle leg, and 53 : 44 : 24 : 16 : 13 : 9 : 5.5 in hind leg. Wing (text fig. 44, *b*) milky white, with macrotrichia comparatively sparse, found only on distal part and along anal margin; R_1 and R_{4+5} straight; R_{4+5} ending far before level of end of M_{3+4}; fMCu under middle of R_1. Halteres white. Abdomen with terga brown, sternal and pleural sides extensively yellowish brown; hypopygium (text fig. 44, *a*) pale brown, with large styles; ninth tergum slightly setigerous on caudomeson, with a slender anal point; dorsal appendage of coxite with several setæ, without accessory projection; intermediate appendage strong, with many strong setæ on apex; ventroproximal appendage small, with a simple hair on end.

Female.—Body length about 2.2 millimeters. Head pale brown; eyes oval, very widely separated, the distance between them far wider than the vertical length of eye; frontoclypeus with about fourteen setæ; antenna mainly pale brown, with scape and distal half of ultimate segment brown, 5-segmented (15 : 33 : 20 : 22 : 40); segment two distinctly constricted at middle; segments three and four fusiform; segment five not suddenly swollen basally; maxillary palpus 5-segmented (1 : 2 : 4 : 6 : 10). Thorax with four reddish brown vittæ that are distinctly separated by three lines of pale dots; shoulder parts yellowish white; caudoscutal area yellowish brown; lateral sclerites pale brown; sternal side brown; lateral membranes yellowish white. Legs pale brown, with pulvilli larger than in male; proportional lengths of segments 35 : 29 : 28 : 16 : 12 : 8 : 5 in foreleg, 35 : 32 : 14 : 8.5 : 7 : 5 : 4 in middle leg, and 42 : 37 : 18 : 12 : 10 : 6 : 4 in hind leg. Wing (text fig. 44, *c*) with R_{4+5} about twice as long as R_1. Abdomen extensively yellowish white; first tergum with a pair of large pale-brown markings; second tergum extensively pale brown, yellowish white along posterior margin; other terga each with a T-shaped yellowish brown marking; ultimate sternum pale brown; cerci pale brown, setigerous, subtriangular.

Habitat.—Hilly country; Honshu, Japan.

Holotype.—Male; Mount Hiei, Kyoto; March 17, 1932.

Allotopotype.—Female; March 17, 1932.

Paratopotype.—Female; March 17, 1932.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 20. *Tanytarsus* (*Tanytarsus*) *stagnarius* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus; *e*, spermatheca.

21. *Tanytarsus* (*Tanytarsus*) *parvicrinis* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus.

22. *Tanytarsus* (*Tanytarsus*) *kyotoensis* sp. nov. *a*, Male hypopygium; *b*, female cercus; *c*, spermatheca.

23. *Tanytarsus* (*Tanytarsus*) *kyotoensis* sp. nov. *a*, Male wing; *b*, female wing.

24. *Tanytarsus* (*Tanytarsus*) *atagoensis* sp. nov. *a*, Female wing; *b*, male hypopygium; *c*, spermatheca.

25. *Tanytarsus* (*Tanytarsus*) *atagoensis* sp. nov. Male wing.

26. *Tanytarsus* (*Tanytarsus*) *uraiensis* sp. nov. Male hypopygium.

27. *Tanytarsus* (*Tanytarsus*) *uraiensis* sp. nov. *a*, Male wing; *b*, female wing; *c*, female cercus; *d*, spermatheca; *e*, thoracic respiratory organ of pupa; *f*, dorsal side of pupal abdomen; *g*, larval antenna; *h*, larval mandible; *i*, larval hypopharynx; *j*, larval maxilla; *k*, larval mentum; *l*, larval premandible; *m*, distomesal appendage of larval epipharynx; *n*, median and midproximal appendages of larval epipharynx; *o*, distal appendage of larval labrum; *p*, laterodistal appendages of larval labrum; *q*, hooklet of anterior pseudopod of larva; *r*, plumose hair of larval abdomen.

28. *Tanytarsus* (*Tanytarsus*) *pelagicus* Tokunaga. Caudolateral spine of eighth abdominal segment of pupa.

29. *Tanytarsus* (*Rheotanytarsus*) *pentapoda* Kieffer. *a*, Male wing; *b*, male hypopygium; *c*, female wing; *d*, female antenna; *e*, female cercus; *f*, spermatheca; *g*, thoracic respiratory organ of pupa; *h*, dorsal side of abdominal segments of pupa (segment four omitted); *i*, caudal end of pupal abdomen; *j*, ventral side of abdominal segment four of pupa; *k*, plumose hair of larval abdomen; *l*, larval mentum; *m*, claws of posterior pseudopod larva; *n*, larval antenna.

30. *Tanytarsus* (*Rheotanytarsus*) *pentapoda* Kieffer. *a*, Larval labrum; *b*, larval epipharynx; *c*, larval premandible.

31. *Tanytarsus* (*Rheotanytarsus*) *æstuarius* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium.

32. *Tanytarsus* (*Rheotanytarsus*) *æstuarius* sp. nov. *a*, Female cercus; *b*, spermatheca.

33. *Tanytarsus* (*Micropsectra*) *fossarum* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium.

34. *Tanytarsus* (*Micropsectra*) *fossarum* sp. nov. *a*, Female cercus; *b*, spermatheca.

35. *Tanytarsus* (*Micropsectra*) *daisenensis* sp. nov. *a*, Female wing; *b*, male hypopygium.

36. *Tanytarsus* (*Micropsectra*) *daisenensis* sp. nov. Male wing.

37. *Tanytarsus* (*Micropsectra*) *daisenensis* sp. nov. Female cercus.

38. *Tanytarsus* (*Lundströmia*) *telmatophilus* sp. nov. *a*, Male wing; *b*, female wing; *c*, male hypopygium; *d*, female cercus; *e*, female spermatheca.

FIG. 39. *Tanytarsus* (*Lundströmia*) *tredecemarticulus* sp. nov. Male hypopygium.

40. *Tanytarsus* (*Lundströmia*) *tredecemarticulus* sp. nov. Male wing.

41. *Tanytarsus* (*Stempellina*) *bicolioculus* sp. nov. *a*, Male hypopygium; *b*, female cercus; *c*, spermatheca.

42. *Tanytarsus* (*Stempellina*) *bicolioculus* sp. nov. *a*, Male wing; *b*, female wing.

43. *Tanytarsus* (*Zavrelia*) *kibunensis* sp. nov. Male wing.

44. *Yuasaiella kyotoensis* gen. et sp. nov. *a*, Male hypopygium; *b*, male wing; *c*, female wing; *d*, *Tanytarsus* (*Zavrelia*) *kibunensis* sp. nov. Male hypopygium.

GENUS TRICHOGLOTTIS IN THE PHILIPPINE ISLANDS

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The genus *Trichoglottis* was described in 1825 by Blume [1] and by him divided into two sections. The first section contained two species, *T. retusa* and *T. lanceolaria.* The second section contained a single species, *T. rigida,* which is now considered to be a species of *Sarcanthus.*

In the Sarcanthinæ the genera are notoriously difficult to define and to delimit. No two orchidologists are able to agree on the characters to be used in the delimitation of genera, and to what genus a given species should be referred. In monographic work among the genera of the group it is necessary not only to study the species assigned to a given genus, but also to examine the species of other genera to which a plant might be referred. This makes the possibility much greater of overlooking a plant that should be placed in a genus other than the one to which it was originally assigned. For example the plant treated in this paper as *T. Loheriana* has been described as a new species under both *Acampe* and *Vandopsis.*

The number of genera in the Sarcanthinæ is probably larger than it should be. A genus that, at the time it was proposed, was apparently based on good characters may often be shown, on the evidence of additional material, to be merely a group or section of another genus.

The majority of the species treated in this review have been referred to *Trichoglottis,* at one time or another, but some of them have usually been treated as belonging to other genera.

The last treatment of any part of this genus was a short paper by Ames and Quisumbing [2] in which *T. fasciata, T. philippinensis, T. philippinensis* var. *brachiata,* and *T. Wenzelii* were placed in the genus *Stauropsis* Reichb. f. This treatment is not tenable, because *Stauropsis* must be typified by *S. pallens* which was on several occasions referred to *Phalaenopsis* [3] by

[1] Bijdr. Fl. Ned. Ind. (1825).
[2] Philip. Journ. Sci. 52 (1933) 462–468.
[3] Orch. Rev. 8 (1900) 327; 13 (1905) 226.

Rolfe, who monographed that genus. The present author believes that the plant is a *Phalaenopsis*.

The genus *Staurochilus* Ridl.[4] was based on *Trichoglottis fasciata* and should be referred to *Trichoglottis* as a synonym.

Stauropsis, at least as that name is used by most authors, has been separated from *Trichoglottis* on the following considerations:

1. The large size of the flowers; this characters seems to be of little or no value because there is an almost complete intergradation between the two extremes in the genus. The type species of *Trichoglottis*, *T. retusa*, has medium-sized flowers.

2. In conjunction with large flowers, a cruciform middle lobe of the lip has been cited as a character for generic separation. As a fundamental in separating genera lobing of the lip would seem to be a questionable character; in this particular, however, authors have not agreed, for species lacking the cruciform midlobes have been placed in *Stauropsis*. Moreover, *Trichoglottis calochila*, a small-flowered species just discovered, has a trilobulate or cruciform midlobe of the lip.

3. The footless condition of the column in the segregated genera contrasted with a column having a foot in *Trichoglottis*. While this condition may exist in some cases, the column foot in the true *Trichoglottis* is most difficult to distinguish and probably does not exist in some species. Dr. J. J. Smith[5] says "Sepalen etwas an sehr kurzem Säulenfuss herablaufend und oft etwas breiter," and again "Säule . . . . mit . . . . kurzem Fuss." The lateral sepals of the true *Trichoglottis* are occasionally adherent to the back of the spur, perhaps indicating that there is a short column foot. This condition, however, is not found in all species of the true *Trichoglottis*.

4. The presence of a spur in contrast to a saccate base of the lip. However, since there is a complete transition between the two extremes, within the genus this character seems to be of little generic significance.

Genus TRICHOGLOTTIS Blume

Trichoglottis BLUME, Bijdr. (1825) 359; BENTHAM & HOOKER, Gen. Pl. **3** (1883) 576; PFITZER in Engler & Prantl, Nat. Pflanzenf. II **6** (1889) 218; RIDLEY, Mat. Fl. Malay Pen. (1907) 157; SCHLECHTER, Die Orchideen (1914) 578; Fedde's Rep. Beih. 1 (1914) 992;

[4] Journ. Linn. Soc. **32** (1896) 351, nomen; Mat. Fl. Malay Pen. (1907) 153.

[5] Orch. Java **6** (1905) 613.

Beih. 4 (1919) 286; AMES, Orch. 5 (1915) 254; in Merrill, Enum. Philip. Fl. Pl. 1 (1925) 439 (as *Trichoglottis* Reichenbach f.).

Stauropsis of authors in part, not Reichenb. f. in Hamb. Gartenzeit. 16 (1860) 117; BENTHAM & HOOKER, Gen. Pl. 3 (1883) 572; PFITZER in Engler & Prantl, Nat. Pflanzenf. II 6 (1889) 218; RIDLEY, Mat. Fl. Malay Pen. (1907) 150 (as *Stauropsis* Benth.); AMES, Orch. 5 (1915) 224; AMES & QUISUMBING in Philip. Journ. Sci. 52 (1933) 462.

Staurochilus RIDLEY in Journ. Linn. Soc. 32 (1896) 350, nomen; Mat. Fl. Malay Pen. (1907) 153; SCHLECHTER, Die Orchideen (1914) 577; in Fedde's Rep. Beih. 4 (1919) 286; AMES in Merrill, Enum. Philip. Fl. Pl. 1 (1925) 441.

Key to the species and varieties of Trichoglottis.

a 1. Lip not decidedly spurred at the base; ligule not elongated or if elongated the flower small and the inflorescence a raceme.
 b 1. Inflorescence at least as long as the leaves, usually much longer and branched; many-flowered.
  c 1. Midlobe of the lip either distinctly trilobulate or nearly as broad as long and triangular.
   d 1. Midlobe of the lip not triangular in outline.
    e 1. Lateral lobules lanceolate, acute .... 1. *T. fasciata.*
    e 2. Lateral lobules semirotund, obtuse .... 2. *T. Guibertii.*
   d 2. Midlobe triangular in outline .... 5. *T. ionosma.*
  c 2. Midlobe of the lip not distinctly trilobulate.
   d 1. Lip less than 7 mm long, midlobe only slightly longer than broad. 10. *T. intermedia.*
   d 2. Lip much longer than 7 mm, midlobe much longer than broad.
    e 1. Midlobe of the lip acute, elongated; stem abbreviated, few-leaved .... 4. *T. luzonensis.*
    e 2. Midlobe of the lip obtuse; stem elongated, many-leaved.
     f 1. Apex of the midlobe thin, dilated, semirotund; leaves 8 to 15 cm long .... 6. *T. mimica.*
     f 2. Apex of the midlobe neither thin nor dilated; mature leaves mostly more than 15 cm long.
      g 1. Dorsal sepal obovate, about 10 mm long. 7. *T. agusanensis.*
      g 2. Dorsal sepal elliptic, about 15 mm long. 3. *T. Loheriana.*
 b 2. Inflorescence much shorter than the leaves, 1- to few-flowered.
  c 1. Midlobe of the lip without lateral lobules .... 9. *T. Wenzelii.*
  c 2. Midlobe of the lip with lateral lobules.
   d 1. Lateral lobules of the midlobe obliquely quadrate-oblong to triangular .... 8. *T. philippinensis.*
   d 2. Lateral lobules of the midlobe acinaciform-linear. 8*a*. *T. philippinensis* var. *brachiata.*
a 2. Lip decidedly spurred at the base; ligule elongated, usually linear and flattened.
 b 1. Midlobe of the lip with three distinct lobules, the lateral pair directed downward .... 16. *T. calochila.*

b^2. Midlobe of the lip simple.

c^1. Lateral sepals as broad across the auriculate base as long, or nearly so .... 14. *T. latisepala.*

c^2. Lateral sepals much narrower across the auriculate base than long.

d^1. Midlobe attached near the opening of the spur, with a callus.

e^1. Callus erect, retuse; midlobe of lip narrowly ovate. 11. *T. mindanaensis.*

e^2. Callus not erect; midlobe of lip not narrowly ovate.

f^1. Callus near the middle of the midlobe; lateral lobes of the lip straight; ligule pubescent and expanded at the apex. 13. *T. Amesiana.*

f^2. Callus near the base of the midlobe; lateral lobes of the lip decurved; ligule not expanded nor pubescent at the apex. 12. *T. bataanensis.*

d^2. Midlobe attached much below the opening of the sac, lacking a callus .... 15. *T. rosea.*

1. **TRICHOGLOTTIS FASCIATA** Reichenbach f.

Trichoglottis fasciata REICHENBACH f. in Gard. Chron. (1872) 699.
Stauropsis fasciata BENTHAM ex Jackson in Ind. Kew 2 (1885) 982; KRÄNZLIN, Xen. Orch. 3 (1894) 132, *pl. 275, figs. 1–7;* Cogn. Dict. Icon. Orch. (1904) *Stauropsis, pl. 3;* AMES & QUISUMBING, Philip. Journ. Sci. 47 (1932) 214, *pl. 2, figs. 4, 5; pls. 12, 28, 29.*
Staurochilus fasciata RIDLEY, Journ. Linn. Soc. Lond. Bot. 32 (1896) 351.
Vandopsis leytensis AMES, Orch. 5 (1915) 222.

LUZON and LEYTE; also in TROPICAL EASTERN ASIA.

2. **TRICHOGLOTTIS GUIBERTII** (Linden & Reichenbach f.) J. J. Sm.

Trichoglottis Guibertii (Linden & Reichenbach f.) J. J. SM., Nat. Tijds. Ned. Ind. 72 (1912) 108; AMES & QUISUMBING, Philip. Journ. Sci. 56 (1935) 464, *pl. 2, figs. 9, 10; pl. 4, figs. 26–35; pl. 10.*
Cleistoma Guibertii LINDEN & REICHENBACH f., ex Reichb. f., Bot. Zeit. 20 (1862) 375.
Vanda Guibertii LINDL. ex Reichb. f., loc. cit. syn.

LUZON. Apparently a very rare plant.

Ames and Quisumbing, in discussing the plant, do not refer to their earlier treatment of the allied species under *Stauropsis* [6] and, while they apparently were not rejecting that genus, they did not refer the present plant to it, which they might well have done were they accepting the genus as valid.

3. **TRICHOGLOTTIS LOHERIANA** (Kränzlin) L. O. Williams comb. nov.

Acampe Loheriana KRÄNZLIN in Fedde's Rep. 17 (1921) 386.
Vandopsis Davisii AMES & QUISUMBING, Philip. Journ. Sci. 49 (1932) 497, *pl. 2, figs. 8–11; pls. 12, 26, 27.*

[6] Philip. Journ. Sci. 52 (1933) 462–468.

LUZON. Probably only Rizal Province.

The closest ally of this species is *T. luzonensis.*

The type of *Acampe Loheriana* is probably a specimen now preserved in the Ames Herbarium, purchased from Fritz Kränzlin by Professor Ames in 1924, along with a considerable number of other specimens that had been preserved in Kränzlin's private herbarium. The specimen consists of four well-pressed flowers and a few notes. It is marked "Typus" in Kränzlin's hand.

4. **TRICHOGLOTTIS LUZONENSIS** Ames.

Trichoglottis luzonensis AMES, Orch. 5 (1915) 255.
Vandopsis Kupperiana KRÄNZLIN in Fedde's Rep. 17 (1921) 390.
Staurochilus luzonensis AMES in Merrill, Enum. Philip. Fl. Pl. 1 (1925) 442.

LUZON.

A distinct and apparently rare species allied to *T. Loheriana.*

5. **TRICHOGLOTTIS IONOSMA** (Lindl.) J. J. Sm.

Trichoglottis ionosma (Lindl.) J. J. SM., Nat. Tijds. Ned. Ind. 72 (1912) 108.
Cleisostoma ionosmum LINDL., Bot. Reg. 33 (1847) *pl. 41.*
Staurochilus ionosma SCHLECHTER, Orch. (1914) 578.

LUZON.

6. **TRICHOGLOTTIS MIMICA** L. O. Williams sp. nov.

Herba epiphytica cum caulibus brevibus. Folia disticha, lineari-oblonga, obtusa, retusa et paulo obliqua, coriacea. Inflorescentia pauciflora. Sepalum dorsale anguste obovatum, coriaceum. Sepala lateralia obliqua, obovata, obtusa, coriacea. Petala anguste obovata, obtusa, coriacea. Labellum trilobatum, leviter saccatum; lobi laterales erecti, prope apicem subtus breviter apiculati, coriacei; lobus medius carinatus, plusminusve oblongus, cum carina pubescenti e basi loborum lateralium fere ad apicem lobi medii et cum callo juxta lobos laterales; in sacco ligula concava papillifera, oblonga, obtusa stat.

An epiphytic herb with short stems which are about 1.5 dm long or longer, and 7 to 8 mm thick, without adventitious roots so far as known. Leaves distichous, linear-oblong, obtuse, retuse, somewhat oblique, about 2 cm apart, the blade 8 to 15 cm long, 1.5 to 2.5 cm broad, contracted and slightly conduplicate at the base, coriaceous, with veins fairly prominent at least in dry specimens. Peduncle breaking through the leaf-sheath opposite and just above the base of the leaf, many times exceeding the leaves in length, up to about 6 dm long, often with a few short lateral branches (that is, somewhat panicled). Apparently each inflorescence bearing a relatively small number of flowers. Bracts of the inflorescence small and inconspicuous. Dorsal sepal narrowly obovate, obtuse, coriaceous, 13 to 16 mm long, 7 to 9 mm broad. Lateral sepals obliquely obovate, obtuse, coriaceous, about 14 mm long, 7 to 9 mm broad. Petals narrowly obovate, obtuse, coriaceous, 12 to 13 mm long, 5 to 7 mm broad. Lip three-lobed, somewhat saccate, about 15 mm long; lateral lobes erect, 3 to 4 mm high, short-apiculate near the middle, coriaceous, firmly joined to the column, glabrous on both surfaces; middle lobe carinate, approximately oblong, with a densely pubescent median carinate ridge extending from the bases of the lateral lobes almost to the apex of the lobe, between the bases of the lateral lobes a small callus, the lobe dilated laterally at about the same point, apex of the lobe dilated, obtuse, much thinner than the rest of the lobe, glabrous; in the saccate base of the lip a concave, papilliferous, oblong, obtuse ligule directed upward. Column short, stout, about 3 mm long, glabrous, with two falcate pubescent lateral arms at the apex.

MINDANAO, Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13977* October 1912 (Type in Herb. Ames, No. 13448) and *Elmer 13977a*.

The following note by Mr. Elmer is of interest:

Very course tufts or masses upon the large limbs of large trees on a moist wooded ridge near the summit of Duras at 4,000 feet, near cliff; stems less than ½ inch thick, sparingly rebranched, terete, brown or gray sheath covered, very hard and rigid, crooked 1–3 feet long; roots also course, hard and extremely wirey, rather tightly attached; leaves mostly toward the ascending tips, divaricate, alternate, flat, very rigid, slightly recurved and twisted, folded at the base, pale or yellowish green on both sides, peduncles .... persistant, terete, crooked, erect or nearly so, atropurpureous; flowers likewise rigid, ascending, nearly straminous, the spreading segments light atropurpureous, blotched on the inner side, the lip at the base deep yellow, the young flowers have a stramineous under color, when old it becomes yellow. 'Lantaoñ' in Manobo.

This species is most closely allied to *Trichoglottis ionosma* to which the specimens had been referred. It is easily distinguished from *T. ionosma* by the much smaller leaves, and by the following differences in the flower: (*a*) the midlobe of the lip of *T. ionosma* is much shorter than in the present species and (*b*) comparatively much broader; (*c*) the ligules in the two species are different; (*d*) the lateral lobes of the species are different; (*e*) the column arms of *T. mimica* are much larger than those of *T. ionosma.*

This is the only species of this group of allied species, except the distinctive *T. agusanensis,* known from Mindanao. All of the others are known only from Luzon.

The specimen *Weber 103,* which Ames assigned dubiously to *T. luzonensis* when he described that species, possibly belongs to *T. mimica.*

A species very closely allied to *T. mimica* cannot be described at this time because the available material is not satisfactory. This plant has apparently received two herbarium names but has never been published.

7. **TRICHOGLOTTIS AGUSANENSIS Ames & Quisumbing.**

Trichoglottis agusanensis AMES & QUISUMBING in Philip. Journ. Sci. 59 (1936) 10, *pl. 1, figs. 10, 11; pl. 6, figs. 1–10.*

MINDANAO.

The only specimen I have seen is from the type plant, said to have been collected in Agusan Province. The species is quite distinctive.

8. **TRICHOGLOTTIS PHILIPPINENSIS Lindl.**

Trichoglottis philippinensis LINDL. Ann. & Mag. Nat. Hist. 15 (1845) 386; AMES, Orch. 7 (1922) 137.

Stauropsis philippinensis REICHB. f., Hamb. Gartenz. 16 (1860) 117; Xen. Orch. 2 (1862) 8; AMES & QUISUMBING, Philip. Journ. Sci. 52 (1932) 463, *pl. 2, figs. 11–13; pl. 7, figs. 19–27; pl. 16, fig. 1.*

LUZON, NEGROS, TAWITAWI, MINDANAO.

8a. **TRICHOGLOTTIS PHILIPPINENSIS var. BRACHIATA (Ames) L. O. Williams comb. nov.**

Trichoglottis brachiata AMES, Orch. 7 (1922) 136.

Stauropsis philippinensis var. *brachiata* AMES & QUISUMBING, Philip. Journ. Sci. 52 (1933) 465, *pl. 3, figs. 11–13; pl. 7, figs. 10–18; pl. 16, fig. 2;* LAYCOCK, Malay. Orch. Rev. 2 (1936) *pl. on page 99.*

Stauropsis purpurea LAYCOCK in Malay. Orch. Rev. 2 (1936) 97, nomen subnudum.

CATANDUANES, POLILLO, BILIRAN, MINDANAO.

This variety seems, on superficial examination, to be easily distinguished from the species, but when good characters are sought they prove to be most evasive. It is probable that the living plants appear more distinct than pressed specimens.

9. **TRICHOGLOTTIS WENZELII** Ames.

Trichoglottis Wenzelii AMES, Philip. Journ. Sci. § C 8 (1913) 440.
Trichoglottis retusa AMES, Orch. 5 (1915) 257, nom. nud. in syn., non Blume.
Stauropsis Wenzelii AMES & QUISUMBING, Philip. Journ. Sci. 52 (1933) 467, *pl. 3, figs. 14, 15; pl. 7, figs. 28–35; pl. 17.*

LUZON, LEYTE, SAMAR, BASILAN, MINDANAO.

This species is closely allied to *T. geminata* J. J. Sm. but I lack sufficient evidence to be sure of the relationship between the two.

10. **TRICHOGLOTTIS INTERMEDIA** L. O. Williams sp. nov.

Folia disticha, lineari-oblonga, obtusa, retusa, coriacea. Inflorescentia cum plusminusve 20 floribus. Bracteae inflorescentiae hyalinae, triangulae, parvae. Sepalum dorsale anguste obovatum, obtusum, coriaceum. Sepala lateralia anguste obovata, obtusa, leviter obliqua, coriacea. Petala elliptico-oblanceolata, obtusa, coriacea. Labellum trilobatum, basi leviter saccatum; lobe laterales erecti, late lanceolati, acuti; lobus medius pubescens; in sacco ligula lanceolata, acuta stat.

Size of the plant unknown, stem probably course, 5 to 6 mm thick or more, adventitious roots probably present but their extent unknown. Leaves distichous, linear-oblong, obtuse, retuse, oblique, crowded, coriaceous, contracted and conduplicate at the base, 9 to 23 cm long, 1.5 to 3.5 cm broad. Peduncle simple or branched, up to 20 cm long, raceme bearing 20 flowers, more or less. Bracts of the inflorescence hyaline, small, about 1 mm long. Dorsal sepal narrowly obovate, obtuse, coriaceous, about 8 mm long, 3 to 4 mm broad. Lateral sepals narrowly obovate, obtuse, slightly oblique, coriaceous, about 8 mm long, 4 mm broad. Petals elliptic-oblanceolate, slightly oblique, obtuse, coriaceous, about 7 mm long, 3 mm broad. Lip three-lobed, somewhat saccate at the base, about 5 mm long; lateral lobes erect, broadly lanceolate, acute, firmly joined to the column, about 2 mm long; midlobe rounded, extremely thick, furrowed down the middle, pubescent especially near the sinuses; in the saccate base of the lip there is a lanceolate, acute ligule which is directed outward. Column short, about 1 mm long, the terminal arms nearly obsolete.

LUZON, Rizal Province, *Loher 14652* (Type in Herb. Ames, No. 44,960), *Loher s. n.*, September 1909.

Trichoglottis intermedia is the most unusual Philippine species of the genus. It appears to have no near allies. It seems to be a species intermediate between the two groups of *Trichoglottis* found in the Philippines. It is like the small-flowered species in the size of the flower and the structure of the ligule; in other characters, short spur, type of inflorescence and leaf, it seems to be allied to the large-flowered species. The characters exhibited by this plant help to strengthen the contention that the group of species with which this paper treats should all be referred to one genus rather than to two genera.

11. **TRICHOGLOTTIS MINDANAENSIS Ames.**

Trichoglottis mindanaensis AMES, Philip. Journ. Sci. § C **8** (1913) 439.

LUZON, SAMAR, PANAY, MINDANAO.

A distinct and well-marked species easily distinguished from all allied species. Apparently fairly common.

12. **TRICHOGLOTTIS BATAANENSIS Ames.**

Trichoglottis bataanensis AMES, Orch. **1** (1905) 105, *text figure*.
Cleisostoma subviolaceum REICHENBACH f. in Bonpl. **10** (1862) 335, non *Trichoglottis subviolacea* (Llanos) Merrill.

LUZON, PALAWAN.

The history of this species, which occurs rather commonly at low elevations in Luzon, is of interest. Vidal[7] called the plants collected by Cuming, which belong here, *Trichoglottis rigida* Blume. Previous to that time the plant had been named *Cleisostoma subviolaceum* by Reichenbach f. In 1918 Merrill changed *Synptera subviolacea* Llanos to *Trichoglottis subviolacea* (Llanos) Merrill, at the same time suggesting that *T. bataanensis* Ames was referable to that name. The illustrative specimens sent out[8] are *Trichoglottis bataanensis*. I am unable to accept the name *Trichoglottis subviolacea* because there can be no certainty about its application.

13. **TRICHOGLOTTIS AMESIANA L. O. Williams sp. nov.**

Herba epiphytica cum caulibus usque ad 7 dm longis. Folia disticha, lineari-lanceolata, acuta vel acuminata, coriacea. Bracteae inflorescentiae parvae. Sepalum dorsale ellipticum vel anguste oblongo-ellipticum, obtusum, leviter concavum. Sepala lateralia oblonga, basi cum auricula. Petala oblanceolato-linearia, obtusa vel acuta. Labellum trilobatum, saccatum; lobi laterales erecti, lineari-oblongi; lobus medius suborbicularis, pro-

[7] Phan. Cuming. Philip. (1885) 150; Rev. Pl. Vasc. Filip. (1886) 271.
[8] Merrill: Species Blancoanae No. 733.

pe medium, cum callis duobus; saccus callo magno pubescenti et ligula subcircinata ornatus.

Stems (on specimen seen) up to 7 dm long, about 3 to 4 mm thick, terete, without adventitious roots. Leaves distichous, linear-lanceolate, acute or acuminate, mostly about 3 mm apart on the stem, 8 to 13 cm long, 7 to 12 mm broad, contracted and slightly conduplicate at the base, coriaceous. Peduncles breaking through the leaf sheaths opposite and just above the base of the leaf, very short and few-flowered, about 1 cm long. Bracts of the inflorescence small and inconspicuous. Dorsal sepal elliptic to narrowly oblong-elliptic, obtuse, slightly concave, 6 to 7 mm long, 2 to 3 mm broad. Lateral sepals semihastate or oblong with an auricle at the base, about 6 mm long, 3 mm broad. Petals oblanceolate-linear, obtuse or acutish, about 6 mm long, 2 mm broad. Lip three-lobed, strongly saccate; lateral lobes erect, linear-oblong, obtuse, about 2 mm long, firmly joined to the column near their base; middle lobe thickened, suborbicular, with a pair of small pubescent calluses near the center, about 4 mm broad; sac about 3 mm deep, at right angles to the column, with a large pubescent callus within at the base of the midlobe of the lip and a subcircinate ligule arising on the posterior wall of the sac about opposite the anterior callus, the ligule, which is about 3 mm long, curved upward and conspicuously flattened particularly at the pubescent apex. Column short, exalate, about 2.5 mm long.

LUZON, Mount Palpag, on a tree, altitude 280 meters, flowers red, yellow, and white, April 13, 1915, *Ramos & Deroy 24109* (Type in Herb. Ames, Nos. 43902 and 43915).

Trichoglottis Amesiana is very closely allied to *T. bataanensis* Ames to which it would no doubt have been referred on superficial examination. The following differences will be found upon examination of the flowers.

T. bataanensis.	*T. Amesiana.*
Midlobe of the lip longer than broad.	Midlobe of the lip broader than long.
Callus on the midlobe near attachment of claw.	Callus on the midlobe in the middle of the lobe.
Lateral lobes of the lip comparatively short, decurved.	Lateral lobes of the lip comparatively long, straight.
Ligule not pubescent nor expanded at the apex, comparatively short.	Ligule pubescent and expanded at the apex, comparatively long.
Column about 1.5 mm long.	Column about 2.5 mm long.

The name of this species is intended in some small degree to honor Prof. Oakes Ames, to whom we are largely indebted for our knowledge of the Philippine Orchidaceæ.

14. TRICHOGLOTTIS LATISEPALA Ames.

Trichoglottis latisepala AMES, Philip. Journ. Sci. § C 4 (1909) 675.

LUZON, CATANDUANES, SAMAR, PALAWAN, BANCALAN, LUMBUCAN, MINDANAO.

Widely distributed in the Islands and not uncommon.

15. TRICHOGLOTTIS ROSEA (Lindl.) Ames.

Trichoglottis rosea (Lindl.) AMES in Merrill, Enum. Philip. Fl. pl. 1 (1925) 440.
Cleisostoma rosea LINDL. in Bot. Reg. 24 (1838) miscl. 80.
Trichoglottis flexuosa ROLFE in Ames, Orch. 1 (1905) 107.
Pomatocalpa roseum J. J. SM. in Nat. Tijds. Ned.-Ind. 72 (1912) 36.

LUZON, LEYTE, BOHOL, PANAY, MINDANAO.

16. TRICHOGLOTTIS CALOCHILA L. O. Williams sp. nov.

Herba epiphytica cum caulibus usque ad 4.5 dm longis. Folia disticha, lineari-lanceolata vel lanceolata, coriacea, acuminata et apice plicata. Bracteae inflorescentiae minimae. Sepalum dorsale elliptico-oblongum, acutum, leviter concavum. Sepala lateralia late ovata, obtusa. Petala anguste oblanceolata, obtusa. Labellum trilobatum, saccatum; lobi laterales erecti, rotundati, obtusi; lobus medius trilobulatus, basi cum callis duobus; ligula in sacco stat.

Stems (on specimens seen) up to 4.5 dm long, 3 to 4 mm thick, terete or nearly so, with a few adventitious roots near the base of the plant. Leaves distichous, linear-lanceolate to lanceolate, acuminate and plicate at the apex, mostly 1.5 to 2 cm apart on the stem, 4 to 11 cm long, 6 to 12 mm broad, slightly conduplicate at the base, probably coriaceous when fresh. Peduncles breaking through the leaf sheaths opposite the base of a leaf, very short, 1- to 3-flowered, mostly less than 0.5 cm long. Bracts of the inflorescence very small and inconspicuous. Dorsal sepal elliptic-oblong, acute, slightly concave, about 8 mm long, 3.5 mm broad. Lateral sepals broadly ovate, slightly oblique, obtuse, about 6 mm long, 4 to 5 mm broad. Petals narrowly oblanceolate, obtuse, about 6 mm long, 1.5 mm broad. Lip spurred, three-lobed; the spur dorsoventrally flattened and with two central ridges, about 3 mm long; lateral lobes erect, rounded, obtuse, about 1 mm high; middle lobe fleshy, trilobulate, the middle lobule (as seen from above) narrowly rhomboid, but with a connecting plate below so that in cross section it is T-shaped, lateral lobules subtriangular, directed downward; there are two mammillate calluses at the base of the midlobe of the lip between the bases of the lateral lobules, and a flattened ligule about 1 mm long on the posterior wall of the spur about opposite the middle lobe. Column about 3 mm long.

BOHOL, Batuan River, on rocks along stream, altitude 1,000 feet, September 2, 1923, *Ramos 796* (Type in Herbarium Ames, Nos. 44055 and 44056. LEYTE, Dagami (Panda), on trees, March 2, 1913, *Wenzel 115*, is probably this species.

Trichoglottis calochila is allied to *T. rosea*, to *T. bataanensis*, and to the other species of this alliance which superficially it resembles very much but from which it is very distinct in floral morphology. The trilobulate midlobe of the lip will serve to distinguish it from all other known species of this alliance.

It is of interest to note that the trilobulate character of the midlobe approaches the condition found in *T. fasciata* and *T. philippinensis*, which are large-flowered species with cruciform midlobes of the lip, and helps to invalidate this character as one of generic value.

OBSCURE AND LITTLE-KNOWN SPECIES

1. TRICHOGLOTTIS ATROPURPUREA Reichenbach f.

Trichoglottis atropurpurea REICHENBACH f. in Linnaea 41 (1876) 30.

Dr. Karl Keissler, curator of the Reichenbach Herbarium in Vienna, has the following to say concerning the type: "Ich bemerke, dass *Trichoglottis atropurpurea* in der hiesigen Sammlung leider fehlt." I have not been able to identify the species with a Philippine species.

2. TRICHOGLOTTIS SOLEREDERI Kränzlin.

Trichoglottis Solerederi KRÄNZLIN, in Fedde's Rep. 8 (1910) 98.

This species is said to have been collected by Loher, but in the large Loher collection I found no material referable to it. There is in the Herbarium Ames a photograph of the living plant, derived from the Kränzlin Herbarium, which has the annotation on the back "*Trichoglottis Solerederi* Kränzl. in lit." This specimen is certainly not one of the species treated herein and allied to *T. rosea* and *T. bataanensis*. It has obliquely retuse leaves, as Kränzlin describes it, which is not the case in the above-mentioned species to which he compared it or to any of their allied species.

3. CLEISOSTOMA BRACHYSTACHYUM Kränzlin.

Cleisostoma brachystachyum KRÄNZLIN, Ann. Nat. Hofmus. **30** (1916) 62.

From the description and from the fact that the plant is compared to *Cleisostoma roseum* (= *Trichoglottis rosea*) it is taken to belong to *Trichoglottis*. Possibly it is *T. bataanensis*, but the description is not satisfactory and does not apply well to any species known from the Philippines.

4. TRICHOGLOTTIS BICRURIS Kränzlin.

Trichoglottis bicruris KRÄNZLIN in Ann. K. K. Nat. Hofmus. **30** (1916) 62.

Unknown. Doubtfully from the Philippines.

5. TRICHOGLOTTIS SUBVIOLACEA (Llanos) Merrill.

Trichoglottis subviolacea (Llanos) MERRILL, Sp. Blancoanæ (1918) 116.

Synptera subviolacea LLANOS, Frag. Pl. Filip. (1851) 98.

See the discussion under *T. bataanensis* Ames.

DIATOMS FROM KENON LAKE, TRANSBAIKALIA SIBERIA

By B. W. SKVORTZOW

Of Harbin, Manchoukuo

THREE PLATES

There appears to be no previous record of the algal vegetation of Kenon Lake in Transbaikalia, Siberia. The writer considers himself especially fortunate that so competent collector as Miss K. V. Okunzova, the science teacher of Chita High School, undertook the collection of these diatoms.

Kenon Lake belongs to the Amur river basin and lies near Chita in the Transbaikalia district of Eastern Siberia, halfway between Manchuli station on the western frontier of Manchoukuo and Lake Baikal of Siberia. The sample containing the diatoms described below was collected near the shore of the lake, from the twigs and leaves of *Potamogeton* sp., and sent to my laboratory in Harbin.

The total number of species and varieties recorded from this sample is 111. The diatom flora of Kenon Lake is characterized by significant features: (*a*) Almost all diatoms recorded were of epiphytic nature, with the following species predominating:

Fragilaria intermedia.
Synedra ulna var. *amphirynchus.*
Cocconeis placentula var. *euglypta* and var. *lineata.*
Neidium dubium and fo. *constricta.*
Navicula radiosa.
Navicula amphibola var. *subsalina.*
Cymbella parva.
Gomphonema constrictum.
Epithemia argus, with var. *ocellata* and var. *longicornis.*
Epithemia zebra var. *porcellus.*
Epithemia sorex.
Rhopalodia gibba and var. *ventricosa.*
Nitzschia sublinearis var. *sibirica.*

(*b*) Almost all diatoms recorded are fresh-water species. The 19 brackish-water forms are:

Mastogloia elliptica var. *dansei.*
Caloneis silicula and var. *truncatula.*
Caloneis bacillum.
Anomoeoneis sphaerophora and var. *polygramma.*
Navicula cryptocephala var. *intermedia* and var. *veneta.*

Navicula salinarum.
Navicula cincta.
Navicula anglica var. *subsalsa.*
Navicula amphibola var. *subsalina.*
Cymbella prostrata.
Cymbella hybrida.
Epithemia sorex.
Hantzschia virgata var. *capitellata.*
Nitzschia apiculata.
Nitzschia hybrida.
Surirella patella var. *mongolica.*

(*c*) No forms endemic in Lake Baikal have been recognized in the Kennon diatom flora. (*d*) It was interesting to see in Kenon Lake the following species: *Eucocconeis minuta* Cleve, reported from northern districts; *Achnanthes affinis* var. *bistriata* Skv., recently recorded from Nippon; *Gyrosigma attenuatum* (Kütz.) Rabh. var. *asiatica* Skv., known from Western China; *Neidium distincte-punctatum* Hust., known only from European Lakes. (*e*) Of special taxonomic interest is the discovery of the following 11 new forms:

Anomoeoneis serians var. *sibirica.*
Navicula Kenon.
Navicula longirostris var. *sibirica.*
Navicula viridula var. *argunensis.*
Navicula costulata var. *sibirica.*
Navicula amphibola var. *subsalsa.*
Pinnularia undulata var. *sibirica.*
Nitzschia angustata var. *capitata.*
Nitzschia capitellata var. *sibirica.*
Nitzschia sibirica.
Surirella patella var. *mongolica* var. nov.

MELOSIRA GRANULATA (Ehr.) Ralfs STATUS X. Plate 1, fig. 2.

Melosira granulata (Ehr.) Ralfs, FR. HUSTEDT, Bacillar. (1930) 87, fig. 44.

Valve cylindrical, with robust beads. Valve height 0.015 mm; breadth, 0.009. Striæ 9, puncta 7 to 8 in 0.01 mm. Infrequent.

MELOSIRA ARENARIA Moore. Plate 1, fig. 10.

Melosira arenaria Moore, A. SCHMIDT, Atlas Diatom. (1893) 179, figs. 15–20.

Frustule from valve view circular, with distinct broad marginal rim and radiating striæ. Central space punctate. Diameter 0.068 to 0.076 mm. Marginal striæ 6 in 0.01 mm. Infrequent.

CYCLOTELLA COMTA (Ehr.) Kützing.

Cyclotella comta (Ehr.) Kützing, FR. HUSTEDT, Bacillar. (1930) 103, fig. 69.

Valve circular, with radiate striæ and punctate central space. Diameter 0.011 mm. Striæ 12 in 0.01 mm. Rare.

CYCLOTELLA MENEGHINIANA Kützing fo. **PLANA** Fricke. Plate 3, fig. 4.

Cyclotella Meneghiniana Kütz. fo. *plana* Fricke, FR. HUSTEDT, Bacillar. (1930) 100.

Valve circular with robust radiating costæ. Central space hyaline. Diameter 0.015 mm. Striæ 7 to 8 in 0.01 mm. Rare.

FRAGILARIA INTERMEDIA Grunow. Plate 1, figs. 13 and 31.

Fragilaria intermedia Grunow, FR. HUSTEDT, Bacillar. (1930) 139, fig. 130.

Valve linear-lanceolate, parallel or gibbous in the middle. Ends subrostrate. Striæ in the middle interrupted only on one side of the valve. Length, 0.0155 to 0.025 mm; breadth, 0.0036 to 0.0051. Striæ 9 to 10 in 0.01 mm. Abundant.

FRAGILARIA CAPUCINA Desm. var. **MESOLEPTA** (Rabh.) Grunow. Plate 1, fig. 3.

Fragilaria capucina Desm. var. *mesolepta* (Rabh.) Grunow, FR. HUSTEDT, Bacillar. (1930) 138, fig. 128.

Valve linear-lanceolate, biconstricted in the middle with interrupted striæ. Length, 0.0153 to 0.025 mm; breadth, 0.0028 to 0.0034. Striæ 15 in 0.01 mm. Infrequent.

FRAGILARIA CONSTRUENS (Ehr.) Grun. var. **SUBSALINA** Hustedt. Plate 1, figs. 15 and 32.

Fragilaria construens (Ehr.) Grun. var. *subsalina* FR. HUSTEDT, Bacillar. (1930) 141, fig. 139.

Valve elliptic or elongate-elliptic. Central area lanceolate. Length, 0.0065 to 0.015 mm; breadth, 0.0034 to 0.004. Striæ 12 to 15 in 0.01 mm. Differs from the type in its narrower valves. Common. Reported from brackish water.

SYNEDRA ULNA (Nitzsch) Ehr. var. **AMPHIRYNCHUS** (Ehr.) Grunow.

Synedra ulna (Nitzsch) Ehr. var. *amphirynchus* (Ehr.) Grunow, FR. HUSTEDT, Bacillar. (1930) 154, fig. 167; A. SCHMIDT, Atlas Diatom. (1914) pl. 302, figs. 23–26.

Valve linear-lanceolate, with attenuate and capitate ends. The middle space unstriated. Length, 0.14 mm; breadth, 0.005. Striæ 9 in 0.01 mm. Abundant.

SYNEDRA VAUCHERIAE Kützing. Plate 2, fig. 23.

Synedra Vaucheriae Kützing, A. SCHMIDT, Atlas Diatom. (1914) pl. 305, fig. 30.

Valve lanceolate, with unilateral interruption in the middle. Length, 0.009 to 0.015 mm; breadth, 0.003 to 0.0034. Striæ 12 to 15 in 0.01 mm. Common.

SYNEDRA RUMPENS Kütz. var. SCOTICA Grunow.

Synedra rumpens Kütz. var. *scotica* Grunow, FR. HUSTEDT, Bacillar. (1930) 156, fig. 177.

Valve linear-lanceolate, in the middle suddenly undulate. Ends attenuate and subcapitate. Length, 0.037 mm; breadth, 0.0025. Striæ 15 in 0.01 mm. Infrequent.

SYNEDRA ACUS Kütz. var. RADIANS (Kütz.) Hustedt.

Synedra acus Kütz. var. *radians* (Kütz.) FR. HUSTEDT, Bacillar. (1930) 155, fig. 171.

Valve narrow linear, with long attenuate ends. Striæ interrupted in the middle by a round vacant space. Length, 0.102 mm; breadth, 0.0028. Striæ 12 to 14 in 0.01 mm. Common.

EUNOTIA PRAERUPTA Ehr. var. BIDENS Grun.

Eunotia praerupta Ehr. var. *bidens* Grunow, FR. HUSTEDT, Bacillar. (1930) 174, fig. 213.

Valve robust, almost straight, slightly biundulate, with broad obtuse and subcapitate ends. Length, 0.06 mm; breadth, 0.0136. Striæ 7 to 8 in 0.01 mm. Rare.

COCCONEIS PLACENTULA (Ehr.).

Cocconeis placentula (Ehr.) FR. HUSTEDT, Bacillar. (1930) 189, fig. 260.

Valve elliptic, with broad-rounded ends. Upper valve with fine punctate and radiate striæ. Axial area narrow-linear. Length, 0.03 mm; breadth, 0.023. Striæ 18 in 0.01 mm. Common.

COCCONEIS PLACENTULA (Ehr.) var. EUGLYPTA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *euglypta* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 261.

Differs from the type in the striæ being crossed by five broad, longitudinal, blank, undulating, bands. Length, 0.02 mm; breadth, 0.0136. Striæ 21 in 0.01 mm. Abundant.

COCCONEIS PLACENTULA (Ehr.) var. LINEATA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *lineata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 262.

Valve variable in size, elliptic. Differs from the type in the presence of 10 to 12 longitudinal bands on each side of the valve. Abundant.

COCCONEIS DIMINUTA Pantocsek. Plate 1, fig. 4.

Cocconeis diminuta Pantocsek, FR. HUSTEDT, Bacillar. (1930) 190, 191, fig. 265.

Valve broad-elliptic. Striæ of the upper valve crossed by three broad longitudinal blank, undulating, bands. Length, 0.0085 to 0.011 mm; breadth, 0.005 to 0.006. Striæ of the lower valve about 30, striæ of upper valve about 18 in 0.01 mm. Rare. Reported from bottoms of large lakes.

EUCOCCONEIS MINUTA Cleve. Plate 1, figs. 23 and 24.

Achnanthidium minutum CLEVE, Diatoms of Finland (1891) 53, pl. 3, figs. 6, 7.

Valve elliptic, with broad-rounded ends. Upper valve with oblique, narrow-linear, axial, area, and subrectangular central area. Striæ mostly parallel, about 21 to 22 in 0.01 mm. Lower valve with similar axial and central area. Striæ finer. Length, 0.015 mm; breadth, 0.0076. Smaller than the type from Northern Europe. Rare.

ACHNANTHES MINUTISSIMA Kützing.

Achnanthes minutissima Kützing, FR. HUSTEDT, Bacillar. (1930) 198, fig. 274.

Valve linear-elliptic, with more distinct middle striæ. Length, 0.01 mm; breadth, 0.0025. Striæ very fine, about 30 in 0.01 mm. Infrequent.

ACHNANTHES MINUTISSIMA Kützing var. **CRYPTOCEPHALA** Grun.

Achnanthes minutissima Kützing var. *cryptocephala* Grun., FR. HUSTEDT, Bacillar. (1930) 198, fig. 275.

Differs from the type in its subcapitate ends. Length, 0.0136 mm; breadth, 0.002. Infrequent.

ACHNANTHES LANCEOLATA Breb. var. **ROSTRATA** Hustedt.

Achnanthes lanceolata Breb. var. *rostrata* Hustedt, FR. HUSTEDT, Bacillar. (1930) 208, fig. 306*b*.

Valve elliptic-lanceolate, with undulate middle part and rostrate ends. Length, 0.01 mm; breadth, 0.0034. Striæ about 12 in 0.01 mm. Valve with a horseshoe-shaped area in the middle of one side. Infrequent.

ACHNANTHES AFFINIS Grun. var. **BISTRIATA** Skvortzow. Plate 2, fig. 25.

Achnanthes affinis Grun. var. *bistriata* SKVORTZOW, Diatoms from Shengtu, Szechwan, Western China, pl. 3, fig. 7.

Valve elliptic-lanceolate, with broad-rounded ends. Lower valve with rectangular central area with two more distinct shortened marginal striæ. Length, 0.0085 mm; breadth, 0.0027. Striæ 24 in 0.01 mm. Shorter than the type. Common. Known from Western China.

MASTOGLOIA ELLIPTICA Agardh var. DANSEI (Thw.) Grunow. Plate 1, fig. 14.

Mastogloia elliptica Agardh var. *dansei* (Thw.) Grunow, FR. HUSTEDT, Bacillar. (1930) 217, fig. 318.

Valve elliptic-lanceolate, with parallel margins and cuneate ends. Median line in a distinct siliceous rib, linear in the middle part and capitate cuneate at the ends. Striæ radiate and punctate. Length, 0.025 mm; breadth, 0.0085. Striæ 15 in 0.01 mm. Known from fresh and brackish water. Rare.

GYROSIGMA ACUMINATUM (Kütz.) Rabh. Plate 3, fig. 3.

Gyrosigma acuminatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 222, fig. 329.

Valve sigmoid, with attenuate and obtuse-rounded ends. Axial area very narrow. Central area small elliptic. Median line sigmoid. Length 0.102 mm; breadth, 0.015. Striæ longitudinal and transversal, 18 in 0.01 mm. Rare.

GYROSIGMA ATTENUATUM (Kütz.) Rabh. var. ASIATICA Skvortzow. Plate 3, figs. 11, 14, and 15.

Gyrosigma attenuatum (Kütz.) Rabh. var. *asiatica* SKVORTZOW, Diatoms from Shengtu, Szechwan, Western China, pl. 4, fig. 8.

Valve gently sigmoid and lanceolate, gradually tapering from the middle to the sigmoid obtuse ends. Length, 0.23 mm; breadth, 0.027. Transverse striæ, 10 to 11 in 0.01 mm, radiating in the middle; longitudinal striæ 7 to 8 in 0.01 mm. Rare. Reported from Western China.

CALONEIS SILICULA (Ehr.) Cleve.

Caloneis silicula (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 236, 237, fig. 362.

Valve linear-elliptic, moderately triundulate with cuneate round ends. Length, 0.093 mm; breadth, 0.016. Striæ 17 to 18 in 0.01 mm. Common. Reported from fresh and brackish water.

CALONEIS SILICULA (Ehr.) Cleve var. TRUNCATULA Grunow.

Caloneis silicula (Ehr.) Cleve var. *truncatula* Grunow, FR. HUSTEDT, Bacillar. (1930) 238, fig. 363.

Valve elliptic-lanceolate, slightly gibbous in the middle. Ends broad-rounded. Length, 0.042 mm; breadth, 0.011. Striæ 17 in 0.01 mm. Common.

CALONEIS BACILLUM (Grun.) Mereschkovski.

Caloneis bacillum (Grun.) Mereschkovski, FR. HUSTEDT, Bacillar. (1930) 236, fig. 360*a*.

Valve elliptic-lanceolate, with cuneate ends. Central area a broad rectangular fascia. Length, 0.02 mm; breadth, 0.0042. Striæ 30 in 0.01 mm. Uncommon. Reported from fresh and brackish water.

NEIDIUM DUBIUM (Ehr.) Cleve.

Neidium dubium (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 246, fig. 384*a*.

Valve elliptic-lanceolate, with rostrate ends. Length, 0.028 to 0.04 mm; breadth, 0.01 to 0.0136. Striæ 15 in 0.01 mm. Very common. Reported from fresh water.

NEIDIUM DUBIUM (Ehr.) Cleve fo. CONSTRICTA Hustedt.

Neidium dubium (Ehr.) Cleve fo. *constricta* FR. HUSTEDT, Bacillar. (1930) 246, fig. 384*b*.

Differs from the type in constricted valves. Length, 0.066 mm; breadth, 0.016. Striæ 18 in 0.01 mm. Very common.

NEIDIUM IRIDIS (Ehr.) Cleve fo. VERNALIS Reichelt. Plate 1, figs. 27 and 34.

Neidium iridis (Ehr.) Cleve fo. *vernalis* Reichelt, FR. HUSTEDT, Bacillar. (1930) 245, fig. 380.

Valve linear-elliptic, with broad ends. Central nodules large and comma-shaped, turned in opposite directions. Length, 0.042 to 0.047 mm; breadth, 0.012 to 0.014. Striæ 15 in 0.01 mm. Our species are akin to *Neidium mirabile* Hustedt, reported from Tibet. Infrequent.

NEIDIUM IRIDIS (Ehr.) Cleve var. AMPHIGOMPHUS (Ehr.) Van Heurck.

Neidium iridis (Ehr.) Cleve var. *amphigomphus* (Ehr.) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 245, fig. 382.

Valve elliptic-linear, with long and cuneate ends. Length, 0.07 mm; breadth, 0.022. Striæ about 15 in 0.01 mm. Infrequent.

NEIDIUM DISTINCTE-PUNCTATUM Hustedt. Plate 1, fig. 18; Plate 3, fig. 6.

Neidium distincte-punctatum FR. HUSTEDT, Bacillar. (1930) 247, fig. 386.

Valve elliptic-lanceolate, parallel in the middle, attenuate and cuneate at the obtuse ends. Median line straight, filiform, with distinct terminal nodules and central pores slightly curved in opposite directions. Axial area linear with rectangular central area, not reaching the margins. Length, 0.052 to 0.06 mm; breadth, 0.015 to 0.017. Striæ 9 to 10, puncta 12 to 15 in 0.01 mm. Infrequent. Our specimens are larger than the European.

ANOMOEONEIS SPHAEROPHORA (Kütz.) Pfitzer. Plate 1, fig. 20.

Anomoeoneis sphaerophora (Kütz.) Pfitzer, FR. HUSTEDT, Bacillar. (1930) 262, fig. 422.

Valve elliptic-lanceolate, with attenuate capitate ends. Median line filiform and straight, with curved terminal fissures. Axial area linear, central a rectangular unilateral fascia. Striæ radiate, punctate, and interrupted by a long, broad, irregular, band, from the end to the middle of the valve. Length, 0.066 to 0.085 mm; breadth, 0.017 to 0.024. Striæ 14 to 20 in 0.01 mm. Common. Reported from fresh and brackish waters.

ANOMOEONEIS SPHAEROPHORA (Kütz.) Pfitzer var. POLYGRAMMA (Ehr.) O. Müll. Plate 1, fig. 19.

Anomoeoneis sphaerophora (Kütz.) Pfitzer var. *polygramma* (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 262, fig. 425.

Differs from the type in its elliptic valves. Length, 0.069 mm; breadth, 0.025. Striæ 15 in 0.01 mm. Common. Known from fresh and brackish waters.

ANOMOEONEIS SERIANS (Breb.) Cleve var. SIBIRICA var. nov. Plate 3, fig. 5.

Differt a typo striis robustis. Longis valvis 0.06 mm; latis valvis 0.012. Striis radiantes, 15 ad 16 in 0.01 mm, cum vittis longitudinali interruptis. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit K. V. Okunzova.

Valve narrow-lanceolate, tapering to the subacute ends. Axial area narrow, central suborbicular. Striæ radiate and punctate, crossed by longitudinal irregular lines. Length, 0.06 mm; breadth, 0.012. Striæ 15 to 16 in 0.01 mm. Differs from the type and var. *brachysira* (Breb.) Hust. fo. *thermalis* (Grun.) Hust. in its more robust striæ. Rare. The type is known in northern and alpine regions.

Genus NAVICULA Bory

NAVICULÆ ORTHOSTICHÆ CLEVE

NAVICULA CUSPIDATA Kütz.

Navicula cuspidata Kütz., FR. HUSTEDT, Bacillar. (1930) 268, fig. 433.

Valve lanceolate, with acute ends. Length, 0.136 mm; breadth, 0.028. Striæ parallel. Infrequent.

NAVICULA CUSPIDATA Kütz. var. AMBIGUA (Ehr.) Cleve.

Navicula cuspidata Kütz. var. *ambigua* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 268, fig. 434.

Differs from the type in its subrostrate ends. Length, 0.085 mm; breadth, 0.023. A craticular form was also observed.

Length, 0.056 to 0.085 mm; breadth, 0.015 to 0.023. Striæ 15 in 0.01 mm. Common.

NAVICULÆ BACILLARES CLEVE

NAVICULA PUPULA Kützing. Plate 1, fig. 25.

Valve linear-elliptic with slightly gibbous margin and broad rounded ends. Central area a transverse stauros. Length, 0.03 mm; breadth, 0.0085. Striæ 18 to 20 in 0.01 mm. An intermediate form between var. *rectangulatis* and var. *capitata*.[2] Common.

NAVICULA PUPULA Kütz. var. **CAPITATA** Hustedt.

Navicula pupula Kütz. var. *capitata* FR. HUSTEDT, Bacillar. (1930) 281, fig. 467*c*.

Valve linear-lanceolate, with capitate ends. Length, 0.022 mm; breadth, 0.0068. Common.

NAVICULÆ MESOLEIÆ CLEVE

NAVICULA KENON sp. nov. Plate 2, fig. 20.

Frustulis quadratis, superne discoidalis, fronte elliptico-lanceolatis cum polis obtusis. Raphe directa. Area axillaris angusta linearis, centralis vitta transversa nuda interruptis. Striis radiantes punctatis, ad raphem cum vittis duabus atris elongatis ornata. Longis valvis 0.017 mm; latis valvis 0.006. Striis 18 in 0.01 mm. Habit. inter Potamogeton in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Frustule quadrate, with thick siliceous membrane, from upper view almost circular, from side view elliptic-lanceolate with strong convex surface. Median line filiform. Axial area narrow-linear, central area a broad rectangular stauros, not reaching to the margin. Striæ radiate throughout and distinctly punctate, interrupted by longitudinal bands. Length, 0.017 mm; breadth, 0.006. Striæ 18 in 0.01 mm. A distinct species. Rare.

NAVICULÆ DECIPIENTES CLEVE

NAVICULA LONGIROSTRIS Hust. var. **SIBIRICA** var. nov. Plate 2, fig. 31.

Differt a typo striis transversis robustris. Longis valvis 0.015 mm; latis valvis 0.0034. Striis 22 to 24 in 0.01 mm. Habit. inter Potamogeton in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear-lanceolate, with parallel margins in the middle and attenuate rostrate ends. Axial and central areas very

[1] FR. HUSTEDT, Bacillar. (1930) 281, figs. 467*b* and *c*.

narrow. Striæ almost parallel, coarser and slightly radiate at the ends. Length, 0.015 mm; breadth, 0.0034. Striæ 22 to 24 in 0.01 mm. Differs from the type in its more robust striæ. Rare.

NAVICULÆ LINEOLATÆ CLEVE

NAVICULA CRYPTOCEPHALA Kütz. var. INTERMEDIA Grunow. Plate 1, fig. 21.

Navicula cryptocephala Kütz. var. *intermedia* Grunow, FR. HUSTEDT, Bacillar. (1930) 295, fig. 497*b*.

Valve lanceolate, with attenuate ends. Axial area narrow-linear, central broad. Striæ radiate, convergent at the ends, longer and shorter in the middle. Length, 0.017 mm; breadth, 0.005. Striæ 14 to 15 in 0.01 mm. Infrequent. Reported from fresh and brackish water.

NAVICULA CRYPTOCEPHALA Kütz. var. VENETA (Kütz.) Grunow.

Navicula cryptocephala Kütz. var. *veneta* (Kütz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 295, fig. 497*a*.

Valve lanceolate with obtuse ends. Striæ convergent at the ends. Length, 0.0187 mm; breadth, 0.0065. Striæ 13 to 14 in 0.01 mm. Infrequent. Reported from brackish water.

NAVICULA SALINARUM Grunow.

Navicula salinarum Grunow, FR. HUSTEDT, Bacillar. (1930) 295, fig. 498.

Valve lanceolate, with broad margins and attenuate acute ends. Central area orbicular, with longer and shorter striæ on both sides. Length, 0.034 mm; breadth, 0.007. Striæ 12 to 15 in 0.01 mm. Rare. Reported from brackish water.

NAVICULA VIRIDULA Kütz. var. ARGUNENSIS var. nov. Plate 1, figs. 9 and 33.

Differt a typo valvis minoris, angustis et striis subtilissimis. Longis valvis 0.032 ad 0.035 mm; latis valvis 0.0051 ad 0.076. Striis 12 ad 15 in 0.01 mm. Habit. inter Potamogeton in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve narrow-lanceolate, gradually tapering from the middle to the subacute ends. Median line filiform and straight with distinct comma-shaped terminal fissures, and sometimes distinct terminal pores. Striæ radiate, striolate, slightly convergent at the ends, shorter and more distinct at the middle of the valve. Length, 0.032 to 0.035 mm; breadth, 0.0051 to 0.0076. Striæ 12 to 15 in 0.01 mm. Differs from the type in its smaller and narrower valves, coarser striæ, and in the presence of terminal pores. Common. Reported from Argun river, Western frontier of Manchoukuo.

NAVICULA COSTULATA Grun. var. **SIBIRICA** var. nov. Plate 2, fig. 22.

Differt a typo valvis ad medium undulatis, polis productis subcapitatis rotundatis. Longis valvis 0.017 mm; latis valvis 0.0034. Striis 18 in 0.01 mm. Habit. inter Potamogeton sp. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear-lanceolate, with undulate middle part and long subcapitate ends. Striæ robust, radiate, convergent at the ends. Lineoles of striæ not distinct. Length, 0.017 mm; breadth, 0.0034. Striæ 18 in 0.01 mm. Differs from the type in its valve being gibbous in the middle and elongate-obtuse at the ends. Our form is akin to var. *intermedia* Skv. and var. *nipponica* Skv. from Biwa Lake, Nippon.

NAVICULA CINCTA (Ehr.) Kützing. Plate 1, figs. 22 and 26.

Navicula cincta (Ehr.) Kützing, VAN HEURCK, Synopsis (1881–1885) pl. 7, figs. 13, 14.

Valve elliptic-lanceolate, with broad-rounded ends. Median line with distinct comma-shaped terminal fissures. Striæ robust, lineolate and radiate, 11 to 12 in 0.01 mm. Median striæ more distinct and more strongly marked than the others. Length, 0.015 to 0.022 mm; breadth, 0.0048 to 0.005. Common. Reported from fresh and brackish water.

NAVICULA RADIOSA Kützing.

Navicula radiosa Kützing, FR. HUSTEDT, Bacillar. (1930) 299, fig. 513.

Valve narrow-lanceolate, gradually tapering from the middle to the acute ends. Central area suborbicular. Length, 0.064 mm; breadth, 0.01. Striæ 11 in 0.01 mm. Very common.

NAVICULA REINHARDTII Grunow. Plate 2, figs. 18 and 19.

Navicula Reinhardtii Grunow, FR. HUSTEDT, Bacillar. (1930) 301, fig. 519; A. SCHMIDT, Atlas Diatom. (1911) pl. 272, figs. 1–9.

Valve elliptic-lanceolate, with short or long rounded ends. Striæ very robust, lineolate and radiate. Length, 0.028 to 0.068 mm; breadth, 0.013 to 0.018. Striæ 6 to 8 in 0.01 mm. Common.

NAVICULA ANGLICA Ralfs.

Navicula anglica Ralfs, VAN HEURCK, Synopsis (1881–1885) pl. 8, figs. 29, 30.

Valve elliptic, with rostrate ends. Striæ radiate, not punctate. Length, 0.02 mm; breadth, 0.006. Striæ 15 in 0.01 mm. Differs from the type in its coarser striæ. Common.

NAVICULA ANGLICA Ralfs var. **SUBSALSA** Grunow.

Navicula anglica Ralfs var. *subsalsa* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 8, fig. 31.

Differs from the type in its much less attenuate and rostrate ends. Length, 0.027 mm; breadth, 0.085. Striæ 10 to 11 in 0.01 mm, fine-lineate. Not common. Reported from slightly brackish water.

NAVICULA PLACENTULA (Ehr.) Grunow.

Navicula placentula (Ehr.) Grunow, FR. HUSTEDT, Bacillar. (1930) 303, fig. 532.

Valve elliptic-lanceolate, with subrostrate ends. Median line filiform. Axial area narrow, central suborbicular. Striæ radiate throughout. Length, 0.034 mm; breadth, 0.015. Striæ 7 to 8 in 0.01 mm. Common.

NAVICULA PLACENTULA (Ehr.) Grunow fo. ROSTRATA A. Mayer.

Navicula placentula (Ehr.) Grunow fo. *rostrata* A. Mayer, FR. HUSTEDT, Bacillar. (1930) 303, fig. 533.

Valve with more rostrate ends. Striæ sometimes lineolate. Length, 0.027 to 0.044 mm; breadth, 0.012 to 0.017. Striæ 7 to 11 in 0.01 mm. Common.

NAVICULA GASTRUM Ehr.

Navicula gastrum Ehr., FR. HUSTEDT, Bacillar. (1930) 305, fig. 537.

Valve elliptic-lanceolate, with broad-obtuse, rostrate, ends. Median striæ longer and shorter. Length, 0.027 mm; breadth, 0.012. Striæ 10 to 11 in 0.01 mm. Common.

NAVICULA EXIGUA (Greg.) O. Müll. Plate 2, fig. 26.

Navicula exigua (Greg.) O. Müll., VAN HEURCK, Synopsis (1881–1885) pl. 8, fig. 32.

Valve elliptic, with narrow ends. Median striæ short and long, with broad rectangular central area. Length, 0.017 mm; breadth, 0.0085. Striæ 15 in 0.01 mm. Infrequent. Reported from fresh and brackish water.

NAVICULA OBLONGA Kütz. var. SUBPARALLELA Rattray. Plate 1, figs. 28 and 29.

Navicula oblonga Kütz. var. *subparallela* Rattray, OESTRUP, Beiträge zur Kenntniss der Diatomeenflora des Kossogolbeckens in der nordwestlichen Mongolei. (1909) pl. fig. 6.

Valve linear, almost with parallel margins, slightly attenuate towards the obtuse ends. Median line robust, enlarged in the middle, with comma-shaped terminal fissures. Axial area narrow, central area orbicular. Length, 0.076 to 0.0132 mm; breadth, 0.013 to 0.017. Striæ 7 to 8 in 0.01 mm. Common. The type is reported from fresh and brackish water.

NAVICULÆ PUNCTATÆ CLEVE

NAVICULA AMPHIBOLA Cleve. Plate 2, fig. 21.

Navicula amphibola Cleve, GRUNOW, Diatomeen von Franz Josefs Land (1884) 98, pl. 1, fig. 35.

Valve elliptic-lanceolate, with attenuate rostrate ends. Median lines slightly flexuous. Axial area narrow, central a stauros, widened outwards. Striæ radiate and punctate. Length, 0.034 mm; breadth, 0.014. Striæ 12 to 13 in 0.01 mm. Our specimens are closely connected with var. *manshurica* Skv., a form with rostrate ends. Rare.

NAVICULA AMPHIBOLA Cleve var. SUBSALINA var. nov. Plate 1, fig. 11.

Differt a typo valvis augustis, polis productis, striis subtilissimis. Longis valvis 0.022 ad 0.035 mm; latis valvis 0.005 ad 0.012. Striis 12 ad 18 in 0.01 mm. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve elliptic-lanceolate, gradually tapering to the acute ends. Length, 0.022 to 0.035 mm; breadth, 0.005 to 0.012. Striæ 12 to 18 in 0.01 mm. Puncta 25 to 30 in 0.01 mm. Very common. Differs from the type in its narrower valves, lanceolate ends, and coarser striæ.

Genus PINNULARIA Ehrenberg

PINNULARIÆ PARALLELISTRIATÆ

PINNULARIA UNDULATA Greg. var. SIBIRICA var. nov. Plate 2, fig. 7.

Differt a typo valvis linearis cum marginem parallelis, polis capitatis. Longis valvis 0.022 mm; latis valvis 0.005. Costis 18 in 0.01 mm. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear, with parallel margins and suddenly capitate ends. Median line filiform. Axial area narrow, central a broad fascia, reaching the margin. Striæ slightly radiate, at the ends somewhat convergent. Length, 0.022 mm; breadth, 0.005. Costæ 18 in 0.01 mm. Differs from the type in its parallel margins. The type is reported from fresh water in mountain districts. Rare.

PINNULARIÆ COMPLEXÆ

PINNULARIA VIRIDIS (Nitzsch) Ehr.

Pinnularia viridis (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 335, fig. 617*a*.

Valve elliptic-linear, with broad ends. Striæ divergent in the middle and convergent at the ends. Longitudinal band indistinct. Length, 0.098 mm; breadth, 0.01. Costæ 6 in 0.01 mm. Infrequent.

PINNULARIA GENTILIS (Donk.) Cleve var. SIBIRICA Skvortzow. Plate 3, fig. 7.

Pinnularia gentilis (Donk.) Cleve var. *sibirica* SKVORTZOW, Diatoms collected by Dr. Y. Okada in Nippon I, pl. 2, fig. 2.

Valve lineate, slightly gibbous in the middle and then with parallel margins. Ends broad-rounded. Median line complex. Axial area narrow, less than $\frac{1}{3}$ of the breadth of the valve. Costæ 6 to 7 in 0.01 mm, moderately divergent and convergent at the ends. Length, 0.074 to 0.139 mm; breadth, 0.016 to 0.017. Smaller than the specimens from Nippon. Infrequent.

PINNULARIA DISTINGUENDA Cleve. Plate 3, fig. 16.

Pinnularia distinguenda CLEVE, Diatoms of Finland (1891) 22, pl. 1, fig. 1.

Valve linear, indistinctly gibbous in the middle. Ends broad-rounded. Axial area less than $\frac{1}{3}$ of the valve breadth. Central area broad and distinct. Length, 0.139 mm; breadth, 0.022. Costæ 6 in 0.01 mm, divergent in the middle and convergent at the ends. Differs from the type in having a broad-rounded central area. Infrequent.

AMPHORA OVALIS Kütz. fo. GRACILIS (Ehr.) Cleve.

Amphora gracilis Ehr., A. SCHMIDT, Atlas Diatom. (1875) pl. 26, fig. 101.

Frustule elliptic, with truncate ends. Length, 0.035 mm; breadth, 0.0085. Striæ 15 in 0.01 mm. Common.

AMPHORA OVALIS Kützing. var. PEDICULUS Kützing.

Amphora ovalis Kütz. var. *pediculus* Kützing, FR. HUSTEDT, Bacillar. (1930) 343, fig. 629.

Valve elliptic, with interrupted striæ in the middle. Length, 0.015 to 0.02 mm; breadth, 0.0034 to 0.0068. Striæ 15 to 18 in 0.01 mm. Common.

AMPHORA PERPUSILLA Grunow.

Amphora perpusilla Grunow, FR. HUSTEDT, Bacillar. (1930) 343, fig. 627.

Frustule broad-elliptic, with ventral side without striæ. Length, 0.01 mm; breadth, 0.0034. Striæ 18 in 0.01 mm. Infrequent.

AMPHORA NORMANI Rabh. Plate 2, fig. 30.

Amphora Normani Rabh., FR. HUSTEDT, Bacillar. (1930) 343, fig. 630.

Valve semielliptic, with long capitate ends. Ventral side without striæ. Length, 0.02 to 0.024 mm; breadth, 0.0034. Striæ 18 to 20 in 0.01 mm. Common.

CYMBELLA VENTRICOSA Kützing. Plate 2, fig. 24.

Cymbella ventricosa Kützing, FR. HUSTEDT, Bacillar. (1930) 369, fig. 661.

Valve semielliptic, with narrow ventral side. Length, 0.014 to 0.018 mm; breadth, 0.005 to 0.0068. Striæ, dorsal 9 to 12; ventral 10 to 15 in 0.01 mm. Infrequent.

CYMBELLA MICROCEPHALA Grunow. Plate 1, figs. 16 and 17.

Cymbella microcephala Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 8, figs. 36–39.

Valve naviculiform, lanceolate, with rostrate ends. Axial area very narrow, central small-orbicular. Striæ almost parallel. Length, 0.0153 to 0.017 mm; breadth, 0.0028 to 0.0034. Striæ 25 to 30 in 0.01 mm. Some forms have one side of the valve constricted. Differs from the type in its parallel margin. The figured specimen is a short one. Common.

CYMBELLA PROSTRATA (Berk.) Cleve. Plate 2, fig. 27.

Cymbella prostrata (Berkl.) Cleve, FR. HUSTEDT, Bacillar. (1930) 357, 358, fig. 659.

Valve semielliptic, boat-shaped, ventral side straight, dorsal arcuate and the ends obtuse. Striæ robust, distinctly lineolate. Length, 0.0187 mm; breadth, 0.0068. Striæ, dorsal 9; ventral 10, in 0.01 mm. Infrequent.

CYMBELLA HYBRIDA Grunow. Plate 2, figs. 28 and 29.

Cymbella hybrida Grunow, CLEVE, P. Synopsis Naviculoid Diatoms 1 (1894) 166, pl. 4, fig. 23; SKVORTZOW, Diatoms from Kizaki Lake, Nippon (1936) pl. 5, fig. 23.

Navicula rhynchocephala Kütz. var. *hankensis* SKVORTZOW, Diatoms from Hanka Lake (1929) 49, pl. 4, fig. 22.

Valve naviculiform, linear-lanceolate, with parallel margins and truncate ends. Striæ radiate, striolate, slightly convergent at the ends, 9 to 13 in 0.01 mm. The median striæ shortened, equal in length, or longer on one side than on the other. Length, 0.027 to 0.03 mm; breadth, 0.068 to 0.0085. Infrequent. Reported from slightly brackish water from Sweden, from Hanka Lake, Eastern Siberia, and from Kizaki Lake, Nippon.

CYMBELLA PARVULA (W. Smith) Cleve. Plate 2, figs. 13 to 17.

Cocconema parvulum Smith, A. SCHMIDT, Atlas Diatom. (1875) pl. 10, figs. 14, 15.

Valve semilanceolate, with straight or centrally slightly gibbous ventral side, and arcuate dorsal. Axial area robust, slightly oblique. Length, 0.032 to 0.049 mm; breadth, 0.0068 to 0.009. Striæ, dorsal 8½ to 10, ventral 10 to 12 in 0.01 mm. Abundant. Common in littoral zones of lakes.

CYMBELLA CISTULA (Hemp.) Grunow.

Cymbella cistula (Hemp.) Grunow, FR. HUSTEDT, Bacillar. (1930) 363, fig. 676*a*.

Valve boat-shaped, with moderately gibbous ventral side and arcuate dorsal. At the ventral side of the central nodule are two puncta, ending the median striæ. Length, 0.051 mm; breadth, 0.014. Striæ 7 to 8 in 0.01 mm. Common.

CYMBELLA AFFINIS Kützing.

Cymbella affinis Kützing, Bacillar. (1930) 362, fig. 671.

Valve cymbiform, with almost straight ventral and arcuate dorsal margin. At the ventral side of the central nodule one punctum, ending the median striæ. Length, 0.045 mm; breadth, 0.013. Striæ, dorsal 8, ventral 9 in 0.01 mm. Infrequent.

CYMBELLA EHRENBERGII Kützing.

Cymbella Ehrenbergii Kützing, FR. HUSTEDT, Bacillar. (1930) 356, fig. 656.

Valve rhombic-lanceolate, with broad margins and attenuate subacute ends. Striæ robust-radiate throughout. Length, 0.19 mm; breadth, 0.035. Striæ 6 in 0.01 mm. Rare.

GOMPHONEMA PARVULUM (Kütz.) Grunow.

Gomphonema parvulum (Kütz.) Grunow, FR. HUSTEDT, Bacillar. (1930) 372, fig. 713*a*.

Valve lanceolate-clavate, with attenuate ends. Length, 0.0187 mm; breadth, 0.0068. Striæ 12 in 0.01 mm. Infrequent.

GOMPHONEMA PARVULUM (Kütz.) Grun. var. LAGENULA (Kütz.? Grun.) Hustedt. Plate 1, fig. 12.

Gomphonema parvulum (Kütz.) Grun. var. *lagenula* (Kütz. Grun.) Hustedt, VAN HEURCK, Synopsis (1881–1885) pl. 25, fig. 7.

Valve lanceolate-clavate, with more elongate ends. Length, 0.02 mm; breadth, 0.0042. Striæ 13 in 0.01 mm. Rare.

GOMPHONEMA ACUMINATUM Ehr. fo. PUSILLA Grunow. Plate 3, fig. 10.

Gomphonema acuminatum Ehr. fo. *pusilla* Grunow, A. SCHMIDT, Atlas Diatom. (1902) pl. 239, figs. 19–21.

Valve biconstricted, clavate. Apex broad-capitate. Length, 0.022 mm; breadth, 0.0085. Striæ 10 in 0.01 mm. Rare.

GOMPHONEMA ACUMINATUM Ehr. var. **CORONATA** (Ehr.) W. Smith.

Gomphonema acuminatum Ehr. var. *coronata* (Ehr.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 370, fig. 684.

Valve biconstricted, with apiculate apex. Length, 0.039 mm; breadth, 0.0085. Striæ 12 in 0.01 mm. Infrequent.

GOMPHONEMA LANCEOLATUM Ehr. var. **INSIGNIS** (Greg.) Cleve.

Gomphonema lanceolatum Ehr. var. *insignis* (Greg.) Cleve, FR. HUSTEDT, Bacillar. (1930) 376, fig. 701.

Valve lanceolate-clavate, with elongate ends. The apex more robust than the basis. Length, 0.035 mm; breadth, 0.0085. Striæ 10 in 0.01 mm. Infrequent.

GOMPHONEMA CONSTRICTUM Ehr.

Gomphonema constrictum Ehr., FR. HUSTEDT, Bacillar. (1930) 377, fig. 714.

Valve clavate, with large capitate apex. Basis long attenuate. Length, 0.037 mm; breadth, 0.01. Striæ 11 in 0.01 mm. Very common.

GOMPHONEMA CONSTRICTUM Ehr. var. **CAPITATA** (Ehr.) Cleve.

Gomphonema constrictum Ehr. var. *capitata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 377, fig. 715.

Differs from the type in its more robust, broad-rounded, apex. Length, 0.027 mm; breadth, 0.011. Striæ 10 to 11 0.01 mm. Infrequent.

EPITHEMIA ARGUS Kützing. Plate 2, figs. 1, 2, and 11; Plate 3, fig. 1.

Epithemia argus Kützing, A. SCHMIDT, Atlas Diatom. (1904) pl. 251, figs. 2, 3, 5, 9, 12–14.

Valve semielliptic-lanceolate, with recurved subcapitate ends. Length, 0.04 to 0.042 mm; breadth, 0.007 to 0.0085. Costæ 2 to 3, striæ 12 in 0.01 mm. Abundant.

EPITHEMIA ARCUS Kütz. var. **OCELLATA** Kützing. Plate 2, fig. 10.

Epithemia arcus Kütz. var. *ocellata* Kützing, A. SCHMIDT, Atlas Diatom. (1904) pl. 251, figs. 25, 26.

Differs from the type in its short-obtuse ends. Length, 0.029 mm; breadth, 0.0085. Costæ 2 to 3, striæ 15 to 17 in 0.01 mm. Abundant.

EPITHEMIA ARGUS Kütz. var. **LONGICORNIS** Grunow. Plate 2, figs. 6 and 12.

Epithemia argus Kütz. var. *longicornis* Grunow, A. SCHMIDT, Atlas Diatom. (1904) pl. 251, fig. 15.

Valve semilanceolate, with slightly or strongly concave and arcuate dorsal margins. Ends not capitate. Length, 0.054 to

0.068 mm; breadth, 0.0085 to 0.009. Costæ 3, striæ 10 to 13 in 0.01 mm. Abundant.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. SAXONICA Kützing. Plate 2, fig. 8.

Epithemia zebra (Ehr.) Kütz. var. *saxonica* Kützing, A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 3–14.

Valve semielliptic, with straight ventral and arcuate dorsal side. Ends obtuse. Infrequent.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. PORCELLUS (Kütz.) Grunow. Plate 2, fig. 3.

Epithemia zebra (Ehr.) Kütz. var. *porcellus* (Kütz.) Grunow, A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 15–21.

Differs from the preceding variety by capitate ends. Length, 0.054 mm; breadth, 0.0068 to 0.007. Costæ 2, striæ 15 in 0.01 mm. Abundant.

EPITHEMIA TURGIDA (Ehr.) Kützing. Plate 2, fig. 4.

Epithemia turgida (Ehr.) Kützing, A. SCHMIDT, Atlas Diatom. (1904) pl. 250, figs. 1–6.

Valve moderately arcuate, with obtuse extremities. Median nodule reaching the middle part of the valve, then curved towards the ventral margin. Costæ radiate, alternating with double rows of puncta. Length, 0.076 mm; breadth, 0.013. Costæ 4, striæ 8 in 0.01 mm. Common. Reported from fresh and brackish water.

EPITHEMIA TURGIDA (Ehr.) Kütz. var. GRANULATA (Ehr.) Grunow. Plate 2, fig. 5.

Epithemia turgida (Ehr.) Kütz. var. *granulata* (Ehr.) Grunow, A. SCHMIDT, Atlas Diatom. (1904) pl. 250, figs. 10, 19.

Valve long, moderately arcuate, with produced subcapitate ends. Length, 0.0136 mm; breadth, 0.014. Costæ 4, striæ 9 in 0.01 mm. Common.

EPITHEMIA SOREX Kützing. Plate 2, fig. 9.

Epithemia sorex Kützing, A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 22–28.

Valve strongly arcuate with median nodule nearly on the margin of dorsal side. Costæ radiate. Length, 0.029 mm; breadth, 0.007. Costæ 6, striæ 12 to 14 in 0.01 mm. Abundant. Reported from fresh and brackish water.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 740.

Valve linear, straight on the ventral side, arcuate on the dorsal, reflexed at the extremities. Length, 0.093 mm; breadth, 0.01. Costæ 6, striæ 12 in 0.01 mm. Abundant.

RHOPALODIA GIBBA (Ehr.) O. Müll var. VENTRICOSA (Ehr.) Grunow.

Rhopalodia gibba (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grunow, FR. HUSTEDT, Bacillar. (1930) 391, fig. 741.

Shorter than the type. Length, 0.042 mm; breadth, 0.0085. Abundant.

HANTZSCHIA AMPHIOXYS (Ehr.) Grunow.

Hantzschia amphioxys (Ehr.) Grunow, FR. HUSTEDT, Bacillar. (1930) 394, fig. 747.

Valve lanceolate, slightly arcuate on the dorsal and constricted on the ventral side. Apices produced and rostrate. Length, 0.083 mm; breadth, 0.009. Keel puncta 8 to 9, striæ 18 in 0.01 mm. Infrequent.

HANTZSCHIA VIRGATA (Roper) Grun. var. CAPITELLATA Hustedt. Plate 2, fig. 33.

Hantzschia virgata (Roper) Grun. var. *capitellata* FR. HUSTEDT, Bacillar. (1930) 395, fig. 753.

Valve nearly straight on the ventral side, strongly arcuate on the dorsal. Keel puncta very distinct and slightly prolonged into costæ. Apices recurved and rostrate. Length, 0.48 to 0.051 mm; breadth, 0.0068 to 0.0085. Keel puncta 5 to 6; striæ 11 to 12 in 0.01 mm. Infrequent. Reported from brackish water.

Genus NITZSCHIA Hassal

NITZSCHIÆ TRYBLIONELLÆ

NITZSCHIA APICULATA (Greg.) Grunow. Plate 3, fig. 9.

Nitzschia apiculata (Greg.) Grunow, FR. HUSTEDT, Bacillar. (1930) 401, fig. 765.

Valve linear-lanceolate, constricted in the middle, with broad-apiculate ends. Striæ almost parallel, in the middle of the valve interrupted by a longitudinal hyaline band. Length, 0.052 to 0.054 mm; breadth, 0.0085. Striæ 15 to 17 in 0.01 mm. Infrequent. A brackish-water diatom.

NITZSCHIA ANGUSTATA (W. Smith) Grunow.

Nitzschia angustata (W. Smith) Grunow, FR. HUSTEDT, Bacillar. (1930) 402, fig. 767.

Valve linear, with parallel margins and produced rostrate ends. Length, 0.074 mm; breadth, 0.008 to 0.009. Striæ 12 to 14 in 0.01 mm. Infrequent. Reported from fresh water.

NITZSCHIA ANGUSTATA (W. Smith) Grunow var. CAPITATA var. nov. Plate 3, fig. 8.

Differt a typo polis subcapitatis. Longis valvis 0.098 mm; latis valvis 0.0085. Striis transversis 13 in 0.01 mm. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear, with parallel margins and slightly attenuate and subcapitate ends. Length, 0.098 mm; breadth, 0.0085. Striæ 13 in 0.01 mm. Differs from the type in its capitate ends. Infrequent.

NITZSCHIÆ BILOBATÆ

NITZSCHIA HYBRIDA Grun. Plate 2, fig. 34.

Nitzschia hybrida Grun., FR. HUSTEDT, Bacillar. (1930) 406, fig. 778.

Valve slightly arcuate at the dorsal side and constricted at the ventral. Apex produced, ends reflexed. Keel puncta distinct, about 9, striæ 22 to 25 in 0.01 mm. Length, 0.068 mm; breadth, 0.0068. Rare. A brackish-water species.

NITZSCHIÆ GRUNOWIÆ

NITZSCHIA DENTICULATA Grun. Plate 1, fig. 8.

Nitzschia denticulata Grun., A. SCHMIDT, Atlas Diatom. (1921) pl. 331, figs. 35, 39.

Valve lanceolate, with keel puncta prolonged into costæ, 5 in 0.01 mm. Striæ punctate, 15 in 0.01 mm. Length, 0.018 mm; breadth, 0.0042. Common.

NITZSCHIÆ LINEARES

NITZSCHIA SUBLINEARIS Hust. var. SIBIRICA var. nov. Plate 1, fig. 30.

Differt a typo valvis marginem punctis carinalibus leniter constrictis, punctis carinalibus et striis robustis. Longis valvis 0.074 mm; latis valvis 0.0068. Punctis carinalibus 9, striis transversis 18 ad 20 in 0.01 mm. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear, with almost parallel margin. Ventral side in the middle slightly constricted. Ends produced and rostrate. Length, 0.074 mm; breadth, 0.0068. Keel puncta 9, striæ 18 to 20 in 0.01 mm. Differs from the type in its constricted middle part and the number of striæ. Fairly common.

NITZSCHIÆ LANCEOLATÆ

NITZSCHIA CAPITELLATA Hust. var. **SIBIRICA** var. nov. Plate 2, fig. 32.

Minor quam forma typica, polis capitatis. Longis valvis 0.017 mm; latis valvis 0.0028. Punctis carinalibus 18, striis transversis indistinctis, delicatissimis. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve lanceolate, with produced and capitate ends. Keel puncta distinct, 18 in 0.01 mm. Striæ very fine. Length, 0.017 mm; breadth, 0.0028. Differs from the type in its smaller size. Rare.

NITZSCHIA FONTICOLA Grunow.

Nitzschia fonticola Grunow, FR. HUSTEDT, Bacillar. (1930) 415, fig. 800.

Valve lanceolate with short subacute ends. Keel puncta 12, striæ 25 in 0.01 mm. Length, 0.014 mm; breadth, 0.0034. Infrequent.

NITZSCHIA PALEA (Kütz.) W. Smith.

Nitzschia palea (Kütz.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear or linear-lanceolate, with attenuate and rostrate ends. Length, 0.03 to 0.037 mm; breadth, 0.0029 to 0.005. Keel puncta 10 to 12, striæ about 35 in 0.01 mm. Infrequent.

NITZSCHIA PALEA (Kütz.) W. Smith var. **TENUIROSTRIS** Grunow.

Nitzschia palea (Kütz.) W. Smith var. *tenuirostris* Grunow, FR. HUSTEDT, Bacillar. (1930) 416; SKVORTZOW, Diatomees recoltees par le Pere E. Licent dans le nord de la Mandjourie (1935) 43, pl. 9, fig. 40.

Valve elongate, slightly constricted in the middle. Length, 0.056 mm; breadth, 0.0036. Keel puncta 11 to 12 in 0.01 mm. Striæ transversal, very fine and indistinct. Not Common.

NITZSCHIA COMMUNIS Rabh.

Nitzschia communis Rabh., VAN HEURCK, Synopsis (1881–1885) pl. 119, fig. 32.

Valve elliptic-lanceolate, with broad-obtuse ends. Length, 0.022 mm; breadth, 0.003. Keel puncta 11 in 0.01 mm. Striæ very fine. Differs from the type in its narrower valves. Infrequent.

NITZSCHIA SIBIRICA sp. nov. Plate 1, figs. 6 and 7.

Valvis linearis-lanceolatis, polis productis obtusis. Punctis carinalibus minimus, 9 in 0.01 mm. Striis 15 in 0.01 mm. Longis valvis 0.0068 ad 0.01 mm; latis valvis 0.0017 ad 0.002. Egrege *Nitzschia frustulum* (Kütz.) Grun. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve linear-lanceolate, with slightly produced-obtuse ends. Keel puncta distinct and robust, about 9, striæ 15 in 0.01 mm. Length, 0.0068 to 0.01 mm; breadth, 0.0017 to 0.002. A distinct minute species akin to *Nitzschia frustulum* (Kütz.) Grun. Infrequent.

CYMATOPLEURA SOLEA (Breb.) W. Smith. Plate 3, fig. 2.

Cymatopleura solea (Breb.) W. Smith, A. SCHMIDT, Atlas Diatom. (1911) pl. 276, figs. 1, 2.

Valve elongate, constricted on both sides. Ends cuneate and rounded. Length, 0.132 mm; breadth, in the middle 0.02, at the broader part of the ends 0.032. Costæ 7 in 0.01 mm. Infrequent.

CYMATOPLEURA ELLIPTICA (Breb.) W. Smith var. **NOBILIS** (Hantzsch) Hustedt. Plate 3, fig. 13.

Cymatopleura elliptica (Breb.) W. Smith var. *nobilis* (Hantzsch), FR. HUSTEDT, Bacillar. (1930) 427, fig. 828.

Valve rhombic-elliptic, with produced and rounded ends. Length, 0.129 mm; breadth, 0.062. Costæ 3 in 0.01 mm. Common.

SURIRELLA PATELLA Ehr. var. **MONGOLICA** var. nov. Plate 3, fig. 12.

Differt a typo valvis ovalis cum polis vastis rotundatis. Costis robustis, 4 in 0.01 mm, striis transversalis subradiantes ad area axillaris percurrentes, 12 in 0.01 mm. Area axillaris lineata longitudinalis, nuda. Longis valvis 0.028 mm; latis valvis 0.017. Habit. in lacum Kenon, Transbaikalia, Siberia. Legit. K. V. Okunzova.

Valve broad-ovate, with one end broader than the other. Costæ robust, not reaching the axial area. Axial area linear and hyaline. Length, 0.028 mm; breadth, 0.017. Costæ 4, striæ 12 in 0.01 mm. Rare. It seems to me that different forms of *Surirella ovata* Breb., reported by me in 1929 from Dalai-nor Lake, eastern Mongolia belongs to several species. In that publication pl. 1, fig. 7 is *Surirella ovalis* Breb., pl. 1, fig. 14 is *Surirella peisonis* Pant., and pl. 1, fig. 6 belongs to *Surirella patella* Ehr. var. *mongolica* var. nov.

SURIRELLA CAPRONII Breb.

Surirella Capronii Breb., FR. HUSTEDT, Bacillar. (1930) 440, fig. 857.

Valve narrow, ovate, with one end much broader than the other, with distinct spines near each end. Costæ reaching the median area. Filaments only.

CAMPYLODISCUS NORICUS Ehr. var. GENUINA Grunow. Plate 1, fig. 1.

Campylodiscus noricus Ehr. var. *genuina* Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 77, fig. 6.

Valve circular, strongly curved. Outer rim distinct, costæ with two rows of beads. Central area punctate. No striæ on the surface of the valve. Diameter 0.127 mm. Costæ 1½ to 2 in 0.01 mm. Rare. Reported from bottom of large lakes.

CAMPYLODISCUS NORICUS Ehr. var. HIBERNICUS (Ehr.) Grunow. Plate 1, fig. 5.

Campylodiscus noricus Ehr. var. *hibernicus* (Ehr.) Grunow, VAN HEURCK, Synopsis (1881–1885) pl. 77, fig. 3.

Valve triangular, strongly curved, distinctly striated. Outer rim distinct. Costæ with one row of beads. Central area not punctate. Differs from the type in its hyaline central area. The type has a punctate central part of the valve. Diameter 0.102 mm. Costæ 2 in 0.01 mm. Rare.

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SKVORTZOW, B. Diatomees recoltees par le Pere E. Licent dans le nord de la Mandjourie. Tientsin (1935).

SKVORTZOW, B. Diatoms from Kizaki Lake, Nippon. Philip. Journ. Sci. 61 (1936) 9.

SKVORTZOW, B. Diatoms from Shengtu, Szechwan, Western China. Unpublished manuscript.

SKVORTZOW, B. Diatoms, collected by Dr. Y. Okada in Nippon. I. Unpublished manuscript.

SKVORTZOW, B., and C. I. MEYER. A contribution to the Diatoms of Baikal Lake. Harbin (1928).

SKVORTZOW, B. Bottom diatoms from "Olhon-Gate" of Baikal Lake, Siberia. Philip. Journ. Sci. 62 (1937) 293.

VAN HEURCK, H. Synopsis des Diatomees belgiques. Anvers (1881–1885).

ILLUSTRATIONS

Plate 1

FIG. 1. *Campylodiscus noricus* Ehr. var. *genuina* Grun.
2. *Melosira granulata* (Ehr.) Ralfs *status X.*
3. *Fragilaria capucina* Desm. var. *mesolepta* (Rabh.) Grun.
4. *Cocconeis diminuta* Pant.
5. *Campylodiscus noricus* Ehr. var. *hibernicus* (Ehr.) Grun.
FIGS. 6 and 7. *Nitzschia sibirica* sp. nov.
FIG. 8. *Nitzschia denticulata* Grun.
9. *Navicula viridula* Kütz. var. *argunensis* var. nov.
10. *Melosira arenaria* Moore.
11. *Navicula amphibola* Cleve var. *subsalina* var. nov.
12. *Gomphonema parvulum* (Kütz.) Grun. var. *lagenula* (Kütz.? Grun.) Hust.
13. *Fragilaria intermedia* Grun.
14. *Mastogloia elliptica* Agardh var. *dansei* (Thw.) Grun.
15. *Fragilaria construens* (Ehr.) Grun. var. *subsalina* Hust.
FIGS. 16 and 17. *Cymbella microcephala* Grun.
FIG. 18. *Neidium distincte-punctatum* Hust.
19. *Anomoeoneis sphaerophora* (Kütz.) Pfitzer var. *polygramma* (Ehr.) O. Müll.
20. *Anomoeoneis sphaerophora* (Kütz.) Pfitzer.
21. *Navicula cryptocephala* Kütz. var. *intermedia* Grun.
22. *Navicula cincta* (Ehr.) Kütz.
FIGS. 23 and 24. *Eucocconeis minuta* Cleve.
FIG. 25. *Navicula pupula* Kütz.
26. *Navicula cincta* (Ehr.) Kütz.
27. *Neidium iridis* (Ehr.) Cleve fo. *vernalis* Reichelt.
FIGS. 28 and 29. *Navicula oblonga* Kütz. var. *subparallela* Rattray.
FIG. 30. *Nitzschia sublinearis* Hust. var. *sibirica* var. nov.
31. *Fragilaria intermedia* Grun.
32. *Fragilaria construens* (Ehr.) Grun. var. *subsalina* Hust.
33. *Navicula viridula* Kütz. var. *argunensis* var. nov.
34. *Neidium iridis* (Ehr.) Cleve fo. *vernalis* Reichelt.

Plate 2

FIGS. 1 and 2. *Epithemia argus* Kütz.
FIG. 3. *Epithemia zebra* (Ehr.) Kütz. var. *porcellus* (Kütz.) Grun.
4. *Epithemia turgida* (Ehr.) Kütz.
5. *Epithemia turgida* (Ehr.) Kütz. var. *granulata* (Ehr.) Grun.
6. *Epithemia argus* Kütz. var. *longicornis* Grun. Anomali.
7. *Pinnularia undulata* Greg. var. *sibirica* var. nov.
8. *Epithemia zebra* (Ehr.) Kütz. var. *saxonica* Kütz.
9. *Epithemia sorex* Kütz.

FIG. 10. *Epithemia arcus* Kütz. var. *ocellata* Kütz.
11. *Epithemia argus* Kütz.
12. *Epithemia argus* Kütz. var. *longicornis* Grun.
FIGS. 13 to 17. *Cymbella parvula* (W. Smith) Cleve.
FIGS. 18 and 19. *Navicula Reinhardtii* Grun.
FIG. 20. *Navicula Kenon* sp. nov.
21. *Navicula amphibola* Cleve.
22. *Navicula costulata* Grun. var. *sibirica* var. nov.
23. *Synedra Vaucheriae* Kütz.
24. *Cymbella ventricosa* Kütz.
25. *Achnanthes affinis* Grun. var. *bistriata* Skv.
26. *Navicula exigua* (Greg.) O. Müll.?
27. *Cymbella prostrata* (Berk.) Cleve.
FIGS. 28 and 29. *Cymbella hybrida* Grun.
FIG. 30. *Amphora Normani* Rabh.
31. *Navicula longirostris* Hust. var. *sibirica* var. nov.
32. *Nitzschia capitellata* Hust. var. *sibirica* var. nov.
33. *Hantzschia virgata* (Roper) Grun. var. *capitellata* Hust.
34. *Nitzschia hybrida* Grun.

PLATE 3

FIG. 1. *Epithemia argus* Kütz.
2. *Cymatopleura solea* (Breb.) W. Smith.
3. *Gyrosigma acuminatum* (Kütz.) Rabh.
4. *Cyclotella Meneghiniana* Kütz. fo. *plana* Fricke.
5. *Anomoeoneis serians* (Breb.) Cleve var. *sibirica* var. nov.
6. *Neidium distincte-punctatum* Hust.
7. *Pinnularia gentilis* (Donk.) Cleve var. *sibirica* Skv.
8. *Nitzschia angustata* (W. Smith) Grun. var. *capitata* var. nov.
9. *Nitzschia apiculata* (Greg.) Grun.
10. *Gomphonema acuminatum* Ehr. fo. *pusilla* Grun.
11. *Gyrosigma attenuatum* (Kütz.) Rabh. var. *asiatica* Skv.
12. *Surirella patella* Ehr. var. *mongolica* var. nov.
13. *Cymatopleura elliptica* (Breb.) W. Smith var. *nobilis* (Hantz.) Hust.
FIGS. 14 and 15. *Gyrosigma attenuatum* (Kütz.) Rabh. var. *asiatica* Skv.
FIG. 16. *Pinnularia distinguenda* Cleve.

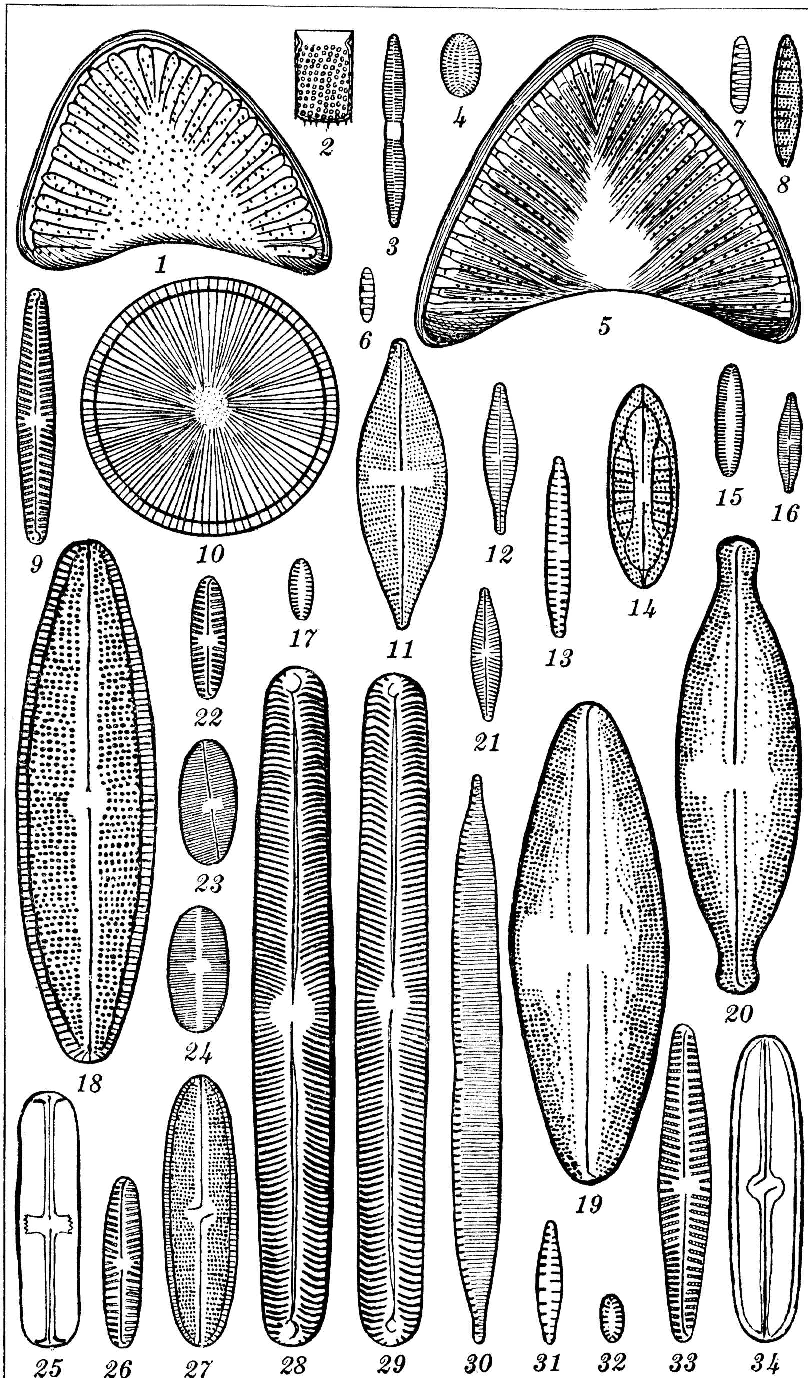
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PLATE 1.

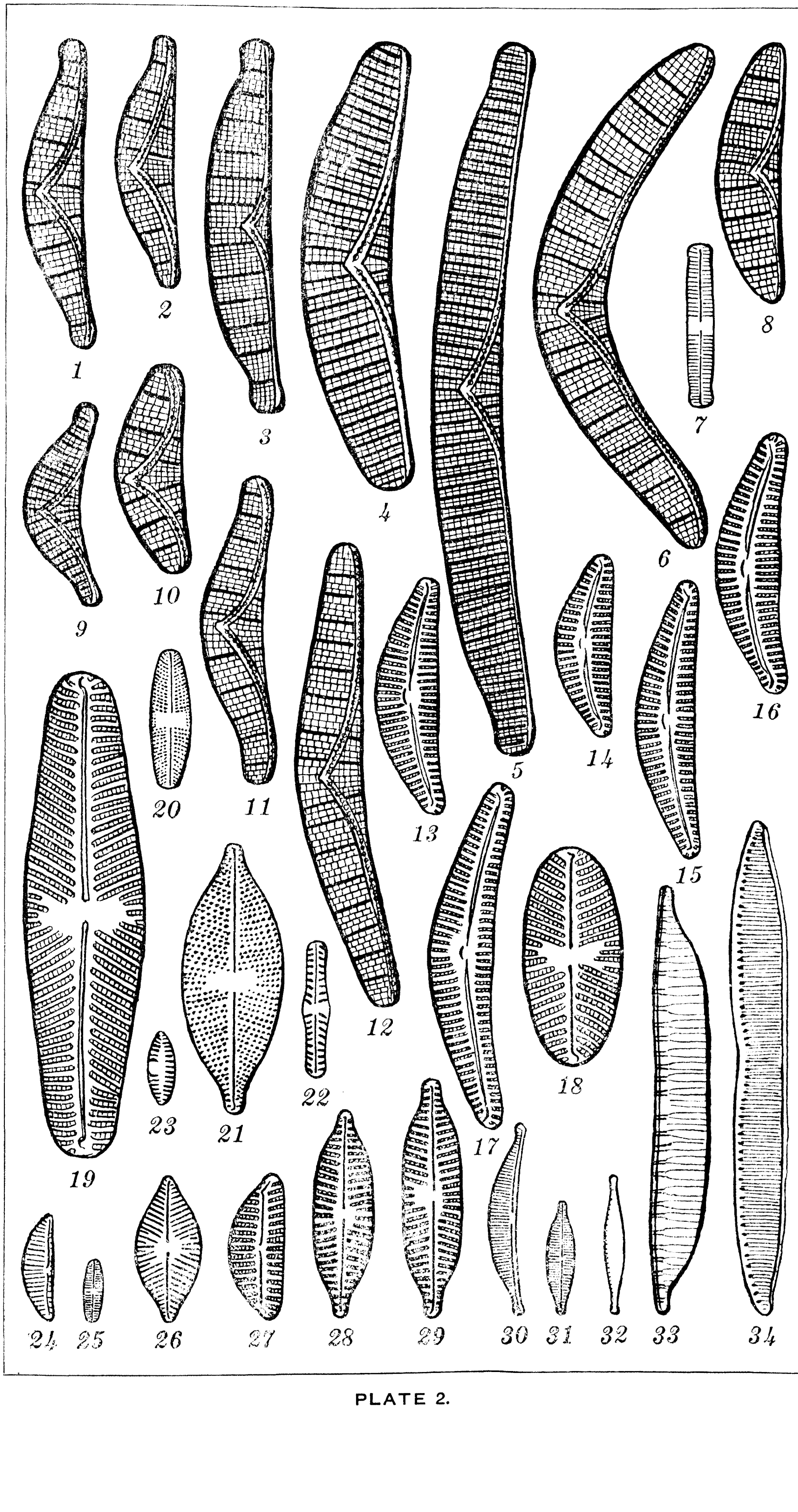
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PLATE 2.

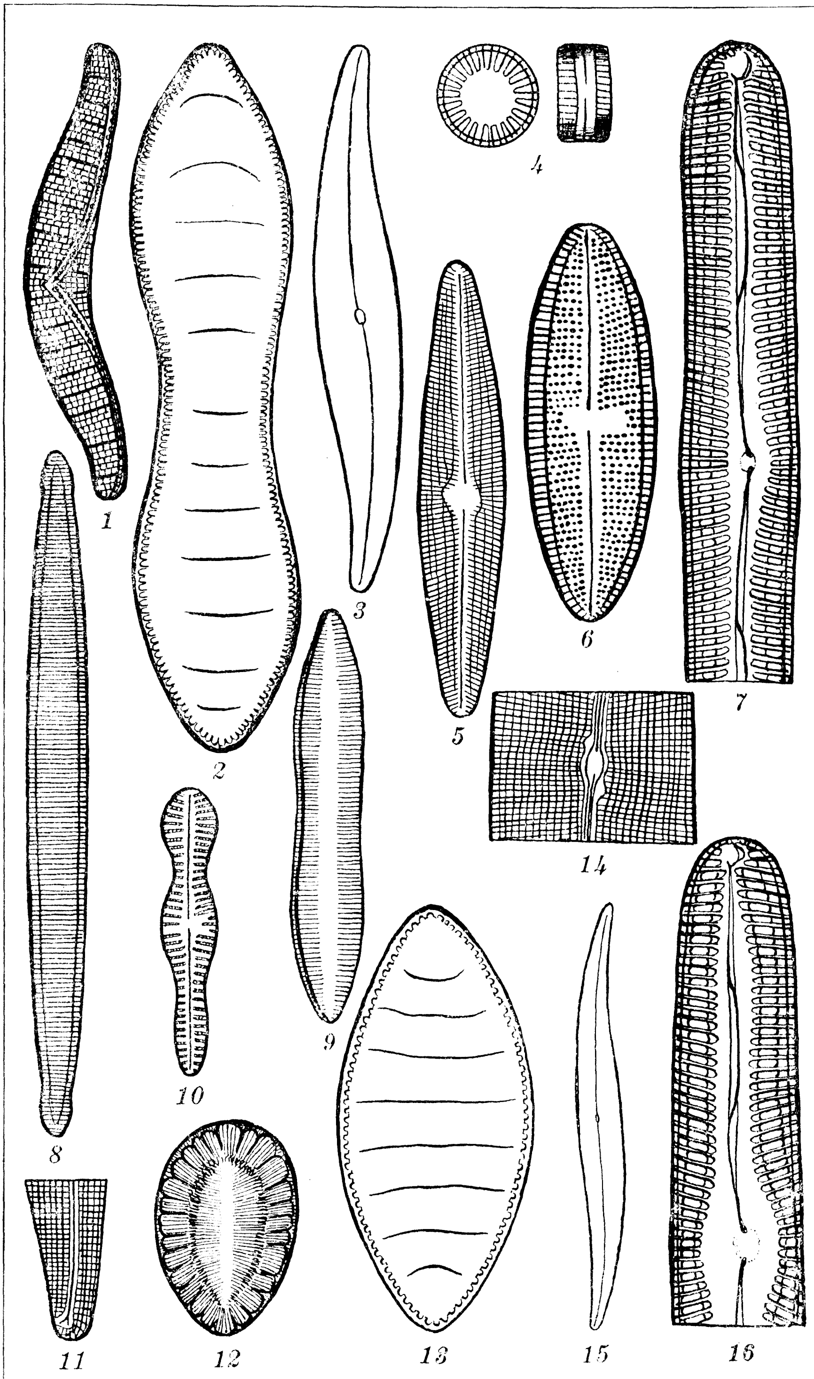

PLATE 3.

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

ABBEY, Mrs. ARTHUR. Practical goat-keeping. London, Cassell & Co., Ltd., 1936. 114 pp., pls. Price, 1s 6d.

American College of Chest Physicians. Pneumothorax directory. 1937 ed. El Paso, Texas, American College of Physicians. 34 pp. Price, $1.

American Society for Testing Materials. Standards on rubber products. Prepared by Committee D-11 on rubber products. Methods of testing specifications. The Society, 1937. 238 pp., illus. Price, $1.25.

Ceramic data book. Featuring equipment and materials catalogs, also buyer's directory, including a review of developments in the industry as recorded in the literature; handbook section; practical tests, and methods of making ceramic calculations. 1938 (10th) ed. Chicago, Industrial publications, Inc., 1937. 292 pp. Price, $5.

FISCHER, LOUIS. The baby and growing child; feeding and health care for physicians, mothers, and nurses. New York, Funk and Wagnalls Company, 1936. 260 pp., illus. Price, $1.50.

FISHER, V. E. Auto-correctivism; the psychology of nervousness. Caldwell, Idaho, The Caxton Printers, ltd., 1937. 337 pp. Price, $3.50.

FRIEDMANN, E. Sterols and related compounds. A series of three lectures delivered at the Institute of Biochemistry, Cambridge. With a foreword by Prof. Sir. Frederick Gowland Hopkins. Cambridge, W. Heffer & sons, ltd., 1937. 100 pp. Price, 7s 6d.

Great Barrier Reef Expedition, 1928–29. Scientific Reports, v. 1–4, 40 nos. London, British Museum (Natural History), 1930–34. Price, ₱100.

Imperial Institute. Mineral Resources Department. The Mineral position of the British Empire. London, Imperial Institute, 1937. 166 pp. Price, 4s.

KIRK, ESBEN. Amino acid and ammonia metabolism in liver diseases. Copenhagen, Levin & Munksgaard, Publishers, 1936. 147 pp.

SAUNDERS, E. R. Floral morphology; a new outlook with special reference to the interpretation of the gynæceum. v. 1. Cambridge, W. Heffer & sons, ltd., 1937. 132 pp. Price, 3s 6d.

STEVENS, J. THOMPSON. The control of goiter; the thyroid in health and disease. New York, A. S. Barnes and Company, 1937. 211 pp., illus. Price, $2.50.

TALBOT, G. A monograph of the Pierine Genus Delias. London, British Museum, 1937. 656 pp., pls., illus. Price, ₱12.50.

REVIEWS

Amino Acid and Ammonia Metabolism in Liver Diseases. By Esben Kirk. Copenhagen, Levin & Munksgaard, Publishers, 1936. 147 pp., tables. Price, 10 kr.

This monograph of 147 pages consists of observations on the amino acid and ammonia content of blood and urine of normal persons and patients suffering from mild liver cirrhosis, obstructive jaundice, and acute hepatitis. The dissertation is characteristic of most European scientific reports, covering extensive reviews of literature, meticulous details of technique, and a thorough discussion of results. Case histories are appended.

Most significant in the whole dissertation therefore is the finding that the blood ammonia in liver cirrhosis is higher than normal. The author however calls attention to the fact that the rise in blood ammonia is not proportional to the severity of the disease. Extremely mild cases have shown higher blood ammonia than moderately severe ones. The possibility is raised that the high blood ammonia may be due not to impairment of the function of the liver per se, but to the shutting off of blood from the liver direct to the inferior vena cava, because of the dilatation of collateral blood vessels commonly known to occur in cirrhosis of the liver. In other words, the lack of conversion of ammonia to urea may be due also to the deviation of blood, so that not all could pass through the liver. Since such a contingency may occur in tumors pressing on the portal vein even with the liver cells normal, a doubt is raised as to the validity of ammonia tolerance as a test of liver function.—N. C.

Atlas of Congenital Cardiac Disease. By Maude E. Abbott. New York. The American Heart Association, 1936. 62 pp., 25 plates. Price, ₱11.

Doctor Abbott has produced a book that is very interesting and instructive to physicians and medical students. The cases studied and explained are clearly pictured in plates and illustrative diagrams. The complex and ingenious congenital defects of the heart originating in embryonic development of the organ is clearly represented in a comparative demonstration with Spitzer's theory of incomplete tortion of the embryonic heart as the causation of cardiac defects.

The clinical classification of congenital cardiac diseases is divided into three groups: Acyanotic, cyanose tardive, and cyanotic. This classification of symptoms and circulatory disturbances based on anatomical lesions of the heart make this atlas a living and dynamic representation of the individual cases, and is very valuable especally to internists and pathologists.

It is interesting to note the following rare and complicated congenital cardiac defects: "Morbus coerleus" or congenital cyanosis, the Eisenmenger complex, the tetralogy of Fallot, the persistent truncus arteriosus, and the congenital rhabdomyoma.

The book has a good bibliography on congenital cardiac diseases.—J. Z. S. C.

Crystallization and Pan-Boiling. By A. L. C. Mathot. Calcutta, Thacker, Spink & Co., Ltd., 1935. 56 pp., diagrams. Price, ₱2.50.

What is known about the mechanics and chemistry of sugar crystallization is briefly explained in this book. Evidently the technic of obtaining a good quality of sugar with regular crystals is either a matter of guess or the product of long experience in the industry. In order to devise a control in the production of an acceptable product, the author set up various experiments to follow the progress of boiling and the stages through which the sugar juice has to go before crystallization begins. As a result, grain is affected by various factors, such as the concentration of the mother liquor before it is conveyed to the crystallizer, agitation during crystallization, purity of the juice, and structure of the apparatus.

Several crystallizers are mentioned, and their construction and advantages are described and explained. The author feels that the book is far from complete without some information about the final molasses. His ideas in this connection are condensed in the form of theoretical considerations.

Among the control apparatus used, the pan-refractometer is especially considered. A sketch is given, showing a simple arrangement and also a short description of the different parts.

In general, the book is a good guide to sugar technologists who are more inclined to the use of pan boiling in the sugar industry. Although the author avoided the use of many technical terms, he incorporated some foreign expressions which made reading of the book difficult. To make it easier reading, particularly to laymen, he should have explained and defined the foreign terms such as pied-de-cuite, masse-cuite, brix, and others.—M. P. R.

Culture Methods for Invertebrate Animals; a Compendium Prepared Cooperatively by American Zoölogists Under the Direction of a Committee from Section F of the American Association for the Advancement of Science. Edited by Paul S. Galtsoff, Frank E. Lutz, Paul S. Welch, and James G. Needham, Chairman. Ithaca, New York, Comstock Publishing Co., Inc., 1937. 590 pp., illus. Price, $4.

"This book has been prepared as an aid to studies that require living animals in continuous supply." It is a compendium of articles prepared by one hundred and eighty-six specialists and edited by a committee of the American Association for the Advancement of Science. The book begins with two installments on the general methods of collecting, maintaining, and rearing terrestrial and aquatic animals. The remainder is taken up with articles arranged systematically by classes under their respective phyla, beginning with the Protozoa and ending with the Chordata. The articles bear the names of their contributors. This volume is, therefore, a valuable record of the practices that the authors have found successful in their cultural management of invertebrate animals. The committee hopes that "this compilation on culture methods may stimulate interest in maintaining living animals in biological laboratories and may lead to further development of the proper technique.

This work will be useful for the teacher of biology in colleges and high schools and for the researcher in the fields of genetics, parasitology, experimental zoölogy, entomology, and microbiology. The reviewer, however, is surprised to find one group of insects, namely, the Siphonaptera, or fleas, not dealt with. Because of the importance of the group in public health work, it is hoped that it will find a place in a future edition of the book.—M. T.

Globe Trotting With a Surgeon. By Alexander H. Peacock. With photographs by the author. Seattle, The Press of Lowman & Hantord Co., c1936. 276 pp.

To lovers of travel and of life, history, and art, reading short passages here and there in reviewing such a book as "Globe Trotting With a Surgeon" is not sufficient. Few are the men who have seen and appreciated as has the author of this book, whose rare ability enabled him to make others unfold the histories of by-gone dynasties, appreciate oriental arts and accomplishments, evaluate the pomp and grandeur of nature, and ably interpret the works of the great masters of art and religion.

In his preface the author cites many ways of circumnavigating the world, but he apparently forgot that reading such a book as his is more useful than circumnavigating the globe without the ability to appreciate and to interpret. This book gives a vivid picture of life on a boat, the making of acquaintances with people of different callings and nationalities. The points of interest picturesquely described are the Garden of Eden of Honolulu, artistic Japan, the ancient splendor and modern poverty in China, a glimpse of Manila, Singapore, Ceylon, Bombay, and other ports. The chapter on Rome with its treasures is the most interesting and instructive of all. The author shows special proficiency in noting differences of customs, dress, and idiosyncracies of nations, but he is just as keen in seeing similarities in the emotions and temperament of these peoples.—I. F.

Health Questions Answered. By W. W. Bauer. New York, The Bobbs-Merrill Company, c1937. 368 pp. Price, $2.

Valuable fundamental knowledge on hygiene, control of contagious diseases, anatomy, physiology, and various health practices is contained in this book for the layman. According to the author's introduction, "This book is a compilation of questions selected from among more than ten thousand letters, asking almost fifteen thousand questions" addressed to the American Medical Association. From it the reader derives an intelligent attitude toward health and disease. Misrepresentations of quacks, impostors, and faddists are exposed, and patients are guided in the selection of a physician. The content is well divided into 13 chapters, and a subject index makes the book convenient for ready reference. This book will be a valuable asset to any home library.—I. F.

L'Infection Bacillaire et la Tuberculose Chez L'Homme et Chez Les Animaux. Etude Bioloque et Experimentale. Vaccination Preventive. Par A. Calmette. 4-ieme ed. entierement revue et complatèe par A. Boquet et L. Negre. Paris, Masson et Cie, 1936. 1024 pp., plates, illus. Price, 175 fr.

The 4th French edition of the book of Dr. Calmette, with the title of "L'Infection Bacillaire et la Tuberculose," published posthumously by his pupils, A. Boquet and L. Negre, is one of the best books written on the general subject of tuberculosis. It summarizes not only the most important pieces of research all over the world in regard to the bacteriology, etiology, pathogenicity, prevention, and immunization of tuberculosis, but also the personal ideas and observations of the author and his collaborators, based on extensive experimental work. The volume is divided into 4 parts, each composed of several chapters, with a historical introduction on tuberculous virus.

In the first part, the bacteriology of tuberculosis in its various aspects, including the filtrable forms, the different paratubercle acid-fast bacilli, and the various preparations of tuberculins, is thoroughly discussed. It also treats of the various forms of tuberculous infection and the anatomopathological lesions in children, adults, and in the aged. The different channels of tuberculous infection, and the character and localization of lesions in the serous membranes and different organs of the human body, are also described. A special chapter is dedicated to the blood culture and bacillæmia of tuberculosis, and to such other important topics as heredity and transmission of the disease through the genital tract.

The second part deals with the various problems of experimental tuberculosis in various animals, the character of the anatomic lesions, and the rôle played by bovine tubercle bacilli in human infection. The natural tuberculosis in various other mammifera and birds are also considered.

The third part is dedicated to the various antibodies and defenses of the body, the channels of elimination of tubercle bacilli, and the various biological and laboratory reactions used in the diagnosis of tuberculosis. The physiological action and the mechanism of the tuberculin reactions are also fully discussed.

The fourth part comprises natural immunity and the various methods of immunization including the active, the passive, and other biological methods, especially antigenotherapy and chemotherapy.

The last chapters are dedicated to the prevention of tuberculosis by means of the B. C. G. vaccine. The experiences of the author and his collabcrators in human beings and vaccinated animals are clearly exposed. The cultural methods of B. C. G., the method of the preparation of B. C. G. vaccine, the toxicity, the antigenic properties of the vaccine, the tuberculin preparations of the B. C. G., the histologic picture of the lesions in vaccinated animals, and all the criticisms of the B. C. G. method, are important and interesting topics.

In conclusion, the work of Dr. Calmette as revised and published by his collaborators, A. Boquet and L. Negre, presented in a very well bound volume and profusely illustrated with photographs, the majority of them in natural colors, constitutes a great piece of research that should be appreciated by all biologists, medical men, and veterinarians dedicated to and interested in the important research problems of tuberculosis.—C. M.

The Intimate Side of a Woman's Life. By Leona W. Chalmers. Foreword by Winfield Scott Pugh. Radio City, New York, Pioneer Publications, Inc., c1937. 128 pp., illus. Price, $1.50.

It takes a medical mind and medical experience to see the need for much more wide-spread information on feminine hygiene, and this book will serve that purpose highly. On the other hand, it takes an adequately informed lay woman to write on this subject in a manner easy to follow by the lay reader. Not only gynæcological diseases, but also many psychological and psychoneurotic tendencies, deficient vitality, and even certain internal diseases, are directly or indirectly traceable to improper feminine hygiene.

The contents include general information on the female pelvic organs; a simple physiology together with pathological influences of neighboring organs, and a frank discussion of sex hygiene and of the paramount importance of general body cleanliness and exercise. The text has its weak points, but as a whole it is exceptional in its clarity and frankness.—I. F.

A Note-Book of Tropical Agriculture. Compiled by R. Cecil Wood. Trinidad, B. W. I, The Imperial college of Tropical Agriculture, 1937. 147 pp. Price, 5s 3d.

This little book carries facts and figures concerning tropical agriculture. It was first published in 1933 by the Imperial College of Tropical Agriculture, Trinidad, B. W. I. The book under review is the revised edition.

The author, R. Cecil Wood, Professor of Agriculture in the Imperial College of Tropical Agriculture, has compiled the contents of the book from many authentic sources, with the acknowledged assistance of his colleagues on the staff of the Imperial College of Tropical Agriculture.

The book covers a wide range of helpful aids, to wit: Facts and figures concerning weights and measures, mensuration and surveying, buildings and roads, machinery, labor, soils, manures, crops, foods and feeding, live stock, dairying, formulas for insecticides, fungicides, baits, and statistics. Being of a handy size, it can be carried in the pocket for ready reference in the field. For the convenience of users, blank pages for notes are inserted to alternate with the pages of the text. To teachers and students in agriculture, as well as to farm managers, administrators, farmers, and agricultural extension workers, this book is a valuable guide.—P. L. P.

The Objective Rate Plan for Reducing the Price of Residential Electricity. By William F. Kennedy. New York, Columbia University Press, 1937. 83 pp., tables, charts. Price, $1.25.

The experience of the Commonwealth and Southern Corporation, the originator of the objective rate plan, is thoroughly analyzed in this book, including data of 49 other companies that have applied the plan. It describes the history, application, and results of the objective rate plan. This treatise gives very convincing proof of the possibility of rate reduction without the financial hazard of an outright rate reduction, something to be seriously considered by electric-plant operators. From the point of view of consumers, it shows how they can use more electricity and pay comparatively smaller amounts. Electric-plant operators should read this book.—F. D. M.

Out of the Night; a Biologist's View of the Future. By H. J. Muller. New York, The Vanguard Press, 1935. 127 pp. Price, $3.

Here is a book predicting the future of the human race under the management of progressive eugenics. According to the author, the central theme of the book "lies in the attempt to show that for a continuance of material, cultural and biological progress in the human race, a thorough-going economic and social change to a more truly coöperative basis of society, together with the regeneration in human motivation attendant upon this, is a prior necessity." The author has stressed the "possibility of positive biological improvement of mankind, *provided* the social reconstruction occurs first." Muller envisions the final severance of love and reproduction. Marriage would continue, but birth control would be practiced; children would be produced by artificial insemination of women with the seed of the outstanding men that the race produces. The book gives a fascinating view of biology by a geneticist who is convinced that economic, social, and intellectual changes resulting from scientific progress will effect a real biological up-building of humanity. The book is without an index.—P. S. S.

The Science of Animal Life. By Arthur Ward Lindsey. New York, Harcourt, Brace and Company, 1937. 656 pp., illus., glossary, bibliography, and index. Price, $3.75.

This book is divided into six parts. Part I deals with the "Foundations of Life," discussing biology or the science of life; living matter; metabolism; and the cell or the unit structure of living matter. Part II, "Organization and classification of animals," has such subjects as the classification and organization of animals, Protozoa, the diploblastic phyla, the worms, animals of uncertain relationship, Echinodermata, Mollusca, Arthropoda, and Chordata. Part III, "Maintenance of the individual," is discussed under the following topics: The animals and their physical environments; the interchange of materials or food, oxygen, and wastes; the internal environment; communication and government; growth and repair; and the relations of animals. Part IV, "Maintenance of the species" is concerned with reproduction, development of the individual, and heredity. Part V, "Problems of origin," is confined to the discussion of the origin of living things and the process of evolution. Part VI deals with very interesting dissertations on Man and his origin, man's environment, biological problems of society, and the future. The book ends with the very valuable working glossary, bibliography, and index.

The book is unique among the various existing text books on biology in that "it leans more toward principles than toward forms, yet it undertakes the illustration of all points with abundant facts from the animal kingdom." In this way the text leads the student to a broader point of view, hence the fundamentals he learns are more readily applicable to various examples of the animal kingdom. Thus the book becomes more interesting from chapter to chapter, with the result that the students develop fondness for the book as they use it from day to day.

The book under review should, therefore, receive acceptance among our colleges and universities giving courses in animal biology.—D. V. V.

Snakes and their Ways. By C. H. Curran and Carl Kauffeld. New York, Harper & Brothers, Publishers, 1937. 285 pp., illus. Price, $3.50.

This book certainly gives its readers a better understanding of the snakes, a group of animals long regarded as evil creatures to be feared. The snakes have a definite place in the world, as they play an important rôle in maintaining the "balance of Nature." There are snakes that eat other snakes; snakes that prey upon destructive rodents; snakes that feed upon useful animals such as worms, frogs, and birds; snakes that constrict and devour large animals, such as hogs, deer, and even man; and still there are snakes that feed upon harmful and useful insects.

This book has also shown the need for widespread knowledge of the habits and natural history of the snakes. Familiarity with the poisonous and the nonpoisonous snakes should result in the reduction of the incidence of death from snake bites to the minimum. It has been definitely known that in the Philippines cases of death due to snake bites are to a certain extent caused by fear rather than by the poison itself. As a matter of fact poisonous snakes are relatively rare as compared with the nonpoisonous.

This book present a very comprehensive treatise on the natural history as well as on the mythological and religious aspects of the history of the snakes. Moreover, it is easy and interesting to read, because of its excellent literary and historical account of the animals in question. In this book, therefore, are combined the scientific and general accounts of the snakes, making it easily understood and appreciated by both the technical man and the layman.

Chapter II of this book, which deals with snake poisons and the treatment of snake bite, should prove of interest to physicians, herpetologists, and the general public.—D. V. V.

A Textbook of Bacteriology and Its Applications. By Curtis M. Hilliard. Revised edition. New York, Ginn and Company, c1936. 339 pp., illus. Price, $3.50.

This book presents a general knowledge of some of the fundamental concepts of bacteriology in relation to the daily life of men. Together with its scientific aspects, it offers the reader a review of the history and evaluation of this important branch of science. It interestingly discusses the life and scientific activities of such great men of science as Edward Jenner, Louis Pasteur, Joseph Lister, and Robert Koch, whose investigations are of immense value to students and research workers in the search for a better understanding of bacteriology.

Unlike other textbooks on bacteriology, which cover only the medical aspect of the science, this book includes a treatise on economic biology that is of great significance to industry. The author gives a brief description of various molds, yeasts, and bacteria concerned chiefly in industrial fermentation. The biological activities of these may draw the basis of more advanced work by research workers in various industrial fields. It also includes a study on soil bacteriology and the rôle played by microörganisms in scientific agriculture. Also of great importance, especially to students of home economics, is the practical treatise on the scientific methods of food preservation, a process involving the general principles of antisepsis and disinfection.

To the students of bacteriology this book will serve as a guide in the study of the cultural characteristics of bacteria. In detailed outline form, which is clear and easy to understand, the author presents the general laboratory methods of identifying them. We are also informed of the various factors which influence the existence of bacteria in nature; such as their nutrition and environment. On the basis of the factors favorable to their growth, appropriate methods of suppressing them can be devised, and consequently, the diseases they produce can be controlled.

Through this book the readers can obtain comprehensive knowledge of the proper procedure for conducting biological investigations of the common food materials in relation to the health of men, such as water, and milk and dairy products. This study deals thoroughly with the bacteriological as well as the epidemiological aspect of the problem. Various infectious diseases frequently encountered in everyday life are widely discussed.

The last chapter of this book shows the composition and activities of a well-organized public health laboratory. An institution of this nature is an indispensable factor in the protection of the health and welfare of the people.—P. J. A.

The World and Man as Science Sees Them. Edited by Forest Ray Moulton. Chicago, University of Chicago Press, 1937. 533 pp. Illustrated with many linecut and halftone illustrations. Price, $3.

This is a symposium on the present progress of the physiological and biological sciences. The authors of the various chapters are professors at the University of Chicago. The editor, who is a noted astronomer, opens the book with the chapter on astronomy. The other subjects treated are: Origin and history of the earth, particles and waves, chemical processes, the nature and origin of life, the problems of life and reproduction in the plant kingdom, evolution and behavior of the invertebrates and the vertebrates, physiological processes, microörganisms and their roles in nature, and man. Each chapter surveys the subject in its broad field, giving fundamental knowledge on the science of life and matter. Students of the sciences in colleges and universities, who should have fundamental knowledge of the physical and biological sciences, as well as others who want to have current information on the subjects treated, will profit much by reading this book. This work is especially useful to teachers of general science in high schools. —P. S. S.

Your Stammer and How to Correct It. By H. St. John Rumsey. With a foreword by W. W. Mollison. London, Frederick Muller Ltd., 1937. 88 pp. Price, 3s 6d.

This book is an authoritative discussion of the nature, cause, and methods of correcting stammering. The author is an authority on the subject, having been head of the speech clinic at Guy's Hospital for fifteen years, where thousands of men and women suffering from speech defects have come to his attention. As stated in the preface, the author's aim in writing this book is "to clear the atmosphere by explaining to my readers how respiration, the vocal tone produced in the larynx and the articulatory movements of the tongue, lips and jaws are coördinated into speech in the normal speaker, and how, and why, in the case of the stammerer this co-ordination breaks down." The author has pointed out that the cure of stammering may be accomplished through well-directed instructions and the will of the patient to correct himself. While the reading of this book will be highly profitable to stammerers, it will not do away with the need of a speech therapist to effectively correct their speech defects.—P. S. S.

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[New names and new combinations are printed in **boldface**.]

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